The Impact of the AER's Draft Decision on ActewAGL's Service Reliability and Safety Performance

Supplementary Report

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Prepared for – ActewAGL Distribution – ABN: 76 670 568 688

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Client: ActewAGL Distribution

ABN: 76 670 568 688

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Glossary of Terms

Term	Definition
ActewAGL	ActewAGL Distribution
AER	Australian Energy Regulator
Asset Management Code	The ACT Electricity Network Assets Management Code
Draft Decision	The document published by the AER on 27 November 2013 entitled Draft decision ActewAGL distribution determination 2015–16 to 2018–19
First Report	The report prepared by AECOM entitled *Impact of the AER's draft decision on ActewAGL's service and safety performance* dated 15 January 2015 and attached to the RRP as Attachment B8
NEL	National Electricity Law
NER	National Electricity Rules
RRP	The Revised Regulatory Proposal for the 2014/15 to 2019 regulatory control period submitted by ActewAGL to the AER on 20 January 2015
Supply Standards Code	The ACT Electricity Distribution Supply StandardsCode
Utilities Act	Utilities Act 2000 (ACT)
WHS Act	Work Health and Safety Act 2011 (ACT)

Executive Summary

In November 2014 the AER provided a draft decision on the revenue ActewAGL may recover from its customers in the 2015-2019 regulatory control period. In response, ActewAGL submitted a revised regulatory proposal (RRP) on 20 January 2015. ActewAGL is preparing a further submission and asked AECOM to contribute an assessment of the probable impact of the draft decision on its customers and its ability to maintain its levels of service.

This report supplements AECOM's report on the impact of the AER's draft determination on service and safety performance[1] by expanding on reliability, safety and environmental impact implications.

ActewAGL has a number of statutory performance targets that it is required to achieve, and a range of legislation expresses its obligations in terms of safety and the environment.

This document summarises these obligations, presents various forms of analysis designed to set the scene for a quantitative estimation of the impact that the AER's draft determination would have in terms of these performance targets and legislative obligations, and illustrates these impacts.

The findings of the report have been structured around the increase in safety risks (focusing on bushfires) that could result from implementing large cuts to OPEX, and what are seen to be the key performance drivers for ActewAGL, which include its SAIFI and SAIDI targets.

If the AER's Draft Determination were to stand, the impact in terms of these obligations is likely to include the following, all of which are supported by quantitative analysis in the body of this report:

- An increase in bushfire starts caused by ActewAGL assets, a result of the extended inspection period, from the present average of only 0.8 per year to a worst case scenario of 24.5 starts per year (as a result of asset failures that will now not be picked up in advance).[2] The extra bushfires would increase property damage and loss of life in the community, and estimates have been made of the degree of this increase.
- An increase in response times to outages, increasing average outage duration to the point that ActewAGL will be operating right at its statutory SAIDI limit (ActewAGL is currently among the best performers in Australia on this metric). In this scenario, it will be almost inevitable that ActewAGL will fail to meet the target. Customers will also suffer a decreased level of service because of the longer outages.
- An increase in the number of outages as a result of increasing the periods between inspections, which is estimated to push SAIFI up to at least 2.0 (where the limit is 1.2 outages per customer per year).
- An increasing risk of ActewAGL being unable to meet its SAIFI targets by being unable to renew critical assets when required. Delays in asset renewal will increase REPEX requirements in following regulatory periods (since REPEX can only be delayed, not avoided), and in the interim ActewAGL will be forced into a suboptimal renewal program that may force ActewAGL to fail its SAIFI target.

The most important conclusion to draw from this analysis is that implementation of the reductions in OPEX contained in the Draft Determination (or, by interpolation, other significant OPEX reductions) would prevent ActewAGL from taking reasonable and practicable steps to minimise the safety risks that arise from its operations, and which could result in a breach of is statutory reliability obligations.

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[1] The Impact of the AER's Draft Decision on ActewAGL's Service and Safety Performance, AECOM, 14 Jan 2015.
[2] This number has been derived from the maximum number of power pole condemnations (i.e., identified for remedial action prior to anticipated failure) that would not be made each year arising from extended pole inspection cycles.
Early symptoms of pole failures would not in many cases be identifiable in advance because the period between onset of observable symptoms and failure would be less than the extended inspection period. It has not been possible to quantify accurately the actual number of condemnations that would not be made because some symptoms would present themselves sufficiently early. It is possible to be state with some confidence, however, that the number of "missed" condemnations would be substantial, leading to a correspondingly increased risk of asset failure and resulting safety (especially bushfire) incidents. To offset this "worst case", the number of fire starts has been calculated using data in relation to catastrophic bushfires.
Other serious but not catastrophic fires may result from failed electricity assets, so using catastrophic fire data only is a very conservative approach to calculating the overall serious bushfire risk arising from ActewAGL's inability to adequately inspect and maintain its poles and associated assets if faced with substantially decreased OPEX allowances.

1.0 Statement of Competency

AECOM is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental, energy, water and government. With the recent incorporation of URS within AECOM, this combined company now has approximately 100,000 employees around the world.

AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation and technical excellence in delivering solutions that create, enhance and sustain the world's built, natural, and social environments.

A Fortune 500 company, AECOM serves clients in more than 140 countries and had revenue of $8.2 billion during the 12 months ended September 30, 2013. More information on AECOM and its services can be found at www.aecom.com

AECOM has grown to become a member of the Fortune 500 list and one of the most respected professional service providers in the world. We have brought together the expertise of our legacy companies to create distinct capabilities that offer clients access to integrated services and seamless delivery.

AECOM is the World's No.1 Pure Designer Company according to the 2014 Engineering News Record's (ENR) Top 500 Design Firms Sourcebook Report in April 2014 issue.

Under the same review, AECOM is consistently included in the top firms in each market sector such as:

- No. 1 in Airports
- No. 1 in Transportation
- No. 1 in Mass Transit and Rail
- No. 1 in Highways
- No. 1 in Marine & Ports Facilities
- No. 1 in Solar Power
- No. 1 in Hydro Plants
- No. 1 in Transmission Lines and Aqueducts
- No. 1 in General Building
- No. 1 in Government and Commercial Offices
- No. 1 in Hotels, Motels and Convention Centres
- No. 1 in Healthcare
- No. 1 in Sports
- No. 1 in Multi-Unit Residential
- No. 2 in Power
- No. 2 in Bridges
- No. 2 in Wastewater Treatment Plants
- No. 2 in Sanitary and Storm Sewers
- No. 2 in Wind Power.

With a global presence in over 140 countries, AECOM freely exchanges resources to meet client's individual needs and provides a seamless service to our clients. This allows us to draw upon a massive global network of outstanding industry knowledge and capability.

AECOM's has a significant capability in risk assessment and management that is applied in almost all our design and program management work to ensure that the outcomes required by our clients are achieved. AECOM also has an Advisory practice that applies risk management and business continuity principles to assist our clients with strategic decision-making and investment prioritisation.

In Australia, risk management and reliability advice has been and continues to be provided to a wide range of clients in most industry sectors. We have developed a particular capability in risk management for infrastructure owners and maintainers, and have been instrumental in developing and applying the concepts of the 'state of good repair' as referred to in this document, in the USA and Australasia, to help our clients address the increasing risk of failure associated with aging infrastructure.

2.0 The Purpose of this Document

ActewAGL stated in its revised proposal that, in its view, the AER failed to consider all dimensions of its regulatory mandate equally. In ActewAGL's view, the AER has placed a high value on short-term price outcomes, and has not given due consideration to the other components of the national electricity objective (quality, safety, reliability and security of supply).

This report was commissioned to address the adverse impact on safety and reliability that a substantial reduction in OPEX (and also REPEX) would have on the ACT electricity distribution network and ActewAGL's customers in terms of service reliability, and also on both customers and the public at large in terms of service safety.

A key objective for this document is to quantify, in a sensible and understandable metric, the magnitude of increase in safety, reliability and environmental risks that would directly arise from implementation of the cost reductions contained in the Draft Decision. To do this, AECOM was also requested to:

1) Evidence ActewAGL's position in regard to the safety, reliability and environmental implications of the AER's Draft Decision; and

2) Highlight and quantify the most severe impacts to the safe operation of ActewAGL's electricity distribution network for ActewAGL customers, staff and the general populous arising from the Draft Decision.

This review was not required to address risks that are not directly affected by the Draft Decision.

The data and information used in this report has been provided by ActewAGL, sourced internally by AECOM or drawn from publically available documents. It is not possible to be definitive about future performance; so much of the discussion in this document is cast in terms of risk (to service delivery capability or levels of service).

This document has been prepared for the sole use of ActewAGL and specifically to review the possible impact of the AER's draft decision on ActewAGL's safety and performance risks. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on ActewAGL's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM has relied on information provided by ActewAGL and other third parties, some of which may not have been verified.

3.0 Background

On the 27th of November, 2014 the AER released its Draft Decision. This decision included a drastic reduction in the expenditure that would be allowed on the ACT's electricity distribution network for the period 1 July 2014 to 30 June 2019. This reduction is in the order of 42% for OPEX and 35% for CAPEX.

On the 20th of January 2015, ActewAGL submitted its RRP addressing the Draft Decision on the basis that the AER had determined the expenditure allowances using flawed analysis and unreliable data.

The National Electricity Objective is the core of national electricity regulation. It is set out in section 7 of the NEL:

> *"…to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to-*
>
> *(a) price, quality, safety, reliability and security of supply of electricity; and*
>
> *(b) the reliability, safety and security of the national electricity system."*

Appendix B of ActewAGL's revised proposal includes a report written by AECOM entitled *"The impact of the AER's draft decision on ActewAGL's service and safety performance"* (AECOM's First Report), which investigated this impact upon ActewAGL's service and safety performance in the context of the AER's draft decision. This supplementary document is intended to evidence and quantify where possible the probable impact of the draft decision on the safety, reliability and security of supply of ActewAGL's network, as relevant components of the National Electricity Objective.

The scope of this report includes:

- historical relationships between funding (REPEX and OPEX) and level of service outcomes, focusing on reliability and safety;
- the likely impact of reduced funding levels as determined by the AER on service reliability, safety and environment implications, focusing on the risk of bushfires.

3.1 Legal Context and Service Obligations

The services that ActewAGL provide must comply with the legislative framework in which it operates. This legislative framework comprises numerous national and ACT laws, regulations and codes.

This report illustrates the potential impact of the proposed funding reductions on ActewAGL's ability to operate within the bounds of this framework by focusing on two specific forms of performance measurement, including:

- reliability of supply; and
- safety with respect to the risk of bushfire arising from failure of electrical equipment.

3.1.1 Reliability Obligations

The Supply Standards Code is promulgated under the Utilities Act. It sets out the technical parameters for the distribution network as well as procedures for dealing with customer concerns over interference and some reporting requirements. This code prescribes minimum standards for the quality and reliability of electricity distributed through the network.

In general, the Supply Standards Code requires electricity work to be carried out in accordance with specified Australian Standards, as well as some published industry standards formerly developed by the Electricity Supply Association of Australia, and now administered by the Energy Networks Association through Standards Australia. The Code also requires compliance with good electricity industry practice.

The Supply Standards Code requires ActewAGL to publish, by the end of each year, supply reliability targets for SAIDI, SAIFI and CAIDI measures. Reliability targets must be equal to or better than the standards published in Schedule 2 of the Supply Standards Code, reproduced here in Table 1.

Table 1 Minimum reliability targets under the Supply Standards Code

Parameter	Target	
Outage time (CAIDI)	74.6	minutes
Outage frequency (SAIFI)	1.2[3]	(number)
Outage duration (SAIDI)	91.0	minutes

3.1.2 Safety Obligations

The Utilities Act imposes specific technical, safety and reliability obligations, and the NEL and NER specify factors that must be considered in relation to determinations of expenditure allowances, including safety, reliability and security of supply. In addition, the WHS Act contains detailed safety obligations that apply to ActewAGL and its officers, including the primary duty of care in section 19 that applies to all businesses. This requires a business to ensure, as far as reasonably practicable, the health and safety of workers and others who might be affected by the conduct of the business. It seems to be accepted that unaffordability is not an excuse or defence to a breach of this duty.

It is known that failure of electricity equipment can be a contributor to serious bushfires: The 2009 Victorian Bushfire Royal Commission found that 5 of 10 fires investigated were caused by failure of electricity assets.[4] The scope of the primary duty of care in the WHS Act will therefore extend to reasonably practicable steps that could be taken by responsible parties to mitigate bushfire risk.

The Commission noted that:

> *'Victoria's electricity assets are ageing, and the age of the assets contributed to three of the electricity-caused fires … DNSP capacity to respond to an ageing network is, however, constrained by the electricity industry's economic regulatory regime. The regime favours the status quo and makes it difficult to bring about substantial reform. As components of the distribution network age and approach the end of their engineering life, there will probably be an increase in the number of fires resulting from asset failures unless urgent preventive steps are taken.*
>
> *The Commission considers that now is the time to start replacing the ageing electricity infrastructure and to make major changes to its operation and management. The seriousness of the risk and the need to protect human life are imperatives Victorians cannot ignore. The number of fire starts involving electricity assets remains unacceptably high—at more than 200 a year.'*

The Commission's recommendations 27 through 34 address electricity-caused fires, and include the following:

- Introduce measures to reduce the risks posed by hazard trees—that is, trees that are outside the clearance zone but that could come into contact with an electric power line having regard to foreseeable local conditions.
- Fit spreaders to any lines with a history of clashing or the potential to do so
- Progressively replace all 22-kilovolt distribution feeders with aerial bundled cable, underground cabling or other technology that delivers greatly reduced bushfire risk as the feeders reach the end of their engineering lives. Priority should be given to distribution feeders in the areas of highest bushfire risk.
- Change asset inspection standards and procedures to require that lines in areas of high bushfire risk are inspected at least every three years.

3.1.3 Environmental Obligations

ActewAGL is required to comply with all relevant environmental legislation, including at least 45 environmentally related Acts. Environmental legal obligations affect all levels of operation, from long-term network planning decisions, through to line construction and maintenance.

[3] This is a measure of the number of outages per customer per year.
[4] Final Report, 2009 Victorian Bushfires Royal Commission, July 2010.

The consequences of non-compliance include large fines, conviction of corporate officers and remedial orders or injunctions. As for all DNSPs, ActewAGL’s officers, employees, managers, directors and contractors must:

- conduct proper environmental impact assessments and obtain the requisite planning approvals and pollution licences
- avoid harm to the environment in the course of conducting business and
- report any incidents immediately in accordance with the POEO Act.

The Environment Protection Act 1997 includes a general environmental duty as follows:

(1) “A person must take the steps that are practicable and reasonable to prevent or minimise environmental harm or environmental nuisance caused, or likely to be caused, by an activity conducted by that person.

(2) In deciding whether a person has complied with the general environmental duty, regard must first be had, and greater weight must be given, to the risk of the environmental harm or environmental nuisance involved in conducting the activity, and, in addition, regard must then be had to-

a. The nature and sensitivity of the receiving environment; and

b. The current state of technical knowledge for the activity; and

c. The financial implications of taking the steps mentioned in subsection (1); and

d. The likelihood and degree of success in preventing or minimising the environmental harm or environmental nuisance of each of the steps that might be taken; and

e. Other circumstances relevant to the conduct of the activity.”

If a utility’s assets are determined to be a primary cause of a bushfire, penalties may be awarded up to $1,100,000.

4.0 Method

This report has investigated and quantified the impacts of the AER’s Draft Decision on reliability, safety and environmental performance by utilising actual ActewAGL performance data to make robust projections for future performance under the AER’s draft operating parameters.

It utilises internal and external data on asset performance and resourcing levels, along with appropriate methods of extrapolation and scenario analysis in order to draw conclusions about the impact of a major reduction in resources on ActewAGL’s performance in these key performance areas.

It then quantifies the risks associated with the change in these key performance criteria.

An outline of the methodology utilised is presented as Figure 1.

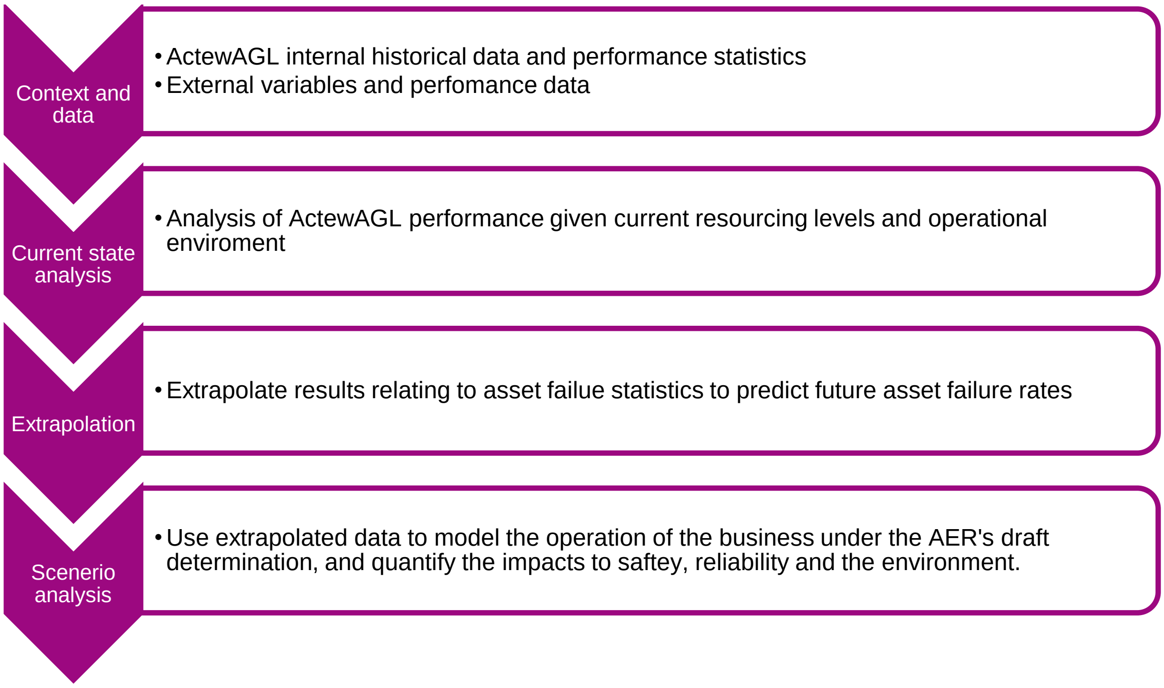

Figure 1 Summary of the methodology used

5.0 Current State Analysis

This section sets out ActewAGL's recent performance in achieving the required service levels. This analysis is then used to project the likely impact of a change in those service levels arising from the severely constrained expenditure allowances that would apply if the Draft Decision is made final.

A large reduction in expenditure allowances will affect almost all areas of the ActewAGL business. Notwithstanding, this report will focus upon analysing ActewAGL's poles and pole-top hardware to illustrate the implications for safety, reliability and the environment.

Data on condemnation and failure of poles or pole-top hardware is readily available, and the number of incidents and the size of the asset population is sufficiently large for valid conclusions to be drawn. These events:

- Interrupt supply, decreasing reliability, quality and security of supply, while increasing safety risk;
- Are identified as causes of fires, and the resulting risk to property and life can be assessed;
- Can also create or increase other safety risks to customers, the public and staff.

This analysis therefore starts with a summary of historical asset failure and ActewAGL's performance in this respect. Section 6 of this report then assesses the likely impact of reduced funding in this area on the rate of failures, to draw conclusions about the impact on ActewAGL's performance with respect to reliability, fire risk and safety as a result of implementation of the AER's Draft Decision.

5.1 Service Reliability

ActewAGL records all outages and tracks customer hours lost. This data can be interrogated to determine the impact on reliability, and on bushfire and other safety risks, of equipment failure.

The impact of past failures of overhead assets on level of service (reliability, using customer hours lost) is shown in Figure 2. The number of incidents is shown as a blue line, with a dotted blue line added to indicate the trend. The solid brown line shows customer hours[5] lost per year (with the trend in the dotted brown line) and the orange shaded area indicates total customer hours lost over the period depicted.

[5] A customer hour is the duration of the outage (in hours) times the number of customers affected. For example, one outage of only 10 minutes could cause a large loss of customer hours if the number of affected customers is large

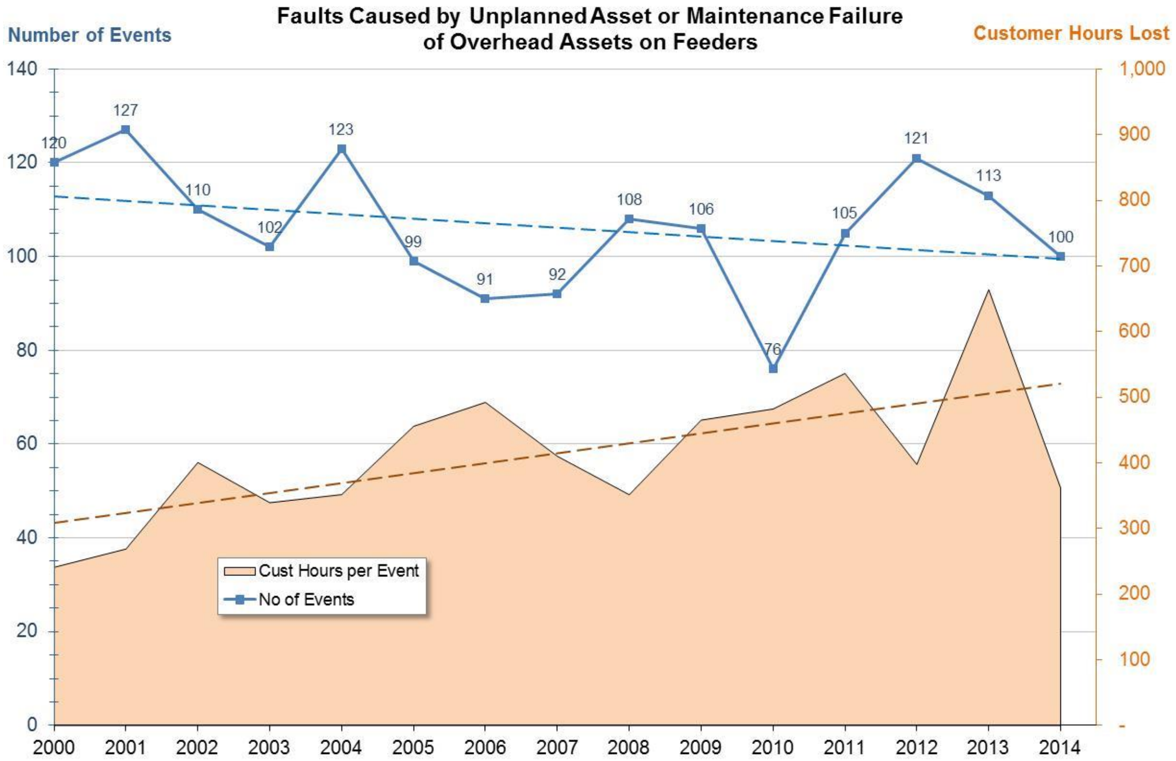

Figure 2 Impact of unplanned asset or maintenance failure of overhead assets in terms of reliability (customer hours lost)

The impact of failures in terms of customer hours lost has been increasing despite a gradual reduction in the number of incidents – this is a natural result of increasing population, and is to be expected. During the period between 2001 and 2014, ActewAGL had an average of 106 failures involving overhead assets each year, and an average loss of 409 customer hours per event. Average outage duration has stayed relatively constant over the period (not shown).

The impact of increasing rates of failure on network reliability is addressed in Section 6.0.

5.2 Pole and Overhead Asset Failure Rate

ActewAGL condemns poles where defects identified are considered likely to cause a failure before the next scheduled inspection. Following condemnation, the pole may be reinforced or replaced, governed by policies designed to minimise costs while preserving required levels of service.[6]

ActewAGL assesses a pole as condemned by reference to objective criteria contained within procedures that were developed in 2003 and modified in 2007, when ActewAGL introduced its current planned pole inspection regime. Large numbers of poles were initially condemned as the entire pole population was inspected. As would be expected, the number of condemnations stabilised (after about 5 years). The number of poles condemned annually has reduced from around 200 poles in 2007 to only 13 in 2013, which reflects the substantial improvement to the overall health of the pole population resulting from the inspection and condemnation regime introduced after 2003. There has been a similar fall in asset failures, from around 9 per annum in 2005 to less than 1 per annum currently. If the current inspection regime is able to continue, ActewAGL now forecasts no pole failures due to factors within its reasonable control.[7]

The result of ActewAGL's current pole management program is shown in Figure 3, where the blue bar indicates poles condemned and the darker line shows actual failures (using the right axis).

This outcome all but removes asset failure as a potential cause of bushfire, and improves system reliability. The cost of this program is addressed in Section 6, as is the impact of reduced expenditure allowances.

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[6] Pole & Overhead Inspection Strategy Review, v1.4, November 2014. ActewAGL.
[7] Failures can occur from random and other causes outside ActewAGL's control, such as vehicle collisions and lightning strikes.

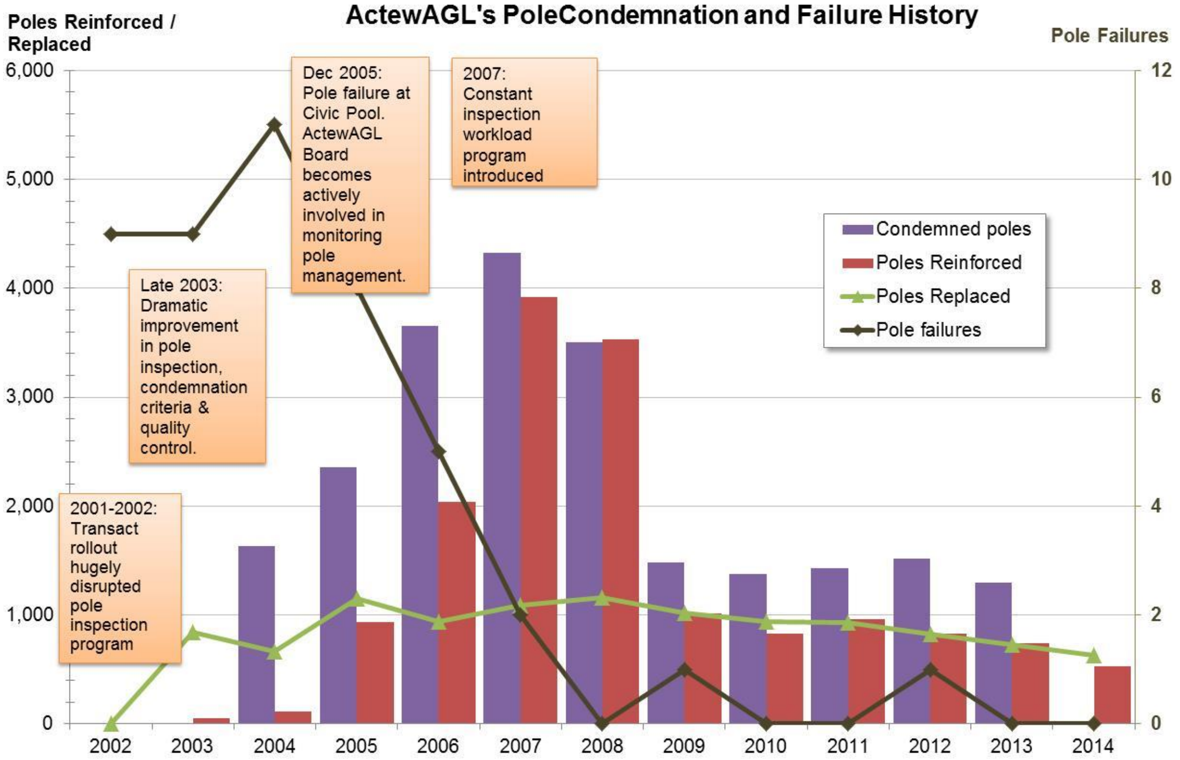

Figure 3 ActewAGL's past pole interventions

In the first few years, relatively large numbers of poles were condemned as the entire pole population was inspected. The annual number of condemnations has reduced from around 4,325 in 2007 to 1,293 in 2013. There has been a similar fall in the rate of (undetected) pole failures from 9 per annum in 2003 to an average of less than 1 per annum since 2008. If the current inspection regime is able to continue, ActewAGL now forecasts no pole failures due to factors within its reasonable control.

This outcome effectively removes asset failure as a potential cause of bushfire, and improves system reliability. The cost of this program is addressed in Section 6, as is the impact of reduced expenditure allowances.

The expected service life of timber poles is considered to be 45 years, and the average age was 46 years as at May 2014.[8] It should be noted, however, that the mean life at condemnation for Tanalith and Creosote (treated wooden) poles has been 26.8 and 38.4 years respectively, with a standard deviation of 5.9 and 9.3 respectively (refer to Appendix A for an analysis of the condemned and current pole population).

Table 2 Current pole analysis statistics

Pole type	Total population	Mean service life at condemnation (years)	Standard deviation (years)
Tanalith	7,676	26.8	5.9
Creosote	5,203	38.4	9.3

This data helps in the projection future condemnation and failure rates, and is applied in Section 6.

[8] Asset Specific Plan, Poles. May 2014, ActewAGL

5.3 Safety and Environment

Failure of pole-top hardware can cause conductors to sag or drop to the ground, with some of these incidents having been determined to be the cause of fires.[9] Fires in urban areas are limited in impact because of the relative lack of flammable material involved and the relative ease in detecting and controlling fires before they develop, whereas similar incidents in rural areas prone to bushfire can result in significant damage to property and life.

The rate of fires incidents in rural areas in the ACT has been in slow decline in recent years, partly due to weather conditions, but also because ActewAGL has been proactive in identifying and dealing with potential failures that could otherwise have ignited a fire through its inspection and replacement programs. ActewAGL continually reviews its inspection programs to identify more effective or less costly approaches, and currently relies more on aerial inspection for those reasons.

The trend in the number of fire incidents caused by ActewAGL equipment is presented in Figure 3.[10]

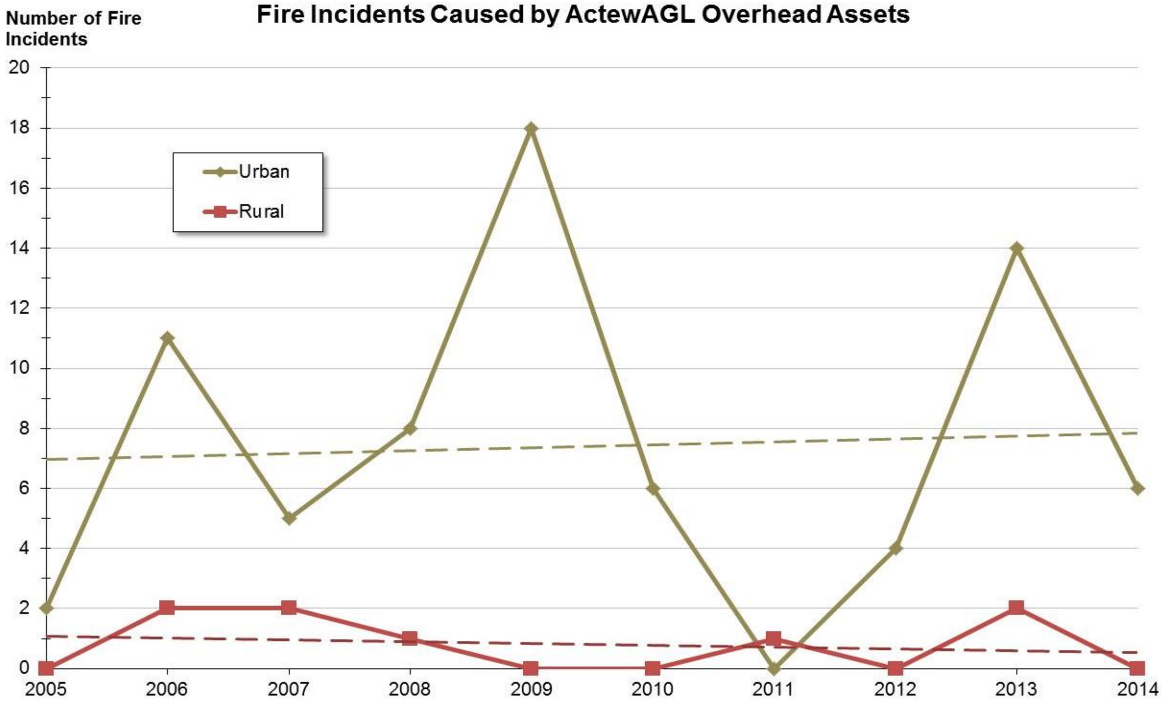

Figure 4 Fire incidents caused by ActewAGL assets

Fires caused by asset failure in urban areas have more varied causes, and the rate of these has increased from around 7 to around 8 incidents per annum over the same period. These tend to be very localised, however, and do not result in significant damage.

Bushfires caused by failure of assets in rural and bushfire prone locations, however, are the most significant environmental issue faced by ActewAGL, since they can and do cause extensive and widespread damage to life, property, and heritage and environmental values.

Rural fires may be caused by vegetation coming into contact or close enough proximity to cause arcing with live conductors, sagging conductors or collapsed poles or pole-top hardware, and other forms of equipment failure. The majority of these can be avoided with an effective risk management regime, including a regular inspection program.

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[9] Final Report, 2009 Victorian Bushfires Royal Commission, July 2010.

[10] Pole and Overhead Inspection Strategy Review, v1.4, ActewAGL. 6/11/14

An outcome of the improved asset management (inspection and condemnation) program that has been adopted by ActewAGL has been a reduction of pole failures to less than 1 per annum (Figure 3). This has resulted in a falling trend in fires caused by assets in bushfire areas from about 1.1 per annum in 2005 to about 0.7 per annum in 2014, a decrease of about 36% (as shown by the dotted line in Figure 4).

ActewAGL maintains all incident and near miss data pertaining to the activities of the business in a records management IT system called Guardian. An analysis of all near miss and incident data associated with failure of ActewAGL's pole and pole top assets contained within this system for the period from 2002 to 2014 revealed that of the 3,233 incidents captured during this period, only 35 related to failure of these assets.[11] This is equivalent to a mean incident rate of only 3 incidents per year across ActewAGL's entire network.

[11] This analysis assumes that all incident and near miss data is captured within the Guardian system

6.0 The Impact of Expenditure Reductions

This section reviews the impact of expenditure constraints on the risk of failure of ActewAGL assets, where failure would cause a supply interruption and therefore affect service reliability for the customers involved and safety risks for both customers and the public at large.

6.1 Impact on SAIDI

Outage duration is very important to a DNSP due to its minimum SAIDI obligations, which provide a strong incentive to be efficient in avoiding or recovering from outages (refer to Table 1).

The historical rate of outages caused by overhead assets was presented in Figure 2, together with the impact in terms of customer hours lost. ActewAGL's data indicates that a typical outage caused by overhead assets lasts about 53 minutes and results in the loss of about 414 customer hours. ActewAGL is currently experiencing an average of about 106 outages each year from overhead asset-related causes, totalling about 43,470 customer hours lost each year. This data is reported by ActewAGL via the CAIDI / SAIDI / SAIFI performance indicators.

Unplanned failures are considerably more costly for any asset owner when compared to planned maintenance:

- Planned maintenance will often involve ensuring ongoing to supply of essential services by switching in other circuits while the planned works are taking place. If alternative supply feeders are not available, ActewAGL is able to schedule the planned works to minimise the impact in terms of customer hours.
- An unplanned failure, in contrast, does not enable this planning ahead, will take longer to resolve than a planned outage (where the equipment and staff needed are waiting to proceed with the planned intervention, have their equipment and parts with them, and have planned the activities required during the intervention to that the work runs smoothly).
- A planned outage last only the length of time it takes to carry out the required works, whereas an unplanned outage will also include additional time delays incurred in notifying ActewAGL's response teams and relocating them to site together with any equipment of parts needed.

A run-to-fail strategy may appear to be a lower cost option by delaying asset renewal until the last moment, but comes at a cost in terms of level of service (the longer outage time faced by customers, referred to as a risk cost).

The effect of expenditure constraints will include:

- An increase in unplanned outages, where the customers affected cannot be made aware of the outage in advance and therefore results in a higher cost of risk (from their point of view), and impacts adversely on SAIFI targets;
- An extended outage period (compared to the minimum that would be required for a planned outage), increasing the overall customer hours lost for ActewAGL and therefore affecting SAIDI;
- An inability to respond to faults in a timely manner, where 150 less operational staff (resulting from an OPEX reduction by 42% as recommended by the AER) are already occupied on other work when the unplanned outage occurs, thereby increasing the length of the outage even further, making SAIDI performance even worse;
- Severely constrained resource availability during holiday periods, when some staff will be on leave, also likely to affect SAIDI.

  The impact of a significant reduction of staffing was illustrated in Section 5.2 of AECOM's First Report, using as an example actual performance data from a holiday period. The 31% reduced staffing at that time resulted in an 85% increase in fault response times, adding an average of 38 extra minutes to outage duration (the required SAIDI target is 91 mins for total outage duration).

  The impact of the reduction also included cancellation of 33% of the planned outages scheduled for that day).

ActewAGL's outage records indicate that outage durations average 53 minutes (Table 3), and average response times are 15 minutes. The impact of the OPEX reductions in the draft determination would be to increase response times by at least 38 minutes (as noted above), which means that the duration of the average outage could increase to 91 minutes (which is the SAIDI target). This gives ActewAGL no room to move, and will inevitably mean that the SAIDI target will be breached.

Table 3 Outage Durations

	No of Events	Consumers Affected (historical average)	Average Response Times (mins)	Outage Duration (historical average)	Customer Hours Lost
Total (Average)	**593**	**610**	**15**	**53**	**245,309**

In summary, a significant reduction in OPEX will increase response times, therefore potentially forcing ActewAGL to breach its SAIDI performance targets.

6.2 Impact on SAIFI

There are various risks to SAIFI performance, and the more significant of these are reviewed in this section.

6.2.1 Overhead Asset Inspections

Pole condition inspections are intended to identify defects before failure, so that a planned maintenance intervention can be scheduled (keeping service interruptions to a minimum) prior to failure. ActewAGL continues to explore options that will provide a more effective inspection outcome, including use of aerial inspections where appropriate. The current strategy involves rural poles being inspected at 4 yearly intervals (already longer than the Victorian Bushfire Royal Commission's recommendation for high voltage feeders), and urban poles at 5 year intervals.

A reduction in overall allowed expenditure levels by 42% would force ActewAGL to reduce expenditure on inspections, but current planning provided by ActewAGL indicates that expenditure on inspections would be reduced by only an estimated 25% because of the importance and relative priority of this activity.

The reduction in expenditures would force an increase the period of the inspection cycles (refer to Figure 5).

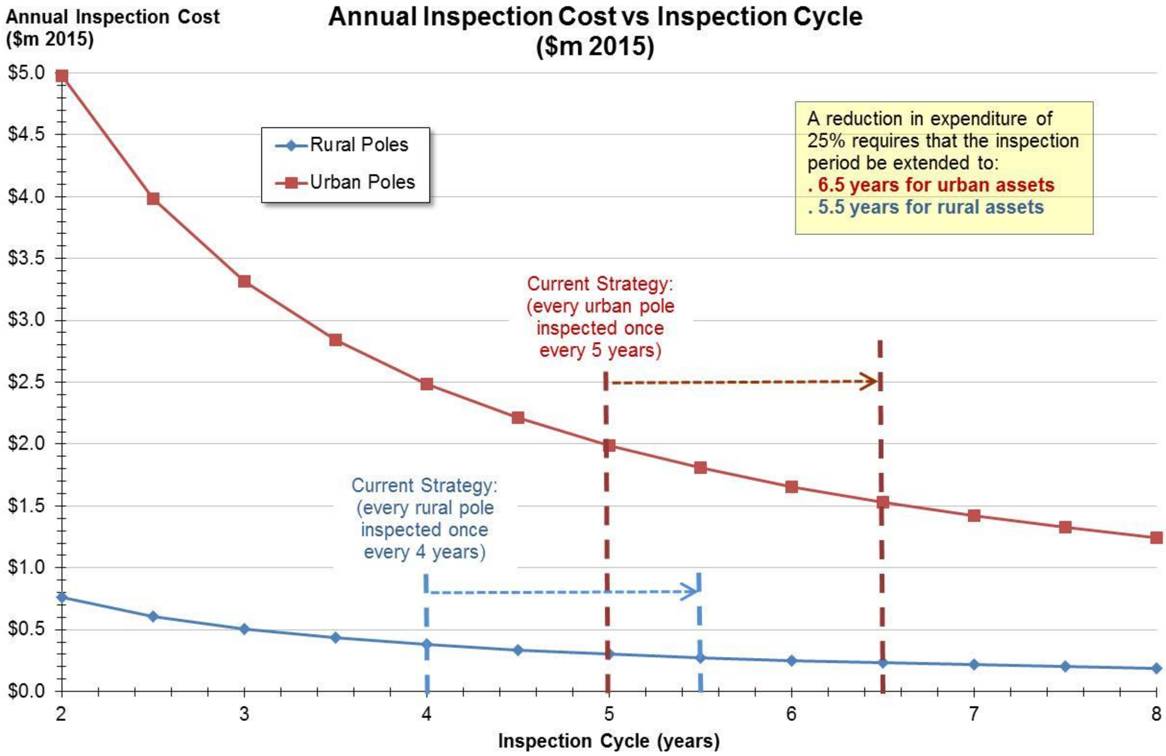


Figure 5 Impact of expenditure reductions on inspection cycles

The outcome of this expenditure reduction would be that:

- rural assets and vegetation could only be inspected at 5.5 year intervals instead of 4, as is ActewAGL's current practice; and
- urban assets at 6.5 instead of 5 yearly intervals.

The inspection regime implied by this reduction in expenditure levels would clearly not comply with the Royal Commission's recommendations for high voltage overhead lines in bushfire prone areas.

ActewAGL's experience indicates that the interval is too long to ensure that all potential failures can be detected in advance, since the deterioration process from the time warning symptoms become observable to failure would normally take less than 5.5 years. An increase in the inspection cycle such as this would inevitably result in an increasing risk and rate of failures, impacting on service reliability and the risk of bush fires. This is discussed further in Section 6.3.

The impact of the current inspection regime was a reduction in condemned pole numbers by a factor of around 10 over a five year period (from an average of around 200 per annum in 2007/08 to an average of around 20 per annum in 2012/13).

Condemnation is an assessment by an experienced inspector, guided by objective criteria, of the likelihood of asset failure before the next inspection. Condemnations are therefore an indicator of future failures, and rates of condemnation can be used as a proxy for rates of failures which cannot be measured directly because the condemnation has avoided a failure (refer to Figure 3).

6.2.2 Outage Frequency

If serious constraints on expenditure allowances result in a lower rate of asset inspections than currently being carried out by ActewAGL, this would cause an increase in the periods between inspections, as depicted in Figure 4 above. A result of this would be an increasing rate of asset failures, as explained in Section 6.1.1 above.

A lower rate of inspections than the current regime, required to meet expenditure constraints, would be expected to result in an increasing rate of pole condemnations and eventually asset failure, as noted above.

It should also be noted that the age profile of the pole population is such that a large cohort with the same age is now at higher risk of failing, and many of these are likely to fail at around the same time. Figure 14 in Appendix A shows about 1,200 Tanalith poles with a current age of 31 years, just outside the standard deviation for that pole type. There is a significant risk that a large proportion of this cohort will have to be replaced or reinforced over a relatively short period of time, an ActewAGL will have to have funding in place to do this work.

This principle and approach can be applied to ActewAGL's pole population, building on the analysis presented in Section 5 and Appendix A.

6.2.3 The Impact on SAIFI

The rate of condemnation of Tanalith and Creosote poles was 2% of the population in 2014, and the rate is increasing (because the mean age is increasing each year) as indicated in Figure 14. From this, and the data provided by ActewAGL, it is possible to project the likely number of pole condemnations for the forward period. This is summarised in Table 4, with detailed calculation provided in Appendix A.

Table 4 Pole condemnation statistics for 2011

Pole type	Pole population	Current condemnation rate	Average poles condemned per year	Condemnation rate increase per year	Predicted poles condemned in 2019
Tanalith	7191	1.7%	140	0.06%	163
Creosote	6097	2.8%	226	0.32%	324

- There are 7,191 Tanalith poles showing in the dataset as currently in use, and 962 have been condemned to date. Given the age of the remaining population, the risk of condemnation is increasing – there are now nearly 4,000 Tanalith poles older than 30 years with a risk of condemnation exceeding 85% (based on data available to ActewAGL, refer Figure 14).
- There are 6,097 Creosote poles showing in the dataset, and 1378 have been condemned to date. There are now nearly 5,000 Creosote poles older than 40 years with a risk of condemnation exceeding 68% (refer Figure 14).

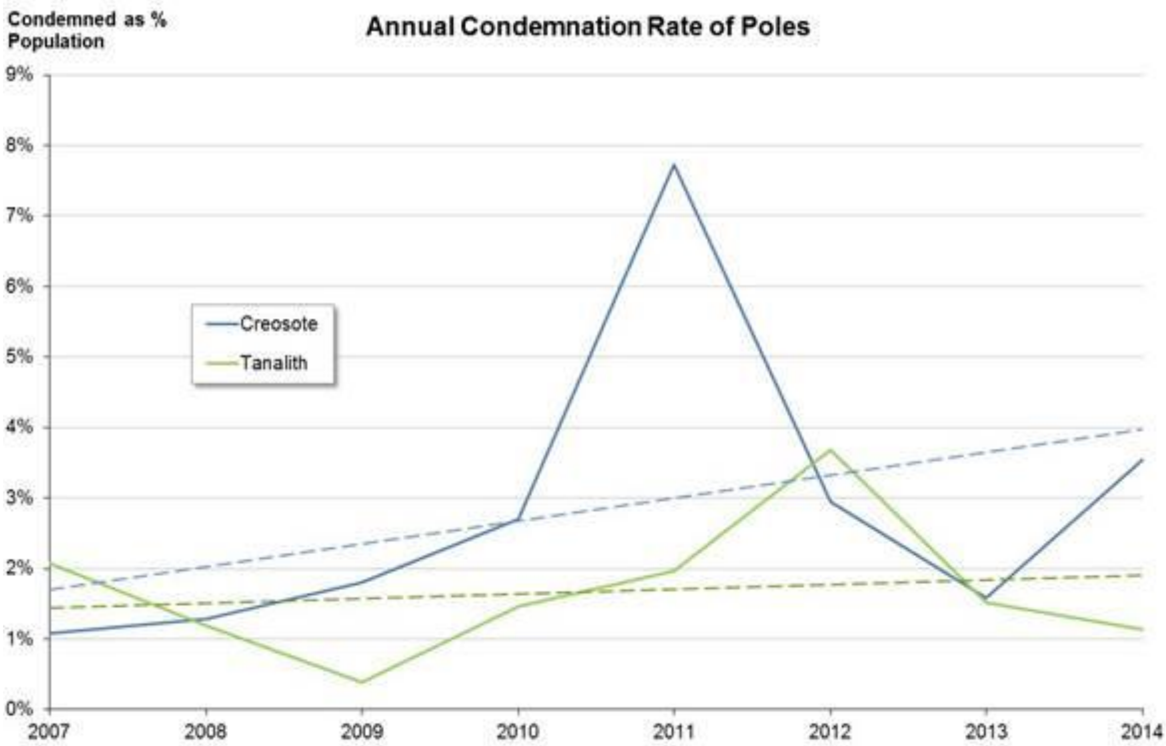


Figure 6: Annual condemnation rate of poles

Figure 5 indicates the increase in inspection periods likely to be required to meet the expenditure reduction required (1.5 extra years for both rural and urban poles). If the new regime is implemented from the beginning of the 2016 year, the increased risk would occur in 2019 (the fourth year of the new inspection regime).

Since the warning signs tend to be detectable up to about 3 years in advance of a failure, the increase in the period between inspections means that, in 2019, 487 condemnations would not have been made. ActewAGL's inspection team suggests that approximately one third of these missed condemnations would result in pole or pole-top hardware failures (the remainder would be picked up in time by the next inspection cycle).

In the worst case, there could therefore be a step increase in failures of about 162 in 2019. This would compound and increase in subsequent years. The actual position should not be as bad as this, for several reasons including:

- It will be possible to predict in advance some failures that would occur in the final 18 months of the 5.5 year inspection cycle, for example by using more conservative condemnation criteria.
- it is likely that some of these imminent failures will be identified during normal business activities In between inspection

However, all actual failures should be expected to result in an outage.

Data provided by ActewAGL shows that there has been an average of 106 outages on feeders, with an average duration of 53 minutes resulting in a total loss of 43,470 customer hours of service (Table 5). As demonstrated above, the increased inspection cycle is expected to result in an additional 162 outage events on feeders, therefore increasing total customer hours lost to 110,873.

Table 5 Past and predicted unplanned outages on feeders (pole-top failures and pole failures)

Annual Outages caused by Asset failure on Feeders	No of Events	Consumers Affected (historical average)	Outage Duration (historical average)	Customer Hours Lost
Average (from past 15 years)	106	613	53	43,433
New Events expected (2019)	162	613	53	67,440
Total (Average)	**268**	**613**	**53**	**110,873**

This increase will affect ActewAGL's SAIFI performance in 2019. ActewAGL's SAIFI performance in 2012 was about 0.8, a good outcome compared to the maximum allowed of 1.2 outages per customer per year.

The average duration and customer hours lost is likely to reduce ActewAGL's SAIFI performance in 2019 to 2.0 as a result of the expenditure reduction imposed by the AER, well outside the maximum allowed.

6.2.4 The Impact of REPEX Reductions

ActewAGL uses specialist software to determine the optimal timing for asset renewal. This section summarises the principles involved to demonstrate the impact of reducing REPEX expenditure on ActewAGL's ability to meet its SAIDI targets.

We note that the AER has allowed ActewAGL's capital plans for poles in its draft determination. This analysis has been based primarily on poles and pole-top hardware, so to avoid introducing making this report more complex and perhaps less easy to follow, we have chosen to continue using these assets to demonstrate the link between REPEX funding levels and mean risk. The principles applied in this section are relevant for all classes of asset.

The key principle is that, to meet the objectives of ISO55001, renewal of each asset, if critical to supply, should be scheduled to occur at a specified maximum acceptable risk of failure. Assets that are not critical (their failure does not affect service levels) can be allowed to run to fail.

This can be demonstrated using the changing risk of failure typical of each asset over its life, the age of the asset at all years in the planning period, and the replacement value. Aggregated this data for all assets in service allows a mean weighted risk profile for the class of assets or the organisation to be determined, and derives the funding needed to achieve the risk levels considered to be acceptable by the asset owners.

An example of this is presented in Figure 7. The assets analysed are ActewAGL's population of Tanalith and Creosote poles (as in Figure 11), and uses the risk profile derived from actual condemnations (Figure 13).

ActewAGL estimates that replacement of a wooden pole costs approximately $12,300 in 2015 dollars. This enables the cost of renewal of these assets at their scheduled renewal point to aggregated, and a total budget requirement derived for the planning period that satisfies a specified risk tolerance. The reverse approach can also be taken, to derive the mean risk profile implied by a specific budget envelope.

In Figure 7, risk is shown on the vertical axis, using a logarithmic scale. The SAIFI target is overlaid on the chart for convenience (the target of 1.2 failures per customer is approximately equivalent to a 1 in 300 risk of failure). The x axis includes two regulatory periods. Any period in which a risk line lies above the SAIFI target represents a period where the mean risk fails to meet SAIFI.

It should be noted that although ActewAGL has never failed to meet its SAIFI target, its asset management systems record the current mean age of its wooden poles as 46 years, where the assumed service life is only 45 – more than half of the poles are currently older than their expected service life (notwithstanding the mean age at which they have been condemned, as noted in Appendix A). The chart implies that ActewAGL is already operating its pole fleet at a higher level of risk than its SAIFI target implies. Since ActewAGL is still meeting its targets, this should be read as a high and increasing risk posed by assets at the end of their service lives, most of which have not actually failed yet.

Four scenarios have been plotted:

1) A ‘do nothing’ option, in which no renewal action is taken (the solid line in the chart). In this case, the poles continue to age into the future and risk continues to increase. It would be expected that the number of failures experienced would also increase with time.
2) The ActewAGL proposal, which is a budgeted expenditure of $9.26 million per annum on poles, using the blue line.
3) The expenditure reduction proposed generally by the AER in its draft determination (shown as though it applied to this class of asset, although in practice this budget has been accepted), using the red line.
4) One option that satisfies SAIDI as soon as possible, using the brown line.

The mean annual budget that enables each risk curve is shown using the same colours in boxes on the bottom left of the chart.

Asset renewal is not a cost that can be avoided. Renewal can be delayed for funding or operational reasons, which introduces a cost of risk for the asset owner and its customers (loss of supply) and also an increasing OPEX cost to cover increased inspections that may be required to ensure safety and increasing maintenance costs. A reduction in budget will therefore delay renewal of a proportion of the assets, and on this chart will contribute to an increased risk of failure.

In summary, a near term expenditure limit imposed on a renewal program may reduce expenditures in the short term, but will force a corresponding increase later in the life of the asset – the unfunded cost is only delayed.

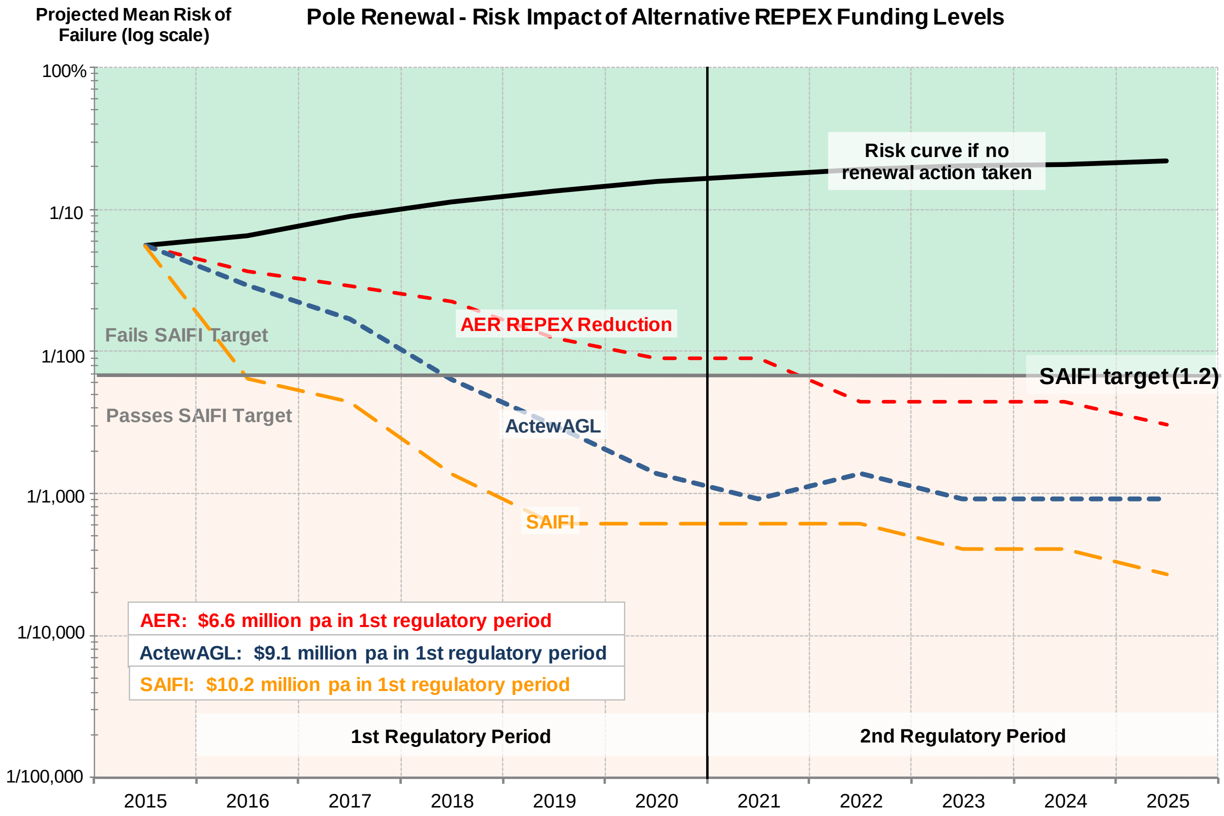


Figure 7: Impact of REPEX expenditure levels on the mean risk of pole failure

The chart indicates that the AER's overall REPEX reduction of 25% would extend the period during which ActewAGL is at significant risk of failing to meet its SAIFI targets (to the end of 2021, in this example, if the reduction were to be applied to this class of assets).

In contrast, ActewAGL's proposal would have improved the mean risk level to meet SAIFI during the 2018 year (three years earlier).

Finally, an expenditure allowance of $10.2 million per annum would enable ActewAGL to meet its SAIFI target in one year, and retain a buffer above the target thereafter.

There are many ways to program this renewal requirement, and slightly different risk outcomes may be achievable in each case, but in general it can be assumed (and demonstrated) that there is a trade-off between expenditure allowances and risk. ActewAGL has a SAIFI target that it is required to meet, and if the funding allowed is not sufficient to cover the renewal program needed to achieve that target, then its customers will eventually suffer from deteriorating levels of service.

The proposed reduction in OPEX would affect ActewAGL's ability to meet its SAIDI targets as well (Section 6.1), compounding the risk of failure to meet its mandatory targets.

This summary uses poles to illustrate the impact of delayed renewal on risk for convenience, but applies to all assets. It refers to future risk, which may not be an accurate projection of future performance.

6.3 Impact on Safety and the Environment

There are many safety issues considered in the planning of ActewAGL's asset inspection and replacement programs. These would be affected by the significant expenditure cuts proposed by the AER:

- Failure of pole-top hardware and cross-arms is the most common form of failure on the overhead distribution system, causing overhead conductors to sag excessively or fall to the ground. The risk to public and worker safety can be significant in such an event.
- Replacement of deteriorating cross-arms and pole-top hardware, and installation of vibration dampers, armour rods, and preformed distribution ties on rural high voltage overhead lines located in high bushfire risk areas is required to minimise the role that these assets can play in starting bushfires which are a significant threat to life and property.

As noted in Section 3, the 2009 Victorian Bushfire Royal Commission found that 5 of 10 fires investigated were caused by failure of electricity assets, and ActewAGL has some of the kinds of assets involved currently in service. Further, Section 5.3 includes historical data on the incidence of bushfires caused by failed electrical equipment on ActewAGL's network.

The NSW Rural Fire Service (RFS) has introduced the concept of a Catastrophic (Code Red) fire danger rating. According to their RFS website[1]:

> *"The Bush Fire Danger Ratings give you an indication of the possible consequences of a fire, if one was to start.*
>
> *Bush Fire Danger Ratings are based on predicted conditions such as temperature, humidity, wind and the dryness of the landscape. The higher the fire danger rating, the more dangerous the conditions."*

As summarised within R2A's report conducting a risk assessment on system failure within Ausgrid's network[2]:

> *"Substantial work has been done to determine the probability of starting fires from network faults on Catastrophic (code red) days. The work of the Powerline Bushfire Taskforce confirmed that 22kV electric arcs can almost instantly start fires. Further work reveals that under Ash Wednesday conditions (Catastrophic), a fallen conductor will most likely start a fire"*

13% of ActewAGL's Creosote and Tanalith pole population are classified as rural. This means that they reside within an area that is classified as having a high risk of bushfire due to the dense native flora that surround these assets, and also the remoteness of these areas can mean that it takes additional time to respond to unplanned outages due to asset failures.

Figure 4 shows the incidence of bushfires caused by failure of ActewAGL;s electricity assets over the period 2005 to 2014. This shows that during this time the average number of fires started per year was 7 for urban, and 0.8 for rural. ActewAGL has had two pole asset failures in the past 8 years, but analysis in Section 6.2.3 shows that in the worst case this may increase to 162 failures per year by 2019 (in the worst case, but as explained in Section 6.2.3, the actual failures would be expected to be less[12]) under the AER's Draft Determination. This means that pole failure rates that may start a fire may increase in the worst case by a factor of 640, although it follows that the actual failure rates would be expected to be less.

Even if constant levels of effectiveness are assumed for other control measures such as vegetation management, the findings of the Power line Bushfire Taskforce as outlined in the R2A report suggest almost every pole failure within bushfire prone areas on catastrophic days will result in a corresponding rural bushfire. This conclusion implies an increase in the number of annual bushfire starts, in the worst case, to 83 [3] as summarised in Table 6.

[1] Rural Fire Service website http://www.rfs.nsw.gov.au/fire-information/fdr-and-tobans/?a=1421, accessed 11 Feb 2015
[2] "AusGrid asset/system failure safety risk assessment", R2A, 2015
[12] It is not possible, on available data, to quantify the extent to which the failure would be less. However, for the reason that symptoms often will not have emerged 5.5 years in advance, it will not be possible to identify many potential failures that would occur in the later stages of the inspection cycle, and a significant increase in actual failures will result.
[3] Calculation based upon 23 pole failures of which 13% are in high risk areas and two catastrophic FDR days a year. 640 x 0.13% = 83

Table 6 Predicted increase in bushfire starts caused by asset failure

Pole risk profile	Average historical bushfire starts	Percentage of condemned pole population	Predicted increased in “catastrophic fire day” fire start rate
High Risk (Rural)	0.8/year	13%	83

If this analysis is extrapolated to other fire danger days on which conditions are conducive to a major fires (including other total fire ban days), the number of bushfire starts would be expected to be even greater. Again, this increase cannot be quantified on data currently available. Furthermore, the effect of the projected temperature increase in the ACT caused by climate change could more than double fire frequency, and increase average fire intensity by 20%.[4] Awareness of this increased risk leads to an obligation to take reasonably practicable measures to mitigate the risk, for example, by implementing a reasonable asset inspection and replacement program.

Appendix B shows the incidence of bushfires within geographical New South Wales for the previous 76 years, including location, and consequence expressed as houses and lives lost. It is reasonable to assume that the ACT, given its geographical location within NSW, would experience a similar consequence of bushfire, as highlighted by the devastating 2003 bushfires experienced within the ACT which resulted in the deaths of four ACT residents and the burning of 164,000 hectares (or nearly 70%) of land in the Territory. Over 500 houses and most of the Mt Stromlo Observatory were destroyed, fire damage to a further 315 houses, and major damage to various infrastructure and facilities,[5] as well as unprecedented environmental damage.

It can be concluded from the data that an average of 1 major fire occurs every 5 years in NSW, resulting in the death of around 5 persons and the destruction of around 50 houses.

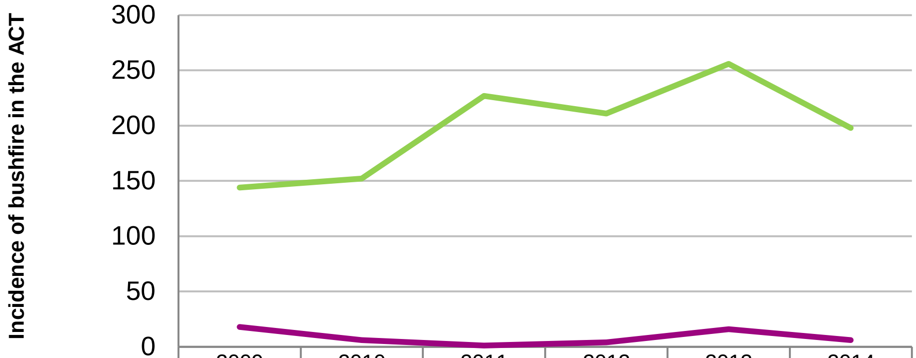
Professor Tolhurst’s draft report[6] into bushfire risk for power distributors in NSW notes in the summary:

> *“This analysis has shown that there are several areas in the study area where Catastrophic impacts could occur, i.e. where more than 1,000 houses could be lost in a single event. Fires starting in the Katoomba, Blue Mountains, Sydney Basin, Nowra, Yass, Goulburn, **Canberra**, and south of Newcastle areas all had the potential to be Catastrophic under the "worst- case" conditions considered.” (emphasis added)*

Further, the 2009 Victorian Bushfires Royal Commission, Final Report Summary states that in the Black Saturday fires, there were 2,133 houses destroyed and 173 deaths occurred. From this it can be concluded that approximately 81 deaths occur for every 1000 homes destroyed by bushfire. This is consistent with the numbers of deaths and homes destroyed stated in the R2A Report.

Table 7 below shows the number of total bushfires within the ACT as compared to those started due to failure of ActewAGL’s overhead electrical equipment over the period 2009 to 2014.

[4] Be Prepared: Climate Change and the ACT Bushfire Threat, Climate Council of Australia, 2014
[5] ACT Emergency Services Agency
[6] Dr Kevin Tolhurst, 2013. Draft Report on the Bushfire Risk for Power Distribution Businesses in New South Wales.



	2009	2010	2011	2012	2013	2014
Total bushfires in the ACT	144	152	227	211	256	198
Bushfire caused by ActewAGL OH assets	18	6	1	4	16	6

Figure 8: historical incidence of bushfire within the ACT

A major fire starts once every five years in geographic NSW (including the area of the ACT) that has the potential to take the lives of 5 people and destroy 50 houses. On average 4.7% of fires in the ACT are started by ActewAGL's network. This implies that, rather than a major fire event caused by failure of ActewAGL's equipment every 106 years in the ACT, one major fire event could be caused every 1.3 years, again on a worst case basis.[7] This finding, expressed in terms of the relative change between the current situation and the AER's Draft Determination, are summarised in Table 7.

Table 7 Summary of impact of increased incidence of bushfires caused by failure of ActewAGL assets

	Average bushfires started by failure of ActewAGL assets per annum	Period between major fire event caused by ActewAGL assets	Average lives lost per year due to bushfire caused by asset failure	Average houses lost per year due to bushfire caused by asset failure
Change implied by the AER's Draft Decision	24.5	105 years	21	208

6.4 Planning Asset Replacement to Achieve Least Whole-of-Life Cost

From an economic viewpoint, there exists a time in an asset's service life at which renewal would occur in order to achieve the least whole-of-life cost for the asset.

Figure 9 shows this. For the asset population depicted in the graph, the lowest point on the yellow curve represents the least annual cost. The yellow curve is simply the sum of the direct costs of installing and inspecting the asset, the risk cost imposed on customers, and the costs of maintaining, repairing and remediating damaged caused by the asset.

The actual time of replacement maybe advanced, to minimise risks, or retarded, to minimise capex budgets, depending on the pressures and environment within the business.

Another function of a graph like this is to show that increasing the time interval between asset inspections increases the risk cost and if the interval is to the right of the lowest point on the yellow line, it will increase the overall lifecycle cost to the owner.

The conclusion to draw is that a short term saving in REPEX to the owner and its customers will be more than offset in later years by the risk cost, and result in an increased total lifecycle cost to the owner and its customers. The effect will be to transfer the cost of underinvestment in early years to a later generation of customers, who will have to pay more in real terms than the initial capex saving

[7] This analysis relies on the assumption that major fire events have started on catastrophic fire rated days (106 / 83 = 1.28).

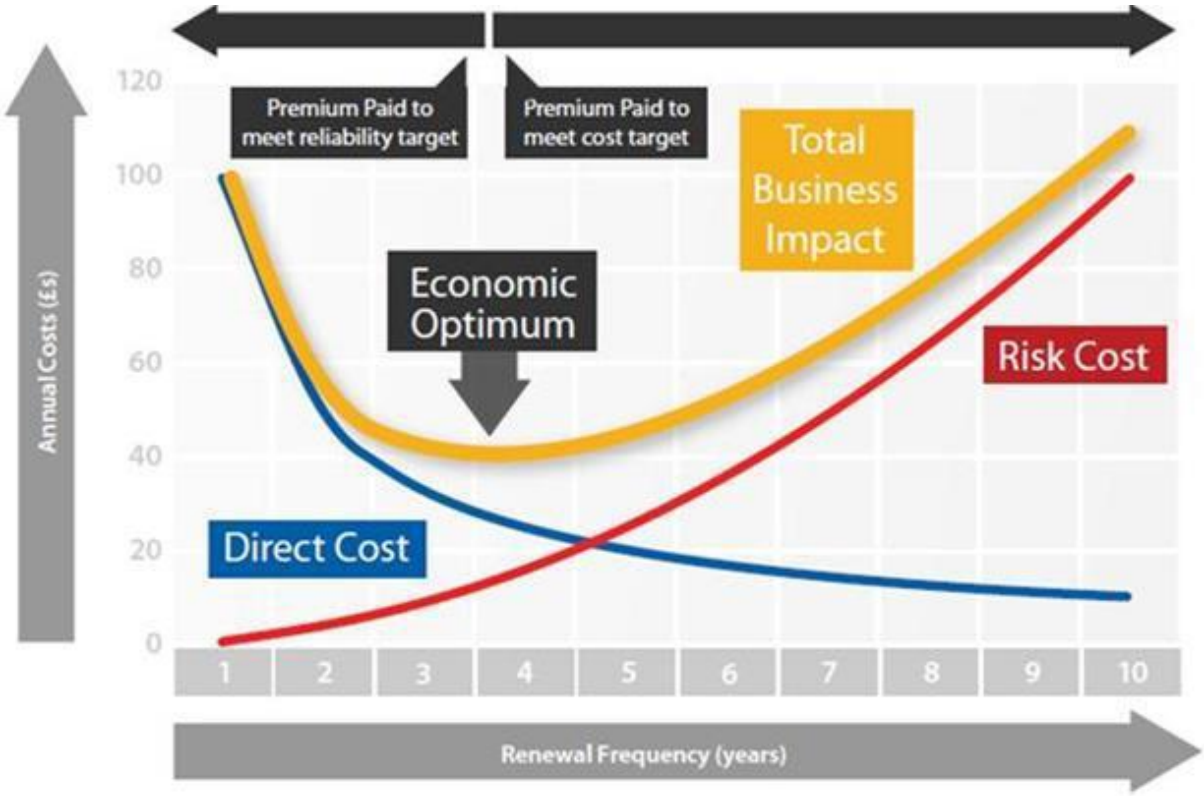


Figure 9 Life cycle cost optimisation

7.0 Conclusions

A number of conclusions have been made through this report. In summary, the report demonstrates that there are very substantial risks for ActewAGL and its customers if large expenditure cuts are implemented, especially at the level proposed by the AER in the Draft Determination. These mainly flow from the cuts to staffing levels that would be required, and include:

- A significant increase in outage duration, putting ActewAGL on the verge of failing to meet its SAIDI target, and increasing safety risks as explained in more detail below
- A reduction in ActewAGL's ability to carry out planned maintenance and force it more into reactive mode, which is a higher cost strategy.
- A significant increase in SAIFI caused by a number of factors, including:
  - An increase in inspection intervals, required to meet OPEX reduction targets as determined by the AER, which are estimated to increase SAIFI in every fourth year to 2.0, well above the statutory SAIFI limit;
  - An increase in the risk of failure of critical assets because inspection frequency would have to be decreased to the point where significant levels of asset failure could not be identified in advance to allow for remedial action. This would also:
    - push ActewAGL over its SAIFI target within the next regulatory period;
    - force an increase in REPEX expenditure for the following regulatory period to pay for delayed renewals (penalising customers at that time for a decision taken at the beginning of this next regulatory period that would benefit current customers), and
    - increase the demand for essential maintenance as assets age past the point of the lowest whole-of-life cost (while the funding for that maintenance has also been reduced, removing much of ActewAGL's capacity to carry out the maintenance).
- ActewAGL has based its proposal for REPEX expenditure on optimisation approaches similar to those outlined in Sections 6.2.4 and 6.4, using specialist software to support that decision making, and considers that its proposal represents the least expenditure needed to ensure that ActewAGL is able to meet its SAIFI targets. A significant reduction in REPEX expenditure allowed may put the SAIFI target in jeopardy, and unnecessarily increase the cost of risk (from service interruptions) for ActewAGL's customers.
- A significant increase in the risk of starting catastrophic and other serious bushfires, through a step increase in failures of rural poles and equipment in the later years of an extended inspection period from 4 years to 5.5 years.

  This strategy may increase bushfire starts caused by ActewAGL's assets from an average of 0.8 per annum to as many as 24.5 (dependent on weather conditions), which would result in an increased cost of damage to the community (potentially resulting in a possible 21 lives lost per year that would not have otherwise been at risk, and the loss of 208 properties per year that would otherwise have been secure (extrapolating from damage caused by recent fires in the ACT and NSW).

Appendix A

Pole Condemnation Analysis

Appendix A Pole Condemnation Analysis

The largest population of pole types are Creosote and Tanalith poles, and nearly 1,400 and 1,000 of these respectively have now been condemned (from a total population of about 6,000 and 7,000 respectively). Analysis of these condemned poles indicates that the mean service lives (until condemnation) of Creosote and Tanalith pole is about 38 years and 27 years respectively (Figure 11).

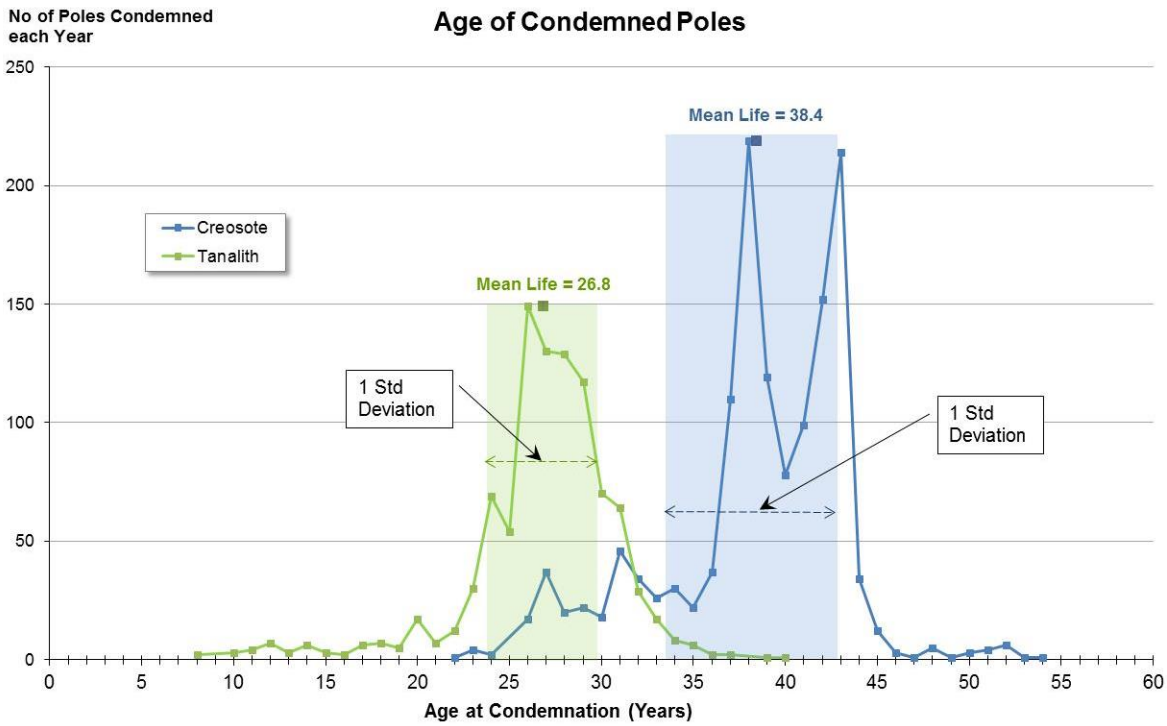


Figure 10 The age spread of condemned Creosote and Tanalith poles

An approximately normal distribution of failures might be expected, but in practice these poles are made from a variety of timbers and are located in a variety of environments, so the total population is actually made up of a number of sub-populations, each with slightly different characteristics. For simplicity, we will continue this analysis using the two larger populations since the slight differences involved will not affect the conclusions to be drawn.

It should be noted that there are poles still in use that are older than the mean life indicated. When they are eventually condemned, it is possible that the mean life of the poles will increase slightly. It should also be noted that while it is not possible to predict statistically when a particular pole will have to be condemned, but it is possible to identify the risk that a proportion of the population is likely to be condemned in any given future period.

The variability in condemnation rates partly reflects the age cohorts of poles installed. The peaks in condemned numbers are partly due to a large age cohort reaching the mean life of the pole (as indicated in Figure 12).[13]

[13] Data provided by ActewAGL's Network Optimisation Branch, Asset Management Division.

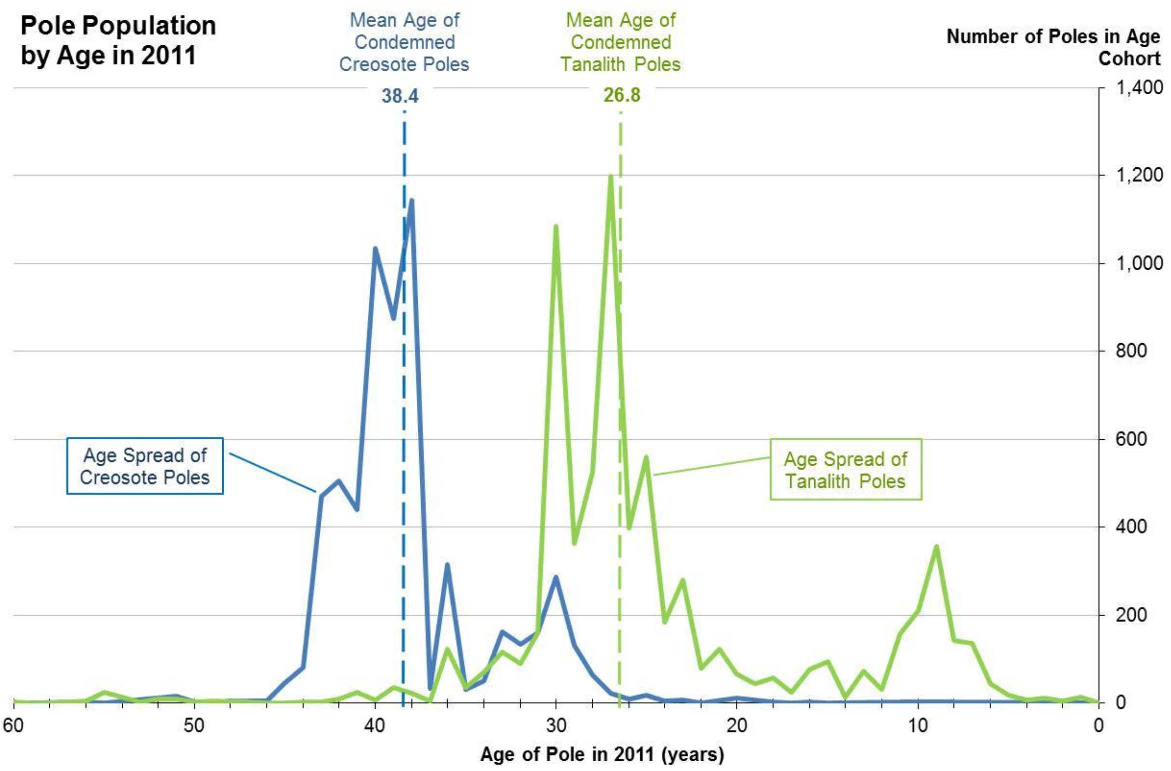


Figure 11 Actual pole population profile by age

The pole data can be re-presented to show the decay curve for each pole type, based on ActewAGL's history (Figure 13). The chart indicates that 50% of the poles had been condemned at 26.8 and 38.4 years of age respectively. The implication is that Creosote poles that are 38.4 years old have a 50% risk of being condemned, and that this risk increases as they age further.

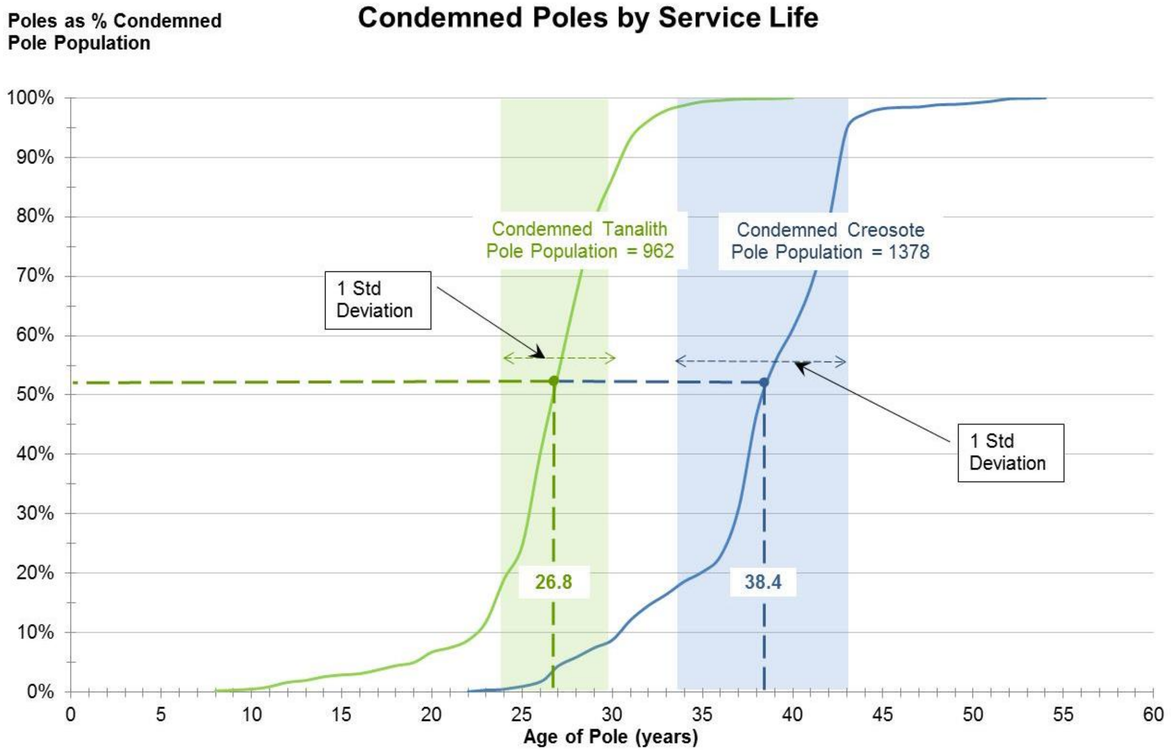


Figure 12 Poles condemned as a cumulative percentage of the condemned population ('decay' curve)

The risk of condemnation can be derived from this data. If 50% of poles can be expected to have been condemned when their age reaches their mean life, the risk of condemnation among poles of that age is 1 in 2. The risk of condemnation of older poles is higher – older poles may not actually have been condemned, but the risk of condemnation among poles of that cohort increases as their age increases.

The risk of condemnation for these poles based on the data available is shown in Figure 14, with risk presented as a logarithmic scale. Since there are older poles that have not yet had to be condemned, it would be expected that future condemnations will gradually increase mean life expectancy of the asset class.

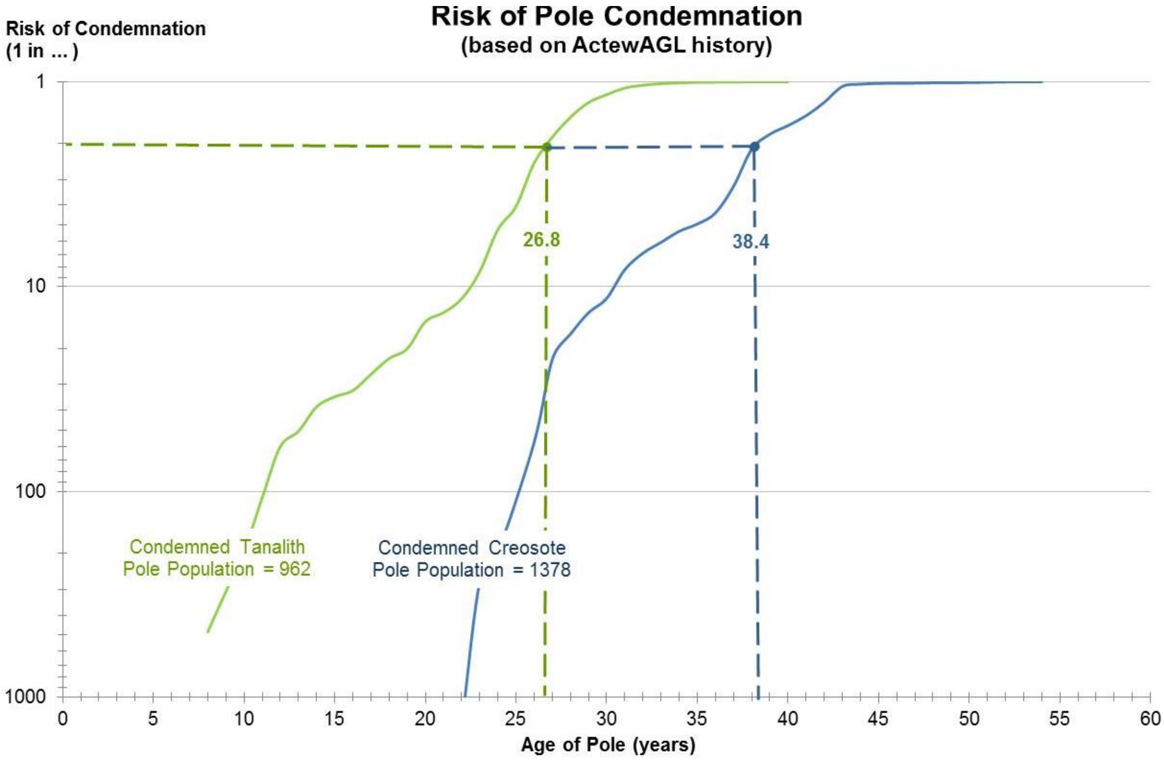


Figure 13 Risk of condemnation of Creosote and Tanalith poles

It is necessary to decide what level of risk is appropriate. If the average age of Tanalith poles in a bushprone area were 28 years, the risk of condemnation (or failure if not condemned) is approximately 50% - it would be expected that half the poles involved could be condemnable. If that risk is considered too high, then funds need to be made available to reduce the risk by inspecting and potentially reinforcing or replacing poles at greatest risk. The alternative is a higher risk of pole failure causing bushfire.

REPEX expenditure constraints have the effect of forcing delays in asset renewal or replacement (until funds become available). This is similar to adoption of a run-to-fail strategy, since funds may not be available when needed for planned proactive renewal or essential maintenance.

It should be noted that the need for asset renewal does not disappear – if funds are constrained, renewal must be delayed, and in the interim ActewAGL will be faced with increased operational costs for assets at the end of their service lives, and a higher risk of failures. When failures occur, ActewAGL would in practice have to reallocate funds from elsewhere to meet its supply obligations, effectively penalizing some other program.

The risk of asset failure increases with age and use, as indicated in Figure 14 (Appendix A). In Section 2.4.3 of AECOM's First Report, the term 'state of good repair' is introduced and explained. The term generally refers to a band of risk tolerance that is acceptable to an infrastructure or asset owner, and is often accompanied by a 'steady state funding level' that reflects an appropriate balance of expenditure and risk for that owner. The relationship between risk tolerance and expenditure lends itself to a comparison of scenarios, where the effect of constrained funds on risk levels can be contrasted and used to enable budget-setting.

This principle and approach can be applied to ActewAGL's pole population, building on the analysis presented in Section 5 and Appendix A.

The current age profile of the pole population is shown in Figure 7. The majority of the population of Tanalith and Creosote poles is about 31 and 41 years old respectively, at or older than 1 standard deviation from the mean age for poles condemned in the past. These therefore carry a high risk of failure.

Note that newer poles are younger and are therefore represented to the right of the chart. This chart, if produced each year for the pole population, would show the pole population increasing in age by 1 year for each additional year in the future, and the curves shown would be seen moving to the left of the chart as the assets age.

By 2020 any of these poles still in service would be another 5 years older, and have an even higher risk of failure. In practice, it would be expected that the majority of these will have been condemned by 2020, even if the current mean service age does increase slightly from its current value as older poles begin to fail.

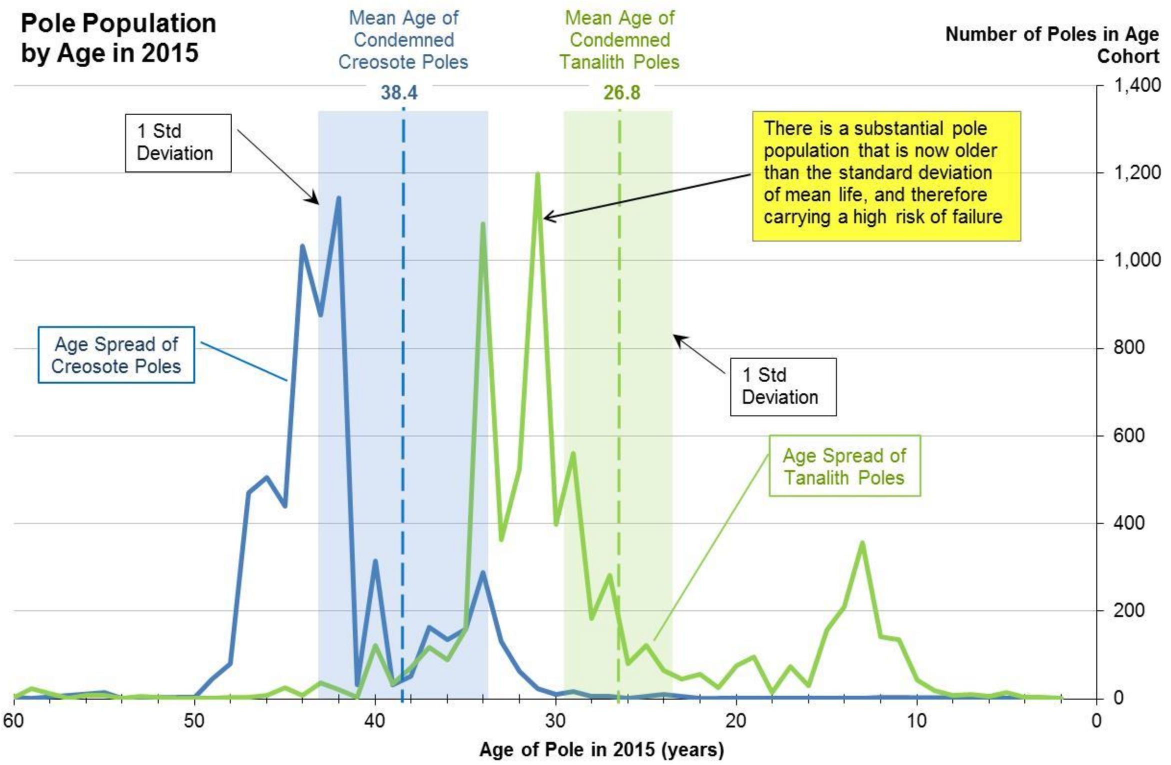


Figure 14 Age profile of the current (actual) pole population in service

Figure 14 indicates a significantly deteriorated and high-risk asset population in 2015. This picture reflects the timing of pole installation - a significant proportion were installed as one cohort in the 1970s and 1980s.

Appendix B

Major Fires in NSW over the Past 76 Years

Appendix B Major Fires in NSW over the Past 76 Years

Date	No. Deaths	Area (ha)	Losses	Location(s)
1938 December – 1939 January	13	73000	Many houses, pine plantations	Dubbo, Lugarno, Snowy Mountains, Canberra
1951 November – 1952 January	11	>4 000 000		Worst affected district around Wagga Wagga and Pilliga in the north-west
1968 September – 1969 January	14	>2 000 000	161 buildings (80 houses)	South Coast (Sept.), much of the coastal and nearby range areas of the state
1974–75	6	4 500 000	50 000 stock, 10 170km fencing	Bourke to Balranald, Cobar Shire, Moolah–Corinya—most of the Western Division
1977–78	3	54000	49 buildings	Blue Mountains
1978–79	Nil	>50 000	5 houses, heavy stock loss	Southern Highlands, south-west slopes
1979–80	13	>1 000 000	14 houses	Mudgee, Warringah and Sutherland Shires, majority of council area, Goulburn and South Coast
1984–85	5	>3 500 000	40 000 stock, $40 million damage	Western Division
1990–91	Nil	>280 000	8 houses, 176 000 sheep, 200 cattle, hundreds of km of fencing	Local government shires of Hay, Murrumbidgee, Carrathool; Hornsby, Ku-ring-gai, Cessnock, Hawkesbury, Warringah, Wollondilly, Gosford, Wyong
1991–92	2	30 fires	14 houses	Baulkham Hills, Gosford City, Wyong Shire, Lake Macquarie
1993 December – 1994 January	4	>800 000 (>800 fires)	206 houses destroyed, 80 other premises destroyed	North Coast, Hunter, South Coast, Blue Mountains, Baulkham Hills, Sutherland, most of Royal National Park, Blue Mountains, Warringah–Pittwater
2001 December – 2002 January	Nil	744 000 (454 Fires)	109 houses destroyed; 6000 head of livestock	Across 44 local government areas in the Greater Sydney, Hunter, North Coast, mid-north coast, Northern Tablelands, Central Tablelands areas
2002 July – 2003 February	3	1 464 000 (459 fires)	86 houses destroyed; 3400 stock; 151 days of severe fire activity	81 local government areas in Greater Sydney, Hunter, North Coast, Northern Tablelands, Northern Rivers, north-west slopes, north-west plains, Central Tablelands, Southern Tablelands, Illawarra, South Coast
2012-13	Nil	1.4 million ha	62 homes destroyed; 5,885 bush and grass fires; large areas of Catastrophic fire danger	Coonabarabran, Shoalhaven, Yass, Cooma-Monaro, Greater Sydney, Far West NSW, Northern Rivers and Northern Tablelands
2013-14	2	575 000 ha	217 homes destroyed; 129 damaged.	Blue Mountains, Central Coast, Southern Highlands, Port Stephens, Riverina, North Coast
Total	76	Deaths	801 houses	