Wood pole replacement program

PAL BUS 4.02 and CP BUS 4.02

Regulatory proposal 2021–2026

CitiPower and Powercor

January 2020

Contents

1 Overview

The purpose of this document is to explain and justify the proposed changes to our wood pole management strategy and the resulting capital expenditure forecast for the 2021–2026 regulatory period. We apply the same asset management approach to our CitiPower and Powercor networks, and hence, this document covers both networks.

As explained in this document, we have engaged extensively with our customers and stakeholders in developing our pole replacement strategy. This includes Energy Safe Victoria (**ESV**), who have undertaken two separate reviews into the condition and sustainability of our pole replacement practices.[1] Consistent with ESV's recommendations, our proposed program reflects the adoption of an enhanced asset management approach that:

- improves our pole condition assessment by including an engineering based analysis of residual pole strength
- recognises that the consequence of a pole failure may vary significantly depending on location.

Our proposed pole replacement program is also consistent with the AER's risk monetisation framework and provides for prudent and efficient replacement volumes that:

- address the concerns of electricity consumers[2]
- comply with our regulatory obligations, including the Electricity Safety Act 1998 and our Bushfire Mitigation Plan (**BMP**)[3]
- consider substitution possibilities between capital and operating expenditure, including inspection frequency and condition monitoring.[4]

A summary of the forecast capital expenditure required for our wood pole replacement program (excluding fault response) is shown in table 1.[5]

Table 1 Capital expenditure forecasts: wood pole replacement program, excluding fault response ($ million, 2019)

Capital expenditure forecast	2021/22	2022/23	2023/24	2024/25	2025/26	Total
CitiPower	11.8	11.8	11.8	11.8	11.8	58.9
Powercor	46.8	46.8	46.8	46.8	46.8	233.8

Source: CitiPower and Powercor

1 PAL ATT133: ESV, *The condition of power poles in south west Victoria, Technical investigation report*, July 2019; PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019.

2 National Electricity Rules, clause 6.5.7(e)(5A).

3 National Electricity Rules, clause 6.5.7(a)(2).

4 National Electricity Rules, clause 6.5.7(e)(5A).

5 Fault response is modelled separately, as per our attached network faults model: CP MOD 4.11 - Network faults - Jan2020 - Public; PAL MOD 4.11 - Network faults - Jan2020 - Public.

2 Background

Poles are essential to an overhead electricity distribution network. Their basic function is to support overhead electrical conductors and other pole mounted assets, and to provide safe clearance from the ground and other adjacent objects (including vegetation).

This section sets out background information in relation to our assets, including a high-level summary of our compliance obligations and a snapshot of the types, population, age profile and historic performance of our pole assets.

2.1 Safety obligations

We are committed to providing customers with a safe, reliable and affordable electricity supply through the application of an effective asset management framework. We are required to manage our network assets in accordance with the Electricity Safety Act 1998, the Electricity Safety (Management) Regulations 2010 and the Electricity Safety (Bushfire Mitigation) Regulations 2013.

The key instruments that govern the management of our network assets, including poles, are:

- our Electricity Safety Management Scheme (**ESMS**) and BMP, which are subject to acceptance by ESV
- our asset management plan and asset class strategies, which provide information about the types of poles used, and their applications, failure rates and modes
- our network asset maintenance policy for inspection of poles, which describes the inspection frequency and scope, depending on pole condition
- our asset inspection manual, which describes how inspections should be conducted and sets out criteria for categorising the urgency of remedial maintenance actions and reporting, and information recording requirements.

ESV's role is to monitor and enforce the safety of the design, construction, operation, maintenance and decommissioning of Victoria's major electricity companies' electrical transmission and distribution networks. It monitors each electricity company's compliance with its obligations under the Electricity Safety Act 1998 to minimise risk 'as far as practicable' (as articulated in our ESMS and BMP).

2.2 Asset population

Our population of poles includes low voltage (**LV**), high voltage (**HV**), sub-transmission and public lighting assets. The material types used include wood, concrete and steel.[6]

Table 2 shows a summary of our poles by type and voltage class.

[6] A small volume of lattice tower structures also exist, particularly for sub-transmission or transmission network level construction which may be shared use by our networks and the transmission network service provider. Given the small volume of these assets (less than 200), they have been excluded from this discussion.

Table 2 CitiPower and Powercor: network pole population

Pole/tower use	Wood	Concrete	Steel	Total
LV	126,095	28,590	5,694	160,379
HV	256,219	92,151	413	348,783
Sub-transmission	19,122	10,270	-	29,392
Public lighting	-	-	96,807	96,807
Totals	**401,436**	**131,011**	**102,914**	**635,361**

Source: CitiPower and Powercor

Determining the type of pole to be installed depends on a range of safety and performance factors, including height and strength, termite/corrosion impacts and pole conductivity. We adopt the following standards in relation to pole installations:

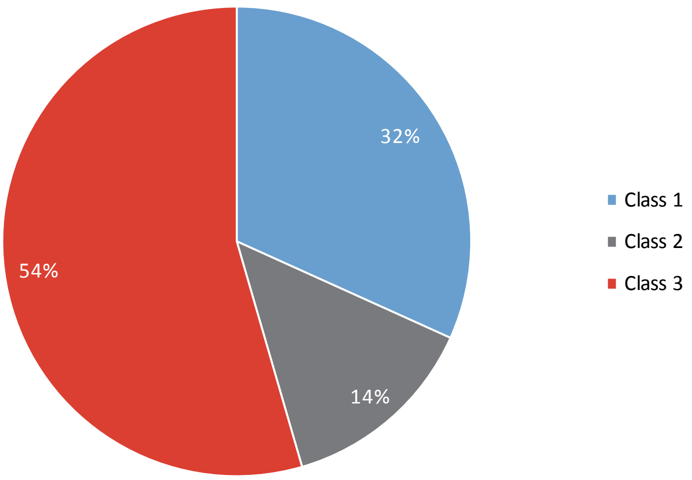
- treated wood poles are standard for new construction south of the Great Dividing Range and for all new and replacement construction for CitiPower, except substation structures
- concrete poles are standard for areas north of the Great Dividing Range
- steel poles are standard for public lighting columns.

2.3 Asset durability class

Durability class is the term used to describe the natural ability of a wood pole to resist attack by fungi and insects. Australian Standards divide timbers into four durability classes, which relate to only the non-preservative treated heartwood or true-wood. The asset lives experienced in service vary widely from pole to pole, even when they are from the same forest and installed in the same locality.

Figure 1 summarises the durability class of our existing wood pole population. Poles of unknown durability class are treated as class three by default. Class three poles have generally been pressure treated with creosote, which is used to protect timber from white ants and decay.

Figure 1 CitiPower and Powercor: durability class of wood pole population



Source: CitiPower and Powercor

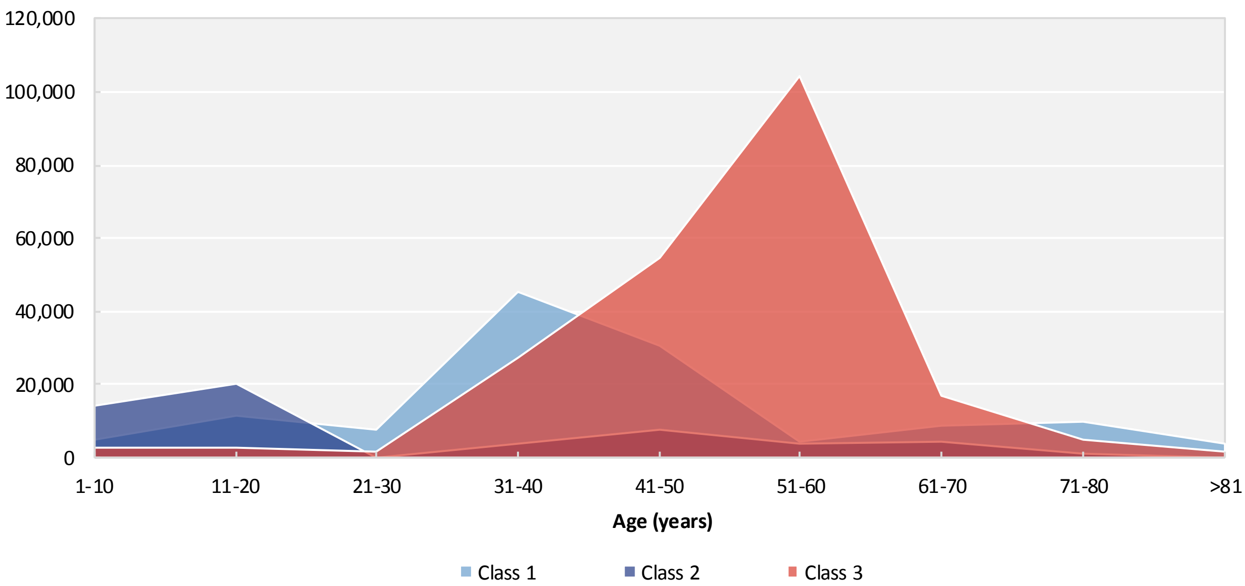
Our wood pole population is also assigned a strength group based on the characteristic strength of timbers. Australian Standards specify seven strength groups for unseasoned timbers (S1–S7), with group one being the strongest. The majority of our wood poles are classified as strength group three.

As explained in further detail in chapter 4, we also estimate each pole's residual strength. This estimation recognises that pole strength declines with age, which is an important factor to consider in determining each pole's serviceability.

2.4 Asset age profile

The age profile of our wood pole population is shown in figure 2, broken down by durability class.

Figure 2 CitiPower and Powercor: wood pole age profile by durability class



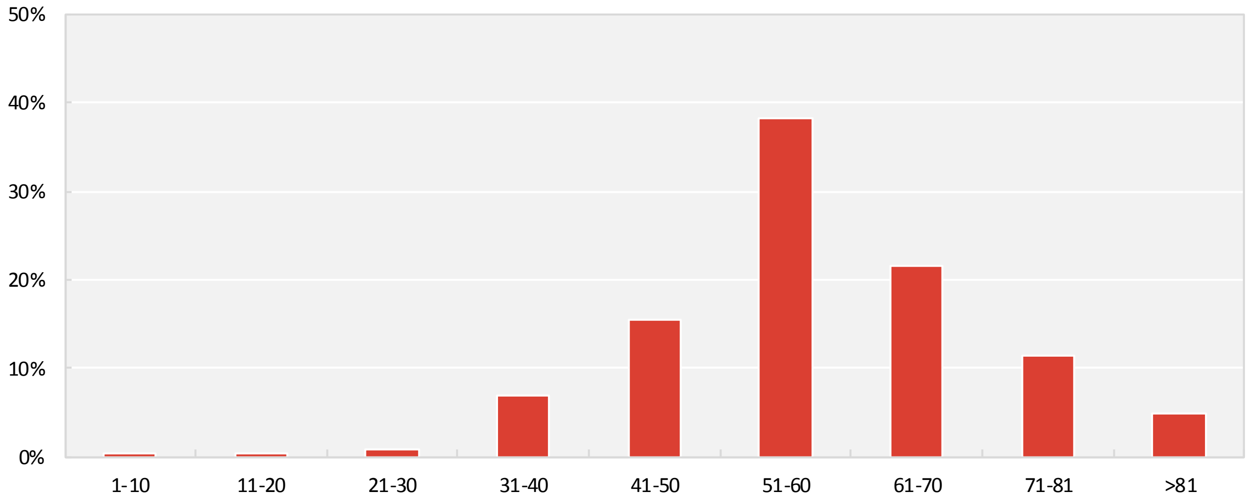
Source: CitiPower and Powercor

The age profile of our wood pole population indicates there is a significant number of poles that exceed their expected service life. In particular:

- 59% of class three poles currently exceed the average life expectancy of a class three pole of 50 years
- 11% of class one poles currently exceed the average life expectancy of a class one pole of 70 years
- 35% of our entire wood pole population is older than 50 years (which correlates to the average age at failure, of 51 years).

The age profile of our reinforced poles (i.e. staked poles) is shown in figure 3. Reinforced poles currently comprise 7% of the wood pole population, and 74% of these are on poles 51 years or older. Reinforcing a pole can extend the average life of the asset.

Figure 3 Age profile of reinforced wood poles (% of reinforced wood pole population)



Source: CitiPower and Powercor

3 Identified need

The identified need is to ensure our wood pole replacement program complies with all our existing safety obligations; supports our commitment to maintaining our reliability performance; and addresses community expectations of a sustainable approach to asset management.

In this section, we consider:

- the need to respond to community safety concerns, including feedback received through public meetings and engagement with State and Federal politicians
- the need to address the matters raised by ESV in its review of our asset management practices
- the need to address the recent deterioration in pole failure rates, despite fewer poles in recent years being classified as 'unserviceable'.

3.1 Community safety concerns

We have been talking to our customers and stakeholders about the development of our 2021–2026 regulatory proposal since 2017. This engagement has included multiple 'phases', the full details of which are set out in our regulatory proposal.

A summary of the engagement process found that customers viewed maintaining the safety of the network as our core business, and a 'given' in terms of priority.[7] This finding was reinforced by survey results that indicated 86% of customers considered 'maintaining and improving the safety of the electricity network for customers and workers (including bushfire risk)' to be extremely or highly important.[8]

3.1.1 Community feedback on pole replacement program

Topic roundtables provided an opportunity to engage directly with local communities in relation to specific issues. With the assistance of Woolcott Research and Engagement, we convened a special topic roundtable in Warrnambool in March 2019 to discuss three topics, including pole inspections and replacements.[9]

At the Warrnambool roundtable, participants were asked what they felt about our initial response to fires in the south-west of Victoria in March 2018—we recognise that concerns regarding pole safety have been raised following the St Patrick Day fires in March 2018.

Participants were also asked about the cost implications of maintaining the current asset management approach during the next regulatory period, which included the following enhancements:

- changing the safety factor threshold for unserviceable poles from 1.25 to 1.40
- increasing the minimum sound wood threshold for a pole to remain in service from 30mm to 35mm (15% increase)
- increasing pole replacements by 1,000 a year
- increasing the inspection frequency from every 2.5 years to every year for serviceable poles with a safety factor between 1.40 and 1.875.

Most participants were supportive of these actions, but found it hard to assess whether they were 'enough':

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7 PAL ATT088: Woolcott Research and Engagement, *Powercor integrated summary report*, August 2019, p. 5.

8 PAL ATT125: Woolcott Research and Engagement, *Powercor residential survey - phase 3*, July 2018, p. 24.

9 PAL ATT240: Woolcott Research and Engagement, *Warrnambool stakeholder roundtable report, Report prepared for Powercor*, April 2019.

"It is a move in the right direction. It has got to be a good thing. But we could be going from really bad to just bad."

"Instead of 30 mm it is going to 35 mm, but is that enough? I don't think that sounds like much of a change at all."

One or two participants suggested the replacement program needed to be flexible to allow for some poles that customers deem to be hazardous (even if they are not) to be replaced. There was a feeling that this would at least show, in a public relations sense, that we are being responsive to customers, particularly coming into bushfire season when residents start becoming nervous and sending in photos of poles they feel need replacing:

"The safety factor takes into account the bare minimum…it needs to go beyond that."

"They need to step out of the regular inspection programmes and look at specific poles, if attention is brought to them."

"Why doesn't Powercor for the sake of community confidence replace poles that look bad in people's photos? They 'live the land'…they know which trees are ready to fall over."

When asked for feedback on the option of increasing the number of pole replacements by an additional 2,000, 3,000 or 4,000 a year, the majority of participants were in favour of increasing pole replacements by 4,000 a year as the bill impact was seen to be minimal in the context of potentially saving lives:

"Whatever cost, it is the cost of human life that is important."

"It is a no brainer. People need to feel that it is safe."

However, some participants questioned if an additional 4,000 poles per year was still enough. Some stakeholders queried the geographical spread of replacements. Concern was also expressed that poles being replaced may not be in the right areas given the physical size of the network and the expanse of hazardous bush fire areas:

"We need to do everything we can to minimise the probability of any problem occurring."

"We are dealing with the impact of past mistakes so people need to get their confidence back."

Participants were quick to stress that the plans should not be about the number of poles to be replaced but about how safe the poles actually are (i.e. they should be replaced if they are not safe, even if the overall number exceeds 4,000). Alongside this discussion, we explained that many poles were installed at the same time so will probably need replacing at the same time. In due course, this could take the number of poles needing replacement beyond the approved level each year:

"They have got to be able to be replaced when needed – there might be more than 4,000 additional a year and then they will all need to be replaced at once because they were put in over a short time."

"It should be about safety not economics."

"What we really want is confidence in the infrastructure. People need to feel that it is safe. It is all about perceptions not numbers."

Stakeholders also expressed concerns about the processes used by the auditors, ESV. Some queried whether ESV was doing enough to audit the work we carry out. It was believed that network auditing by ESV should be more transparent than it is currently:

"I have a real concern – who is auditing the auditors?"

As the discussion about pole replacements progressed, some stakeholders also raised questions about links between the network, ESV and the AER. Related comments were:

"Even if Powercor want to increase replacements, the AER probably won't give them the money. It is an economic regulator…they are not interested in whether customer expectations have changed. There needs to be a stronger relationship between ESV and the AER so that the cost-benefits are properly understood."

3.1.2 Feedback from local politicians and Ministers

The concerns expressed by our communities have been echoed by local Members of Parliament and Ministers. For example, the Member for Polwarth, Richard Riordan MP highlighted the safety concerns of Western Victorians, drawing attention to the findings of the Victorian Bushfire Royal Commission:

"We know from the findings of the Bushfire Royal Commission, and subsequent Grimes Review that compromised power poles can, and have started devastating bushfires in our community."

Mr Riordan also highlighted the small percentage of the pole population that has been replaced in recent years. In his view, there is a 'tsunami of replacements' that will be required because many of the poles are 60 or 70 years old.

In March 2019, a bushfire safety forum in Terang was attended by the Federal Energy Minister, Angus Taylor, and the Federal cabinet minister and Member for Wannon, Dan Tehan, alongside state politicians Richard Riordan and Bev McArthur. The forum was attended by 60 members of the community. The key message from the Energy Minister was that our current inspection and replacement program needed to improve. In addition, Mr Tehan emphasised the need for ESV's regulatory requirements to be enforced and strengthened, calling on ESV to protect the community.

In May 2019, the Member for Western Victoria Region, Bev McArthur used an adjournment debate in Parliament to raise concerns regarding the state of energy infrastructure in her electorate. Bev McArthur has strongly expressed her concern that the current rate of pole replacement is putting the community in Western Victoria at risk.

3.1.3 Our response to community concerns

We have listened carefully to the feedback from our customers and our local and Federal politicians, recognising the strength of the community concerns expressed. The feedback we received has been important in assisting us to develop a response that genuinely addresses these concerns. We have continued to engage with our politicians and communities to explain our proposed response and to gain their support.

In March 2019, for example, we made the following immediate enhancements to our asset management practices:

- we increased the frequency of our inspection and testing process from 30 months to 12 months for all limited life poles, which are now referred to as 'added control – serviceable' poles
- we increased the pole residual strength safety factor from 1.25 to 1.40 for all poles
- we introduced an assessment criterion to address defects only identifiable by visual inspections (such as fungal fruiting bodies, or repeated termite attack) to trigger pole replacement.[10]

The increased inspection frequency for added control – serviceable poles means they are less likely to fail prior to the next inspection. In addition, the other changes to our asset management practices are expected to lead to

[10] Currently there is no means to test the impact of these known defects on the integrity of a pole, and therefore, consistent with industry practice, these poles are replaced.

an increase in the number of poles being classified as 'unserviceable' each year. Unserviceable poles are replaced or reinforced within prescribed time limits, as required under our BMP and ESMS.

As discussed further in this document, we have incorporated these changes into our risk-based asset management approach.

3.2 Sustainable asset management

Following the changes outlined above, and in light of the community concerns, ESV undertook two reviews into the sustainability of our pole replacement practices. The first review focussed on any immediate risks to the public from the condition of our poles in the South West of Victoria, whereas the second considered the longer-term impacts of our existing management practices. As explained below, the ESV's second report concluded that there is an 'identified need' for further enhancements to our asset management practices.

3.2.1 The condition of power poles in South West Victoria

In May 2019, ESV issued its draft technical investigation report into the state of power poles in the South West region of Victoria. The final version of the investigation report was updated to address feedback received from members of the public, and was released in July 2019.[11]

The investigation report supported the changes we had made to the minimum safety factor thresholds governing the amount of sound wood required for a pole to remain in our network. ESV also concluded there was no immediate systemic risk of pole failures in the South West region. However, ESV decided a more detailed technical investigation was required to assure itself that our wood pole management practices would deliver sustainable safety outcomes for the community in the long-term.

3.2.2 Sustainable wood pole safety management approach

ESV's second review involved an end-to-end review of our wood pole asset management life cycle process. This review was detailed and comprehensive. For example, ESV reviewed our asset management strategies, documentation, work practices, and data. ESV also met with our service providers and requested further information where required. We engaged cooperatively with ESV through a series of workshops and site visits, as recognised by ESV in its report.[12]

The clear conclusion from ESV's second review was that the changes introduced in March 2018 to our asset management approach for wood poles will not deliver a sustainable safety outcome. To address this issue, ESV concluded that enhancements to our asset management approach for wood poles were required, particularly in relation to risk management. We support ESV's conclusions, and our proposed enhancements to our asset management approach are discussed in chapter 4.

A summary of ESV's key conclusions is reproduced in figure 4.[13]

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11 PAL ATT133: ESV, *Technical investigation report (final), The condition of power poles in south west Victoria*, July 2019.

12 PAL ATT245: ESV, *Powercor - wood pole management, Sustainable wood pole safety management approach, Detailed technical report*, December 2019, p. 10.

13 PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 25.

Figure 4 ESV's concluding remarks

1	The wood pole management system in place in March 2018, at the time of The Sisters fire at Garvoc, would not deliver sustainable safety outcomes for the future.
2	Since March 2018 Powercor has improved its wood pole management system, which has the effect of increasing the volume of pole replacements and reinforcements. However, these changes will not deliver sustainable wood pole safety outcomes for the future.
3	Powercor is progressing further improvements to its wood pole management system based on more comprehensive risk assessment and better inspection practices that, when implemented, will as far as practicable, deliver sustainable safety outcomes to the community

Source: ESV

3.3 Pole performance

In October 2019, we completed our scheduled reliability centred maintenance (**RCM**) review, which followed earlier RCM reviews in 1997 and 2005. The recent RCM review involved a comprehensive re-examination of our asset management approach for poles, having regard to the latest available data and recent operational experience.[14] Whilst the review was wide-ranging, two specific areas of concern were highlighted that reinforce findings from ESV's technical report:

- our historical trend in pole failures is showing a deterioration in performance
- the number of our poles classified as 'unserviceable' has declined, despite increasing trends in pole failures.

We discuss each of these issues below.

3.3.1 Our pole failure rates are trending upwards

Without diminishing the extent of community concerns, our rate of pole failures has historically been low (i.e. for Powercor, around four wood pole failures per 100,000 poles on our network).

As highlighted by ESV, however, our 2018 failure rate is above all but one of the distributors considered in its comparative sample.[15] This continues an increasing trend in our observed pole failures. For example, figure 5 shows our historical wood pole failures over time, with the impact of weather events removed (to better illustrate the impact of our asset management practices).

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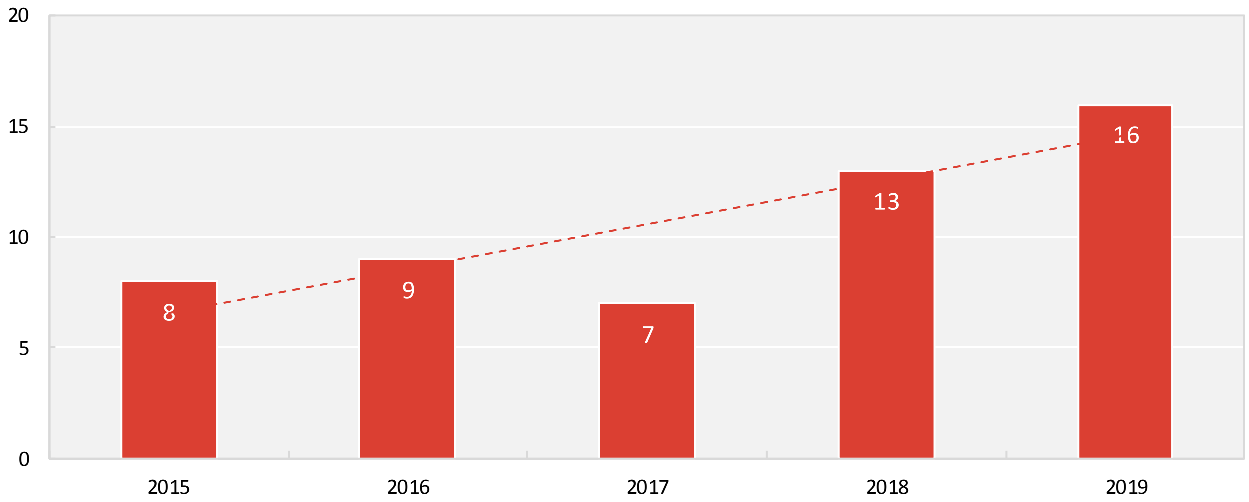
14 PAL ATT093: ARMS reliability, *Final report, 2019 RCM study report*, October 2019.

15 ESV also recognised that the wood pole failure RIN data for Ergon, Energex and AusNet Services (all DNSPs with a combination of rural, semi-rural and urban wood pole populations, like Powercor, and therefore candidates for comparison) appear to be based on different definitions, so appear not to be useful comparators. PAL ATT245: ESV, *Powercor - wood pole management, Sustainable wood pole safety management approach, Detailed technical report*, December 2019, p. 105.

Figure 5 Powercor: historical wood pole failure performance



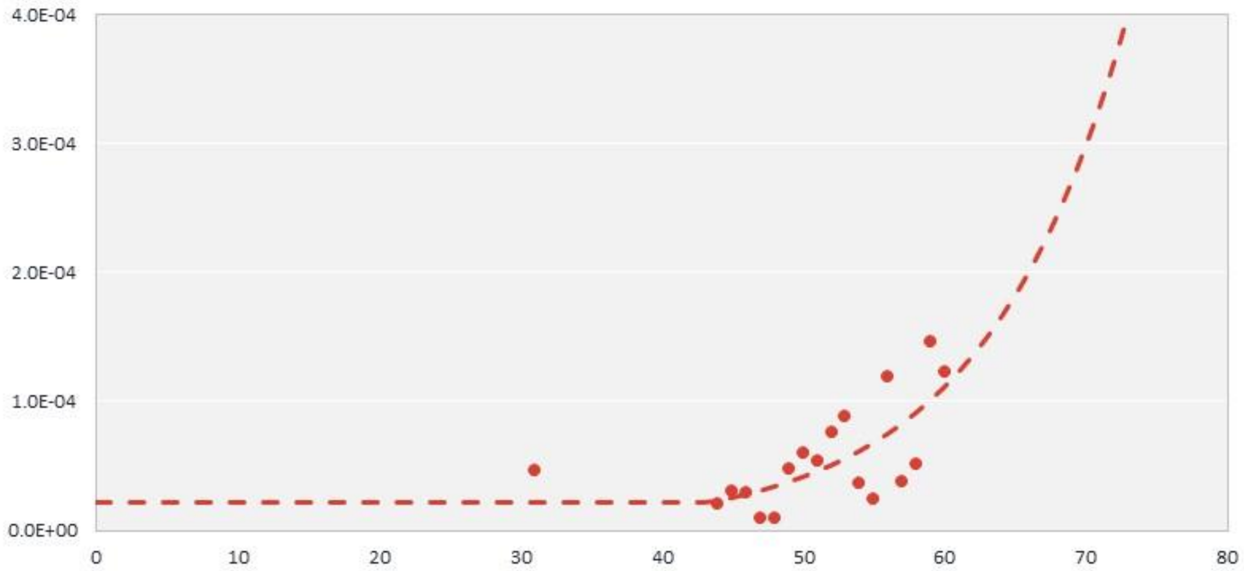
Source: Powercor

The increasing trend in observed pole failures represents the first time we have experienced a sustained period of deteriorating performance above our historical average, which warrants careful consideration. ESV also suggested this increasing trend is one that requires further review.[16]

In part, the underlying increase in pole failures reflects our aging pole population. This is most evident in our lower durability poles. For example, figure 6 shows that failure rates for class three poles have been observed to increase sharply from the age of around 45 years, although the absolute level of risk remains very low.

16 PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 13.

Figure 6 Failure rates observed in class three wood poles (by age)



Source: Powercor

Our analysis shows that a continuation of our current asset management practices would lead to an increase in the average age of our wood pole population from 43 years to 51 years by 2030. Although age is not a true reflection of condition, it can be used as a proxy and the average age of observed wood poles failures on our network is 51 years. Therefore, if the pole population continues to age without any additional risk mitigation measures, it is reasonable to expect an increase in the rate of pole failures. Such an outcome cannot be regarded as acceptable, given our obligation to minimise safety risk as far as practicable.

3.3.2 Fewer poles are classified as unserviceable, despite the increasing trend in pole failures

In managing our wood poles, we undertake cyclic condition assessments and classify each pole as serviceable, added control – serviceable, or unserviceable (with unserviceable poles further classified based on priority). An overview of these classifications is provided in table 3.

Table 3 Pole condition classification definitions

Classification	Definition
Serviceable	These poles are assessed as being serviceable
Added control – serviceable	These poles are assessed as having sufficiently deteriorated to warrant an increased inspection frequency
Unserviceable (priority 1)	These poles are assessed as having sufficiently deteriorated to a point which requires priority replacement (P1 shall be replaced, repaired, made safe or have appropriate action taken within 24 hours)
Unserviceable (priority 2)	These poles are assessed as having sufficiently deteriorated to a point which requires reinforcement or replacement (P2 shall be replaced, repaired or have appropriate action taken within 32 weeks)

Source: CitiPower and Powercor

In recent years, the number of poles classified as unserviceable has declined. As observed by ESV, this conflicts with the increasing trend in pole failures described in the previous section:[17]

> *Over the last five years, the number of poles classified as Unserviceable has reduced sharply whilst unassisted pole failure rates have been increasing. These trends are inconsistent with each other and do not align with the increasing age of the wood pole population. While there are other contributing factors, this mismatch appears to be because the serviceability assessment criteria did not adequately recognise the cumulative effect of significant loss of pole strength through degradation of the fibre strength.*

Our 2019 RCM study further highlighted that 75% of pole failures were from poles classified as 'serviceable', which means these poles are bypassing the added control – serviceable classification.[18] It was stated that this level of transition is 'particularly troubling'.[19]

The 2019 RCM study also stated that an average of 1,181 poles per year will transition directly from a serviceable to unserviceable classification.[20] This study was based on approximately 10,000 individual poles.

These findings reinforce ESV's observation that the serviceability criteria is not adequately capturing pole condition. Evidently, the remedy is to enhance our asset management approach, which is discussed in the next section.

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17 PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 20.

18 PAL ATT093: ARMS reliability, *Final report, 2019 RCM study report*, October 2019, p. 125.

19 PAL ATT093: ARMS reliability, *Final report, 2019 RCM study report*, October 2019, p. 119.

20 PAL ATT093: ARMS reliability, *Final report, 2019 RCM study report*, October 2019, p. 126.

4 Proposed enhancements to asset management

We have committed to enhance our asset management approach to address the identified need and matters raised by ESV, as outlined in chapter 3. In broad terms, our objective is to adopt an asset management approach that:

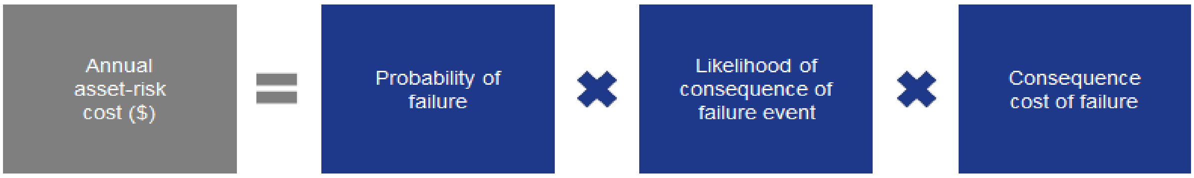
- achieves a sustainable pole lifecycle management program
- maintains acceptable performance levels
- intervenes on the 'right' poles at the 'right' time
- addresses community and stakeholder expectations.

As explained in this chapter, our proposed risk-based asset management approach is conceptually consistent with the AER's risk monetisation framework.[21]

4.1 Risk monetisation approach

We support the application of a risk monetisation approach in relation to pole replacements. A risk monetisation approach applies an economic discipline to investment decisions, and as shown in figure 7, estimates the annual asset-risk cost as a function of the probability of asset failure, the likelihood of the consequence occurring, and the cost of the consequence.

Figure 7 Derivation of annualised risk cost



Source: CitiPower and Powercor

The challenge in relation to pole management is how best to implement a risk monetisation approach given our existing data limitations. In particular, we have limited information to:

- link serviceability assessments from our enhanced pole calculator (discussed in section 4.2) to the probability of pole failure
- estimate the 'likelihood of consequence of failure event' and the 'consequence cost of failure'.

Notwithstanding these data limitations, we have adopted a framework that is consistent with the AER's risk monetisation framework. Our proposed framework is represented in figure 8.

[21] PAL ATT099: AER, *Industry practice application note: asset replacement planning*, January 2019.

Figure 8 Overview of our risk-based asset management approach for poles

Increasing consequence of failure →

Increasing probability of failure ↑

Pole condition	LBRA	HBRA	REFCL (non-SWER)	REFCL (SWER)	BCA (ELCA)
Unserviceable: Serviceability index < 0.65	C2	C2	C1	C1	C1
Added-control serviceable: 0.65 ≤ serviceability index < 0.70	C4	C4	C3	C3	C2
Added-control serviceable: 0.70 ≤ serviceability index < 0.75	C4	C4	C4	C3	C3
Serviceable: 0.75 ≤ serviceability index < 1.0	C5	C5	C5	C5	C4
Serviceable: Serviceability index ≥ 1.0	C5	C5	C5	C5	C5

Source: Powercor

As shown in figure 8, we have adopted serviceability criteria as a proxy for the probability of failure. The probability of failure increases for poles with lower serviceability, with serviceability determined using our enhanced pole calculator (discussed in section 4.2).

The consequence mapping reflects the following fire classifications, in descending order of consequence:[22]

- bushfire construction areas (**BCA**)—our highest bushfire consequence regions[23]
- rapid earth fault current limiter areas with single wire earth return lines (**REFCL non-SWER**), which recognises that REFCLs are not designed to mitigate risk on SWER networks
- REFCL areas serviced by non-SWER lines (**REFCL**)
- hazardous bushfire risk areas (**HBRA**)
- low bushfire risk areas (**LBRA**).

Having regard to the serviceability assessment and fire classification, our proposed framework assigns poles into one of five categories (with C1 representing the highest risk and C5 representing ongoing monitoring and inspection). As detailed in section 4.1.1 and 4.1.2, these classifications include two broad categories of interventions:

- compliance driven interventions (C1 and C2)
- risk driven interventions (C3 and C4).

22 It should be noted that a number of these fire classifications are not relevant to CitiPower, given its service territory.

23 Also referred to as electric line construction areas (**ELCAs**).

In the future we envisage our approach will move towards quantifying the asset-risk cost by distinguishing between the likelihood of consequence of failure events and the consequence cost of failure, and include more implicit consideration of reliability consequences (in addition to fire consequences).

4.1.1 Compliance-driven interventions

The safety of the Victorian electricity networks is governed by the Electricity Safety Act 1998 and relevant regulations, which include:

- Electricity Safety (Management) Regulations 2009
- Electricity Safety (Bushfire Mitigation) Regulations 2013
- Electricity Safety (Installation) Regulations 2009.

If a pole is classified as unserviceable, we would be in breach of our safety obligations if we failed to undertake appropriate action. In this regard, it is important to note that intervention may be a decision to stake the pole rather than replace it. Further, the timeframe for intervention depends on the priority of the classification (i.e. a P2 unserviceable pole must be addressed within 32 weeks, whereas a P1 unserviceable pole must be addressed within 24 hours). Therefore, whilst we must address all unserviceable poles, our response depends on the particular circumstances and risks, rather than being deterministic.

The determination of compliance driven interventions is primarily based on the application of our enhanced pole calculator, as set out in section 4.2. However, our pole calculator does not capture poles that are classified as unserviceable due to factors such as repeated termite attacks or fungal fruiting (as these are not part of our pole serviceability calculations). These pole interventions, therefore, are identified separately through our RCM process.

4.1.2 Risk-driven interventions

In addition to compliance-driven interventions, the application of our approach identifies risk-driven interventions that target pole replacements with the highest asset-risk cost (i.e. due to higher probability and/or consequence of failure). In figure 8 above, for Powercor, these risk-driven interventions include those poles categorised as C3 and C4, however, only C3 interventions with a serviceability index less than 0.7 are included in our forecast for the 2021–2026 regulatory period. For CitiPower, risk-driven interventions represent a sub-set of C4 categories.

The inclusion of risk-driven interventions recognises that in high-risk locations (i.e. BCA and SWER lines in REFCL areas) the consequence of failure may 'outweigh' the probability of failure, such that the cost of intervening is not grossly disproportionate to the benefits of intervening earlier than for a similar condition pole located in LBRA.

4.2 Enhanced pole calculator

The purpose of this section is to explain how we determine pole condition or serviceability, and the enhancements we are proposing to make to our existing 'pole calculator'.

The condition of a wood pole is assessed using the 'pole calculator' to determine the serviceability of each pole. The pole calculator is a program that our pole inspectors use in the field. Inspectors enter the pole inspection data on site, and the algorithm in the program uses the input data to compute a serviceability classification depending on the specified safety factor. As already noted, in 2019 we increased the safety factor from 1.25 to 1.4.

Under the proposed enhancements to our asset management approach for wood poles, we will implement an enhanced pole calculator to ensure a more accurate engineering assessment of the residual strength of wood poles. The major change is to explicitly recognise wood fibre strength degradation in determining the residual strength (or 'structural capacity') of the pole. In doing so, the enhanced pole calculator will consider the impact of asset age on the residual strength of each pole in assessing its serviceability.

In addition to the explicit consideration of fibre strength loss over time, based on species and diameter loss, the revised approach provides flexibility to account for contemporary limit state design (**LSD**) loadings calculated in accordance with AS 7000:2016 Overhead Line Design (**AS 7000**).

The enhanced pole calculator will determine serviceability based on the serviceability index (**SI**) shown in equation 1.

Equation 1 Serviceability index

$$SI = \frac{\text{Residual Capacity}}{\text{Design Load}}$$

Using the enhanced pole calculator, the serviceability index is a measure of the LSD residual structural capacity ('residual capacity') of the pole divided by the ultimate LSD load ('design load'). The residual capacity (**F_{rs}**), is determined from equation 2.

Equation 2 Residual capacity

$$F_{rs} = \frac{\emptyset f_{bs} Z_s}{h} \times 10^{-6}$$

where:

- $\emptyset$ is the strength reduction factor for wood poles, derived from AS 7000
- f_{bs} is the residual fibre strength of the pole, and includes the fibre strength degradation factor for the age of the pole which is derived from ENA research[24]
- Z_s is the residual section modulus of the pole at the section 'h' distance from the tip of the pole to the ground.

Over time, the implementation of the enhanced pole calculator will provide a more comprehensive assessment of each pole's condition, which will ultimately provide a better safety outcome for our customers and the community. In this regard, ESV has made the following observations regarding our proposed enhancements to the pole calculator: [25]

> *Powercor plans to adopt Serviceability Index-based criteria as the basis for its serviceability assessment. This will provide more explicit representation of fibre strength degradation and the capacity to incorporate actual design loading on the pole (i.e. rather than to assume adequate safety factors). This new approach should lead to more accurate representation of the likelihood of pole failure over time.*

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[24] ESV concluded that this ENA research provides a reasonable basis for enhancements to our pole calculator algorithms to incorporate strength degradation more explicitly. PAL ATT245: ESV, *Powercor - wood pole management, Sustainable wood pole safety management approach, Detailed technical report*, December 2019, p. 82.

[25] PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 20.

Powercor also intends to introduce a risk-based asset management (RBAM) intervention criterion based on a methodology that takes into account both the likelihood of failure of poles and the consequences of failure. Based on the information provided by Powercor, it will target poles that provide a high consequence of failure, typically AC Serviceable poles located in HBRA. This proposed approach is a positive step and will increase the number of poles replaced or reinforced over time.

We welcome ESV's comments, noting the further work required to implement the enhanced pole calculator.

4.2.1 Simulated pole calculator outcomes

We have applied our existing pole condition data to our enhanced pole calculator to estimate the serviceability index of poles for each of the bushfire consequence categories outlined previously in figure 8. The application of our existing data through this approach has been reviewed by an independent expert.[26]

The outcome of the simulation of our enhanced pole calculator is presented in table 4 for Powercor, and table 5 for CitiPower. For CitiPower, the application of our enhanced pole calculator has resulted in a proportion of poles that are currently classified as unserviceable being forecast to return to an added control – serviceable or serviceable state (due to pole diameter now being better recognised, and CitiPower's network historically having larger diameter poles).

Table 4 Powercor: simulated pole calculator outcomes mapped to fire classification (2021–2026 pole volumes)

Pole condition classification	LBRA	HBRA	REFCL (non-SWER)	REFCL (SWER)	BCA (ELCA)
Unserviceable: Serviceability index < 0.65	1,742	1,060	9,220	1,489	1,696
Added control – serviceable: 0.65 ≤ serviceability index < 0.70	1,163	831	19,438	4,349	776
Added control – serviceable: 0.70 ≤ serviceability index < 0.75	6,225	3,722	21,704	4,639	456
Serviceable: 0.75 ≤ serviceability index < 1.0	42,847	31,033	42,054	10,170	2,082
Serviceable: Serviceability index ≥ 1.0	40,311	42,376	55,011	15,021	1,487

Source: Powercor

26 See, for example, PAL ATT140 or CP ATT040: Revo Group, *Impacts of the revised pole calculator*, January 2020. It should be noted, however, that we applied a higher pole loading utilisation percentage than Revo Group for REFCL and BCA areas. Our approach was accepted as reasonable by ESV, given the higher potential consequences in these areas.

Table 5 CitiPower: simulated pole calculator outcomes mapped to fire classification (2021–2026 pole volumes)

Pole condition classification	LBRA	HBRA	REFCL (non-SWER)	REFCL (SWER)	BCA (ELCA)
Unserviceable: Serviceability index < 0.65	1,553	-	-	-	-
Added control – serviceable: 0.65 ≤ serviceability index < 0.70	990	-	-	-	-
Added control – serviceable: 0.70 ≤ serviceability index < 0.75	3,037	-	-	-	-
Serviceable: 0.75 ≤ serviceability index < 1.0	20,007	-	-	-	-
Serviceable: Serviceability index ≥ 1.0	16,726	-	-	-	-

Source: CitiPower

As our business-as-usual inspection and maintenance program continues (and captures the full detail required for our enhanced pole calculator), we will further calibrate our serviceability index to better link serviceability assessments to the probability of pole failure. In addition, the LSD load calculation for each pole will be undertaken.

Our roadmap to implement the above factors is being developed as part of our wood pole management improvement plan that is required to be submitted to ESV by 28 February 2020.[27] This plan details the decision by our strategic asset management committee in January 2020 to endorse our enhanced pole management approach.

[27] Consistent with recommendation one of ESV's draft report for our wood pole management practices. PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 2.

5 Options analysis

In section 4, we outlined proposed enhancements to our asset management approach to address the identified need, including the recommendations set out by ESV. The development of our risk-based asset management intervention methodology was recommended by ESV.[28]

In this section we present the forecast interventions resulting from this approach (i.e. option three), and compare these to two alternative wood pole replacement program options and a range of high-level sensitivities.

5.1 Assessment of credible options for wood pole replacements

5.1.1 Option one: maintain the status quo (with improved safety factor of 1.4)

This option would maintain the changes that we introduced in March 2018, namely:

- an increase in the frequency of our inspection and testing process from 30 months to 12 months for all limited life poles
- an increase in the safety factor from 1.25 to 1.40 for all wood poles on our network.

ESV investigated the efficacy of the above approach, and concluded that:[29]

> *[s]ince March 2018, Powercor has improved its wood pole management system, which has the effect of increasing the volume of wood pole replacements and reinforcements. However, these changes alone will not deliver sustainable wood pole safety outcomes for the future.*

We accept ESV's conclusion.

It is also important, and a requirement under the Rules to give appropriate weight to the concerns expressed by our stakeholders, as reflected in public forums and through public statements made by Members of Parliament, as described in section 3.1. A key focus of these concerns relates to the age of our wood pole population; the low percentage of current pole replacements; and the perception of unacceptably high safety risk.

The feedback we have received is clear that we need to do more than 'maintain the status quo', if community concerns are to be assuaged. We consider the case for further action in option two, below.

5.1.2 Option two: improved safety factor of 1.4 and maintain average age

This option adopts the same improved safety factor of 1.4 as set out in option one, but commits to augment the condition-based replacement volumes so that the current average age of the pole population is maintained.

As shown previously in figure 6, the risk of asset failure accelerates for class three poles as their age increases beyond 45 years. At present, the average age of our wood pole population (43 years) is slightly below this threshold level, but many of our poles already exceed 45 years of age.

Table 6 summarises the annual pole replacement volumes under option two over the 2021–2026 regulatory period, for Powercor.[30]

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[28] Refer, for example, to recommendations seven and nine of ESV's draft report. PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 21.

[29] PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 1.

[30] As we consider this option is unlikely to optimise the safety and cost outcomes for our customers, we have not presented the corresponding volumes for CitiPower.

Table 6 Powercor: annual pole replacement volumes for option two

Description	Annual volume
Maintain status quo (with improved safety factor of 1.4)	2,491
Additional replacement volume to maintain average age of wood poles	2,020
Total replacement volumes	**4,511**

Source: Powercor

A key question from an asset management perspective is whether it is prudent and efficient to base our pole replacement plans on an objective of maintaining the average age of the pole population. In our view, this approach is preferable to option one as it directly addresses the feedback we have received from customers and stakeholders, which raised concerns about the risks associated with an ageing wood pole population. Having said that, an asset management approach that is focused on the average age of the pole population is unlikely to optimise the safety and cost outcomes for our customers.

5.1.3 Option three: implement proposed enhancements to our pole calculator and serviceability index

This option involves implementing the enhancements to our asset management approach to wood poles, as described in chapter 4. As explained in that chapter, this approach will employ best practice techniques to assess pole condition and the probability and consequences of asset failure.

Our forecast total intervention volumes for the 2021–2026 regulatory period, for both Powercor and CitiPower, are shown in table 7 and table 8.

Table 7 Powercor: forecast pole intervention volumes (2021–2026)

Forecasting component	Replacements	Reinforcements	Total
Compliance-driven interventions: pole calculator	11,413	4,570	15,983
Compliance-driven interventions: non-pole calculator	5,877	2,354	8,231
Risk-driven interventions	3,588	11,968	15,556
Total	**20,878**	**18,892**	**39,770**

Source: Powercor

Table 8 CitiPower: forecast pole intervention volumes (2021–2026)

Forecasting component	Replacements	Reinforcements	Total
Compliance-driven interventions: pole calculator	1,252	301	1,553
Compliance-driven interventions: non-pole calculator	610	153	763
Risk-driven interventions	-	2,617	2,617
Total	**1,862**	**3,071**	**4,933**

Source: CitiPower

The forecast volumes outlined above are based on the simulated pole calculator outcomes presented previously in table 4 and table 5 (for Powercor and CitiPower respectively):

- all poles assessed as unserviceable (regardless of fire classification location) are forecast to be replaced or reinforced, as required to comply with our obligations described in section 4.1.1
- poles assessed as added control – serviceable, with a serviceability index less than 0.70 and located in BCA areas, are also forecast to be replaced or reinforced as compliance-driven under our general duties obligation to minimise risk as far as practicable (recognising these are the highest consequence areas within Victoria)
- additional compliance-driven interventions are forecast to capture the percentage of poles that will transition to an unserviceable classification due to factors other than condition (i.e. based on our 2019 RCM study, approximately 9% of poles that are 'managed' throughout the forecast period will become unserviceable due to defects identified above two meters on the pole, repeat termite attacks, or fungal fruiting)[31]
- for Powercor, risk-driven interventions are forecast as the balance of poles assessed as added control – serviceable with a serviceability index less than 0.70 and located in REFCL areas, minus those forecast to become unserviceable due to factors other than condition—this ensures compliance-driven obligations are prioritised
- for CitiPower, risk-driven interventions are forecast to maintain a historical reinforcement rate of approximately 82% (excluding poles classified as unserviceable that are already reinforced, recognising the only available intervention activity for these poles is replacement).

It should also be noted that we have applied this methodology to derive indicative forecasts of intervention volumes for the 2026–2031 regulatory period. These forecasts are set out in table 9, and provide confidence that the intervention volumes identified in the 2021–2026 regulatory period are consistent with longer-term, sustainable replacement volumes.

Table 9 Forecast pole intervention volumes in future regulatory periods (2026–2031)

Forecasting component	Powercor	CitiPower
Compliance-driven interventions: pole calculator	26,261	854
Compliance-driven interventions: non-pole calculator	6,209	184
Risk-driven interventions	10,000	2,000
Total	**42,470**	**3,038**

Source: CitiPower and Powercor

31 For Powercor, our 2019 RCM study estimates that approximately 91,485 wood poles will be 'managed' throughout the forecast period, and approximately 8,480 for CitiPower. A managed pole is that which will transition between our pole classification categories.

5.2 Sensitivity analysis

In addition to considering alternative asset management options, we compared our forecast pole intervention volumes against a range of alternative metrics. These metrics are described in table 10. It is important to recognise, however, that each of the sensitivity measures outlined are agnostic to the unique characteristics of our pole population. That is, unlike our risk-based asset management approach, they do not consider factors such as the location of the pole, and therefore, the consequence of failure.

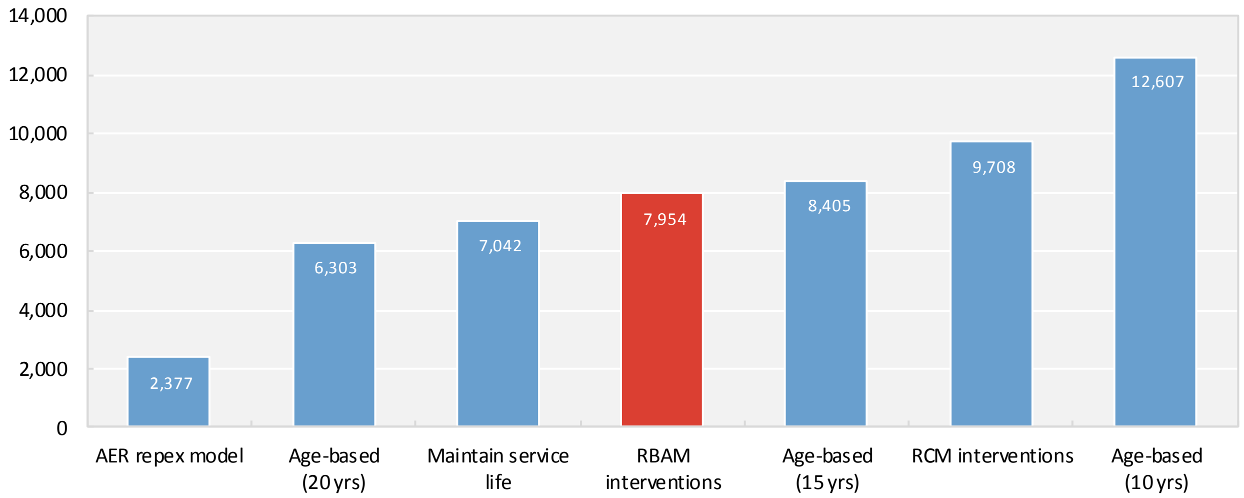
Table 10 Sensitivity metrics

Measure	Description
AER repex model	The AER's repex model provides a forecast of replacement volumes based on historical replacement practices for four alternative scenarios. For the purpose of our sensitivity analysis, we have used the 'expected lives' scenario (consistent with past AER practice). As outlined throughout this document, our historical replacement practices do not reflect the asset management practices that will be implemented over the 2021–2026 regulatory period (i.e. they reflect replacement practices that ESV have explicitly stated will not result in sustainable pole replacement volumes). In this context, comparisons to the AER's repex model represent an unrealistic lower-bound.
Maintain service life	The average age of wood poles on our network at the time of failure is 51 years. As a simple cross-check, dividing our total wood pole population by this age can be used to imply an annual volume of replacements that would maintain an average service life.
Condition-based	Our 2019 RCM study provided an estimate of expected replacement volumes over the 2021–2026 regulatory period based on condition. Our sensitivity metric also includes poles of unknown durability class (consistent with our asset management policy, these are treated as class three poles), and derives total annual intervention volumes based on our historical replacement rate (i.e. the proportion of poles replaced versus reinforced).
Age-based	This measure considers the existing volume of wood poles on our network that are 51 years or older (i.e. the average age of our wood poles at failure), and considers alternative intervention programs to address these poles over 10, 15 and 20 years. This measure does not recognise that additional wood poles will transition into the >51 years age bracket throughout the measured period.

Source: CitiPower and Powercor

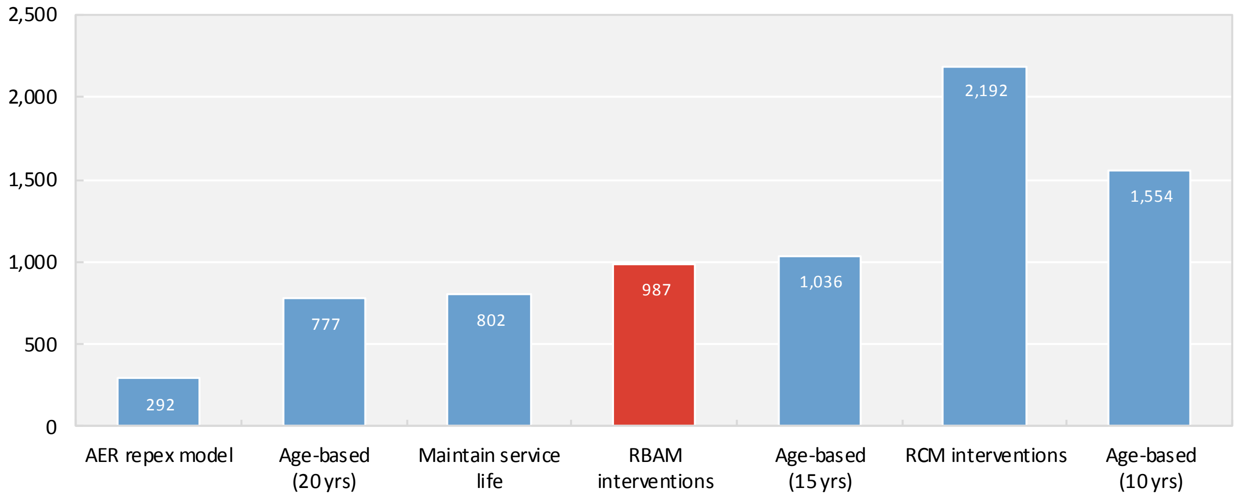
A comparison of the above sensitivity measures against our proposed risk-based asset management approach is shown in figure 9 and figure 10. Given the limitations of each of these measures, any comparisons should be used with caution. Notwithstanding this, our forecast intervention volumes based on proposed enhancements to our pole calculator and serviceability index are reasonably consistent with the maintain service life and age-based replacement estimates, and are lower than the alternative forecast using our 2019 RCM study.

Figure 9 Powercor: sensitivity analysis (annual pole interventions)



Source: Powercor

Figure 10 CitiPower: sensitivity analysis (annual pole interventions)



Source: CitiPower

5.3 Recommended option

For the reasons set out in this paper, our enhanced asset management approach for wood poles is expected to deliver improved safety outcomes for our customers and the community. It reflects contemporary asset management practices, and addresses the concerns expressed by our stakeholders in recent months. The approach is supported by ESV, which has made the following recommendation: [32]

[32] PAL ATT176: ESV, *Draft report: Powercor wood pole management, An assessment of sustainable wood pole safety outcomes, Public technical report*, December 2019, p. 21.

Powercor is to complete the development of its pole risk-based asset management intervention methodology as it is likely to improve the management of pole risk. If implemented appropriately, this approach will enable Powercor to prioritise the poles for intervention in higher risk areas by considering the consequence of failure to the community.

Table 11 shows our proposed capital expenditure for pole replacement for the 2021–2026 regulatory period, which reflects the intervention volumes set out in option three in section 5.1.3. The forecast volumes reflect our best estimates in advance of fully implementing the proposed enhancements to our asset management approach.

Table 11 Capital expenditure forecasts: pole replacement program ($ million, 2019)

Capital expenditure forecast	2021/22	2022/23	2023/24	2024/25	2025/26	Total
CitiPower	11.8	11.8	11.8	11.8	11.8	58.9
Powercor	46.8	46.8	46.8	46.8	46.8	233.8

Source: CitiPower and Powercor

In relation to our capital expenditure forecasts, we have also reduced our proposed replacement capital expenditure in relation to cross-arms and LV services. This work will be undertaken as part of our increased pole replacement program, and therefore offsetting reductions have been made to the cross-arms and LV services replacement programs.