Attachment 03.1

PowerWater

2016-17 Opex Base Year

2019-20 to 2023-24

16 March 2018

PowerWater

Contents

1. Purpose and structure of this document

This appendix:

- analyses and explains how our operating expenditure (opex) for our Standard Control Services (SCS) has evolved over the 2014-19 regulatory period; and
- compares our 2016-17 opex for SCS to that of our network peers at a detailed category analysis level and explains material differences.

It supports our regulatory proposal (the proposal) to the Australian Energy Regulator (AER) and references other supporting documentation that further explain and justify the detail of our 2016-17 opex for SCS.

Unless otherwise stated, all historical opex numbers in this document are presented in $nominal and include direct costs, overheads, and any escalation.

The analysis in this attachment relies on draft version of our response to the AER's Regulatory Information Notice (RIN). The data used will differ to that presented elsewhere in our proposal and in the final audited version of our RIN response submitted to the AER in March 2018.

The primary reason for the difference is due to changes in the treatment of lease costs. The other differences are considered immaterial and are a result of the audit review.

Power and Water utilises operating leases to meet the majority of our motor vehicle and some of our property needs. This in contrast to many other distribution network service providers (DNSPs) who own their property and vehicles outright. Excluding these lease costs from this document is considered to be appropriate to allow for meaningful benchmarking,

Therefore, to enable meaningful comparisons of operating expenditure, lease costs have been excluded from our operational expenditure in this document. We understand that the leasing of corporate headquarters is standard practice amongst DNSPs and, as such, they have been incorporated in the analysis below.

A detailed exploration of Power and Water's approach to the treatment of leases is set out in Attachment 1.20.

2. Overview

This overview section provides context prior to more detailed discussions in subsequent sections. In particular, we:

- summarise current regulatory period trends, identifying significant expenditure changes;
- recognise the impact of external cost drivers on our current expenditure;
- compare our current (2016-17) expenditure to our peers at a high level; and
- highlight the areas where we are looking for future efficiencies.

The following chapter discusses external cost drivers that may impact multiple opex categories. Subsequent chapters consider how these and any other factors may affect each AER cost category individually – namely, maintenance, emergency response, vegetation management, non-network, network overheads and corporate overheads.

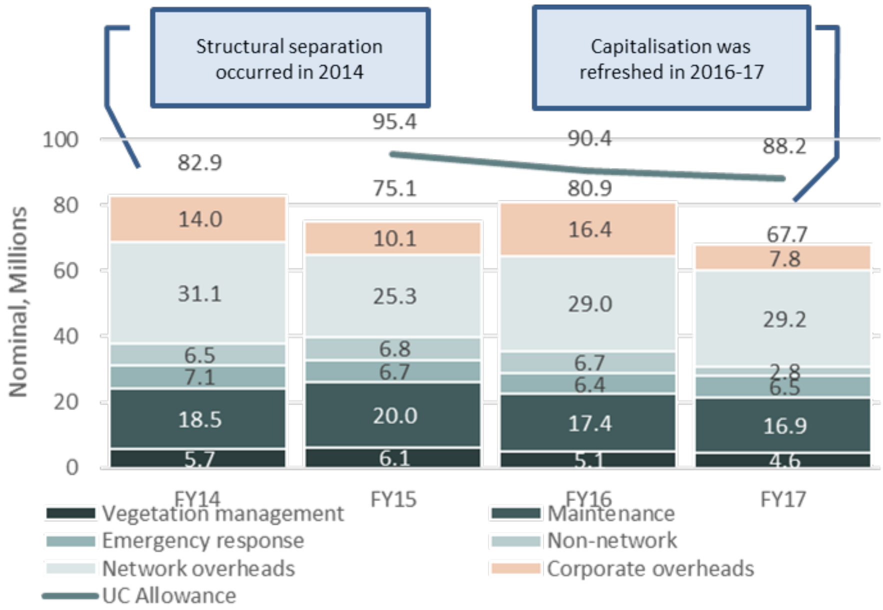
2.1 Current regulatory period trends

Overall, we have reduced our opex by 18% between 2013-14 and 2016-17, which is below the Utilities Commission (UC) allowance and evidence of us achieving efficiency improvements.

Network opex has reduced between 2013-14 and 2016-17, driven mainly by maintenance costs reducing from $18.5 million to $16.9 million ($nominal). To a smaller extent, emergency response costs reduced from $7.0 million to $6.5 million ($nominal) and vegetation management reduced from $5.7 million to $4.6 million ($nominal).

Corporate and network overheads, although a little more volatile, reduced from $14.0 million to $7.8 million ($nominal) and $31.1 million to $29.1 million ($nominal) respectively.

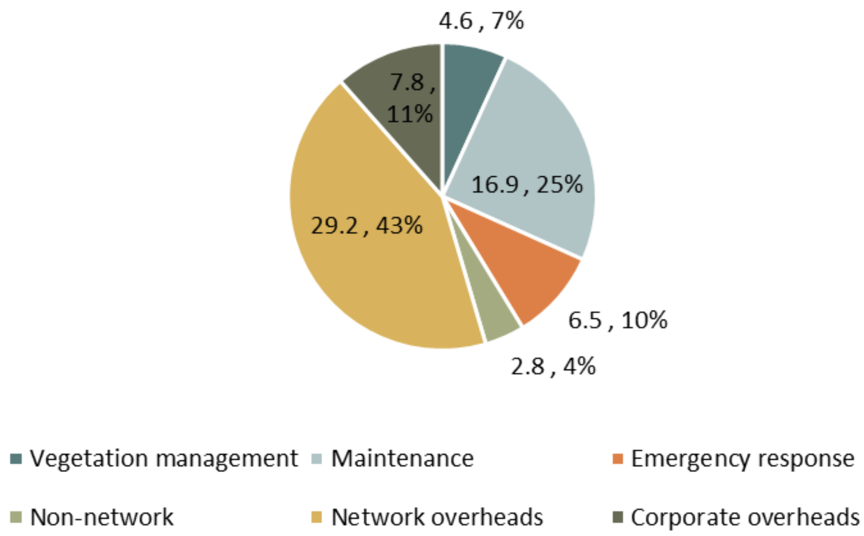
Figure 2.1: Historical opex by category. Nominal, $Million



(a) Source: CA RIN (2.1 Expenditure summary), Utilities Commission Decision for 2014-15 to 2018-19.

The split of activity for the 2016-17 base year is summarised in Figure 2.2.

Figure 2.2: Base year opex split by AER category. Per cent



(a) Source: CA RIN (2.1 Expenditure summary)

Key changes to the base opex in the current regulatory period are summarised in table 2.3, and discussed further in subsequent sections.

Table 2.3: Significant changes to our opex over the current regulatory period

AER cost category	Nature of change
Routine and non-routine maintenance opex	• Optimisation of routine maintenance strategies across a range of asset classes as a result of improved understanding of asset condition, failure modes and direct engagement with other utilities to align with best practice. • Expenditure has typically decreased for substation assets as a result of replacing four major substations due to age and condition in recent years.
Emergency response opex	• Expenditure has been stable as replacement programs have had a positive impact in the current period compared to the previous period where increasing failure rates were being observed. • We have experienced unusually mild wet seasons – which affect the northern part of our network (Darwin and Katherine) – in the last few years.
Vegetation management opex	• Reduction in cyclic clearance of corridors in favor of targeted clearance, based on maintenance requirements and condition. • Combining regional contracts into a single Northern Territory (NT) wide contract to maximise the value of the contract and encourage more market participation.
Network overheads opex	• New accounting standard applied from 2016-17 regarding capitalisation of motor vehicle and property leases. • Increased number of staff populating timesheets from 2014, leading to an increase in labour recoveries. • Capitalised more network overheads from 2016-17 for regulatory reporting purposes due to better recognition of capital-based cost drivers.
Corporate overheads opex	• Transition of the regulation team and finance functions from corporate to the Power Networks business unit which increased our network overheads. • Capitalised more corporate overheads from 2016-17 due to better recognition of capital-based cost drivers.

2.2 Recognising external cost drivers

Businesses in the NT – including ours – face several unique environmental cost drivers that can either increase the amount of activity required or increase the cost of each activity undertaken.

Table 3.1 in the following chapter identifies 11 such cost drivers, and groups them into two broad categories – extreme weather conditions and adverse network characteristics. We discuss these drivers in chapter 3 and how they affect specific cost categories in subsequent chapters.

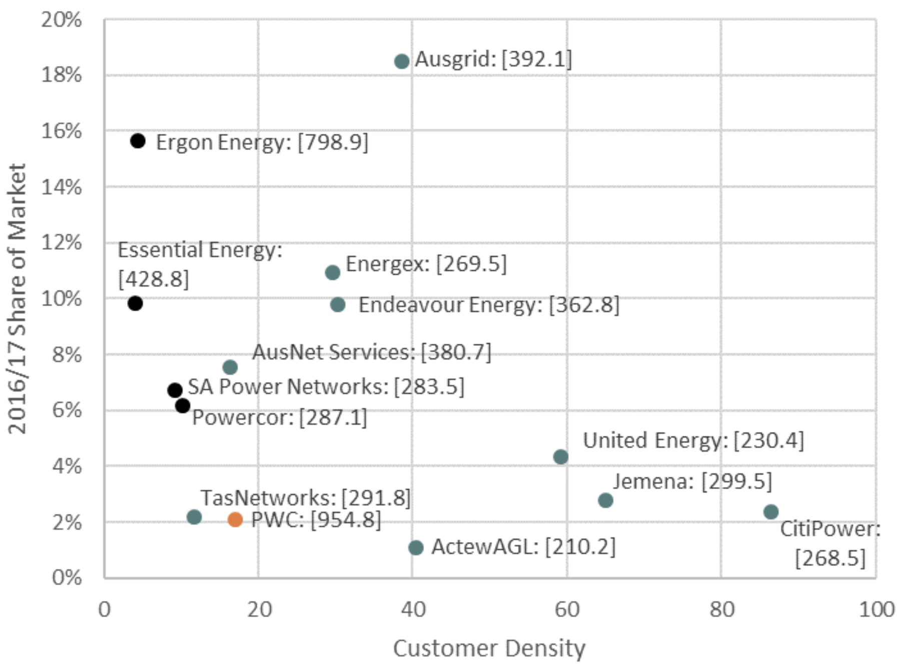
2.3 Comparison to other networks

We are the smallest network in the National Electricity Market (NEM) in terms of customer numbers, energy delivered and maximum demand. Yet, we have among the highest – if not the highest – consumption and demand per customer. This makes it a challenging network to operate and manage.

This document uses our RY17 base year opex for SCS and compares our performance to other networks using their 2016 or 2015-16 RIN data as it is the best publicly available information.

We contribute 2.1% of the roughly $3.2 billion ($nominal) in total opex incurred by the 14 distribution network service providers (DNSPs) regulated by the AER.

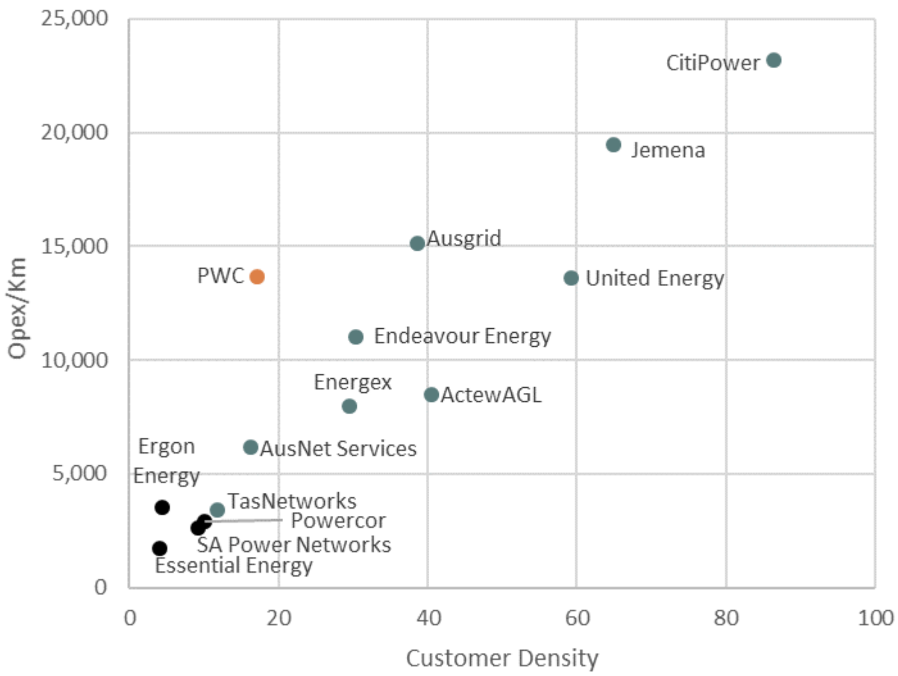
Figure 2.4: Share of total DNSP opex. Per cent



(a) 2016 Share of Market = DNSP 2016 opex / total 2016 opex.
(b) Opex per customer, shown in [] after network name = DNSP 2016 opex / 2016 customer numbers for DNSP.
(c) The black markers indicate our network peers including Ergon Energy, Essential Energy, SA Power Networks and Powercor.

We acknowledge that we do not compare favourably on basic benchmarking measures such as cost per customer and cost per kilometre of route line length, largely due to our unique circumstances.

Figure 2.5: Opex per kilometre of route line length by peer. Nominal. Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

(b) The black markers indicate our network peers including Ergon Energy, Essential Energy, SA Power Networks and Powercor.

This document explains the reasons for this result and why the proposed opex base year is appropriate. In general:

- our vegetation management, non-network and corporate overhead expenditure is comparable to that of other networks;
- our emergency response expenditure is at the higher end of peer rankings, but is explainable due to the extreme weather conditions faced in the NT and challenges accessing the network at times (e.g. during and up to several months after the wet/summer season that affects the north of our network); and
- our maintenance and network overhead expenditure appears high and, although some of this can be explained by external cost drivers such as our lack of scale, there appears to be room for further efficiency improvement.

2.4 Base year efficiency

As identified in section 2.3, when compared to other networks, there appears to be some room for improvement in certain opex categories such as maintenance and network overheads.

However, prior to making any base year efficiency adjustments we should recognise that:

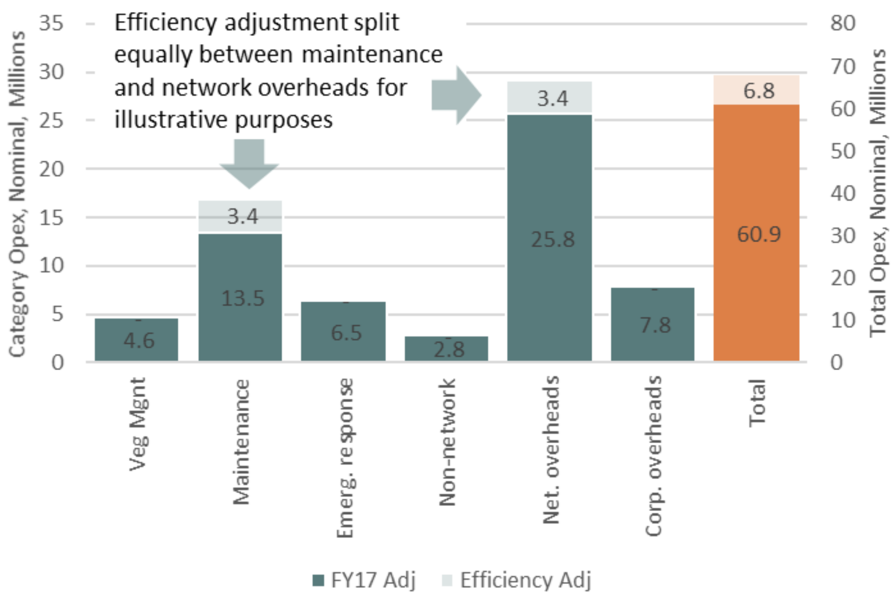
- although on some measures our base year may look comparable or higher relative to other networks, the efficiency target only needs to be modest because most of the difference is explained by our unique circumstances; and

- we have already achieved cost reductions over the last four years, in part, due to the cost initiatives identified in each cost category (discussed in the chapters that follow) and we continue to look for more.

Therefore, as discussed in chapter 11 of our regulatory proposal, we are proposing a 10% overall opex reduction to target those areas for improvement. The efficiency adjustment to be made to the 2016-17 opex base year equates to a reduction of $7.1 million (real 2019) per year or a total of $35.5 million over the regulatory period – or $84 per year for each of our customers.

Given that our performance against other networks differs by opex category, Figure 2.6 shows how we expect the 10% efficiency reduction would likely be allocated. This is indicative only as actual reductions will be based on the implementation of specific initiatives identified in the proposal. The $6.8 million ($nominal) shown for the 2016-17 is equivalent to the $7.1 million (real 2019) noted above, once adjusted for inflation.

Figure 2.6: Potential allocation of proposed efficiency adjustment by cost category. Nominal, $Million



(a) Sources: CA RIN and support material.

(b) Note the location of these efficiency adjustments are purely illustrative

3. Common external cost drivers

This section explains some of the environmental challenges driving costs which are specific to the NT. Each of these common external cost drivers impact multiple opex categories either by creating more work within our network or increasing the cost of the work performed by our team.

Table 3.1: Common external cost drivers and the impacted AER cost categories

Attributes	External cost driver	Cost categories impacted
Extreme weather conditions	Wet and dry seasons (affecting the north of our network)	Maintenance, emergency response and vegetation management
	Extreme heat	Maintenance, emergency response and vegetation management
	High rainfall	Maintenance, emergency response and vegetation management
	High humidity	Maintenance, emergency response and vegetation management
	High winds	Emergency response and vegetation management
	High UV exposures	Maintenance and vegetation management
	Storms and cyclones	Maintenance, emergency response and vegetation management
	Lightning strikes	Maintenance, emergency response and vegetation management
Adverse network characteristics	Lack of scale	Maintenance, emergency response, vegetation management, corporate overheads and network overheads
	Dispersed and diverse micro networks	Maintenance, emergency response, vegetation management and network overheads
	High labour rates	Maintenance, emergency response, vegetation management, corporate overheads and network overheads
	Unique rules, laws and compliance	Vegetation management, corporate overheads and network overheads

This chapter describes the unique circumstances identified in the table in detail and subsequent chapters will refer back to this material when describing the impact on specific cost categories.

3.1 Extreme weather conditions

The combination of extreme weather such as high average temperatures, high rainfall, high humidity and storms during and after the wet season (affecting the north of our network) all contribute to higher operating costs for our network.

The extreme weather conditions in the northern part of the NT are characteristic of the tropical/monsoonal north of Australia, which is typically considered to have two seasons, “wet” and “dry”. The periods between these seasons are typically the most extreme in terms of heat due to the lack of monsoonal rainfall despite the intense build-up of heat and humidity. These conditions also produce severe storm cells that cause intense lightning, flash flooding and high winds.

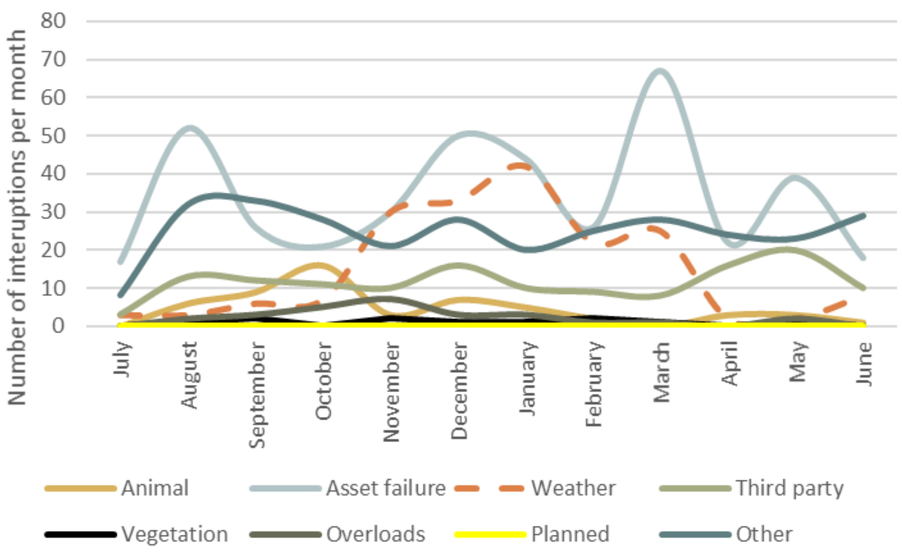
3.1.1 Wet and dry seasons

Over 80% of our network exists in the northern regions, which are subject to the annual “wet” and “dry” season cycles and the transitory weather patterns as the seasons change.

Monthly activity in the current period follows the normal “wet season” and “dry season” profile with peak activity occurring in the wet season.

As an example, the number of interruptions is highly correlated to the time of year or weather which is not something that we can control.

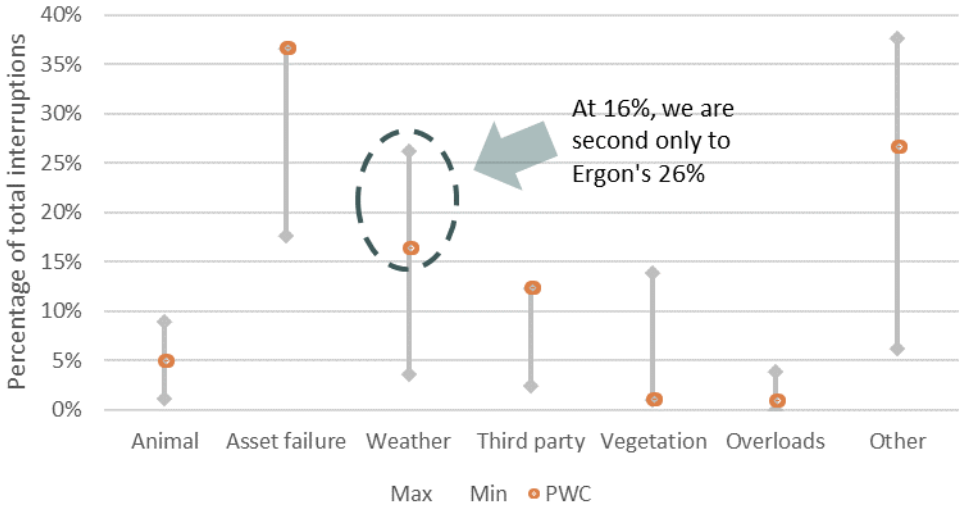
Figure 3.2: Interruptions by type and month. Number, RY17



(a) Source: CA RIN, 6.3 Sustained interruptions.
(b) Based on total interruptions between 1 July 2016 and 30 June 2017.

Figure 3.3 below demonstrates that our share of weather interruptions and asset failures are significantly higher than others.

Figure 3.3: Distribution by type of interruptions. Per cent, RY16



(a) Source: CA RIN, 6.3 Sustained interruptions.
(b) 'Min' represents the DNSP with the lowest interruptions for that type of activity divided by their total interruptions from all interruption types.
(c) 'Max' represents the DNSP with the highest interruptions for that type of activity divided by their total interruptions from all interruption types.

Wet season

The wet season may include intense tropical lightning storms and strong gusty weather before and after monsoon periods particularly in October/November and often towards the end of the wet season.

Dry season

The dry season is characterised by stable weather conditions and low system loads. Access to the system infrastructure is not impeded by weather and road conditions, plus crews are not at risk from transferred voltages due to reduced lightning activity.

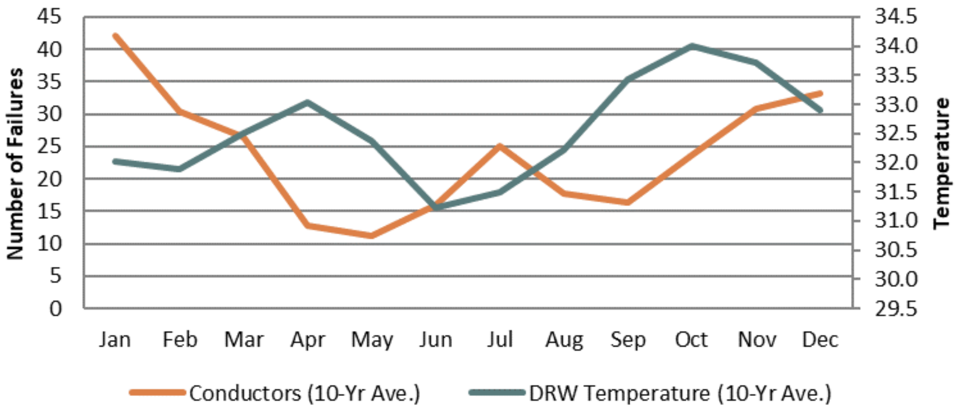
However, animal activity is counter cyclic, as more activity is observed in benign weather periods as animals seeking shelter and roosting positions lead to animal related failures.

Shoulder seasons

The periods between the wet and dry seasons are typically the most extreme in terms of heat due to the lack of monsoonal rainfall despite the intense build-up of heat and humidity. These conditions also produce severe storm cells that cause intense lightning, flash flooding and high winds. This intense "build-up" period leads to a significant rise in system loads as air conditioner demand peaks.

One indicator of this is the spike in failures in June and July as temperatures begin to rise without the relief of rain.

Figure 3.4: Conductor failures by month. Number

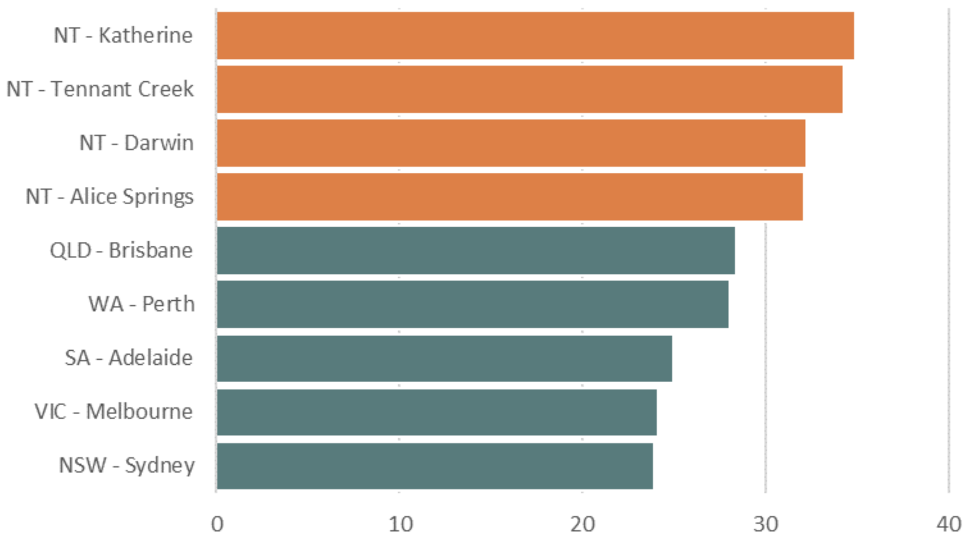


(a) Number and failures and temperatures based on data between 2007-08 and 2016-17.
(b) Source: Power and Water.

3.1.2 Extreme heat

Figure 3.5 below demonstrates the extreme heat that the NT experiences through the wet season in the north and through summer and into early spring in the south.

Figure 3.5: Mean maximum temperatures (degrees C)



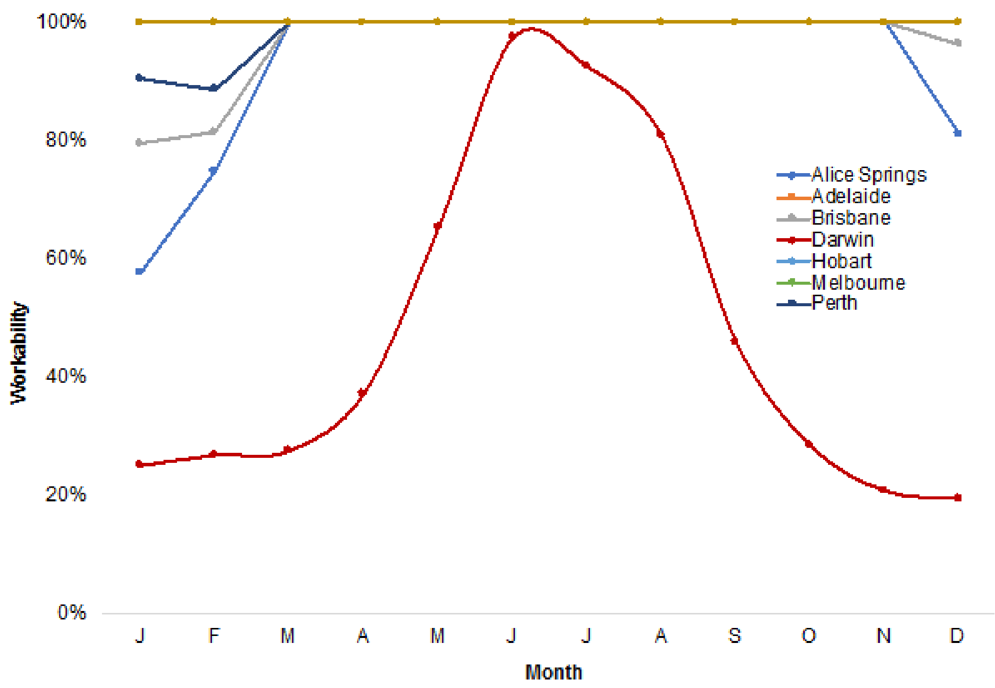
(a) For the months from November through to May.
(b) Source: Bureau of Meteorology (BOM).

These conditions have a significant impact on field crew productivity. We experience work safety issues, especially during the wet season. “Apparent temperatures” result in a significant loss of productivity and three-man crews are required in the wet season, compared to two-man crews in the dry. The additional crew member is required in the wet season as conditions require frequent work/rest cooling breaks to ensure workers do not overheat and core temperatures remain at safe levels.

Considerable work has been undertaken to manage the risks to our crews associated with our working conditions. To consolidate this work, we commissioned an analysis, *Labour Efficiency and Work Management in Hot Humid Climates*[1], to assess the workability and productivity effects for opex work in the NT environment. The analysis also sought to understand how this compares to other regions of Australia, as well as different areas of the NT itself.

Using actual booked labour for FY 16/17, an overall workability factor for opex work has been calculated and applied against this labour to determine the cost effect of work in the tropics. Our overall workability, averaged over the year for all workgroups, was assessed at 68% (i.e. 68% work, 32% rest) which means that productivity is reduced by 32% compared with regions which have 100% workability. Figure 3.6 shows the workability impact on other states is minimal with only Brisbane and Perth being impacted to a small degree in the summer months.

Figure 3.6: Monthly workability for selected Australian locations for high metabolic rate



(a) Sources: Thermal Hyperformance Pty Ltd. [2]

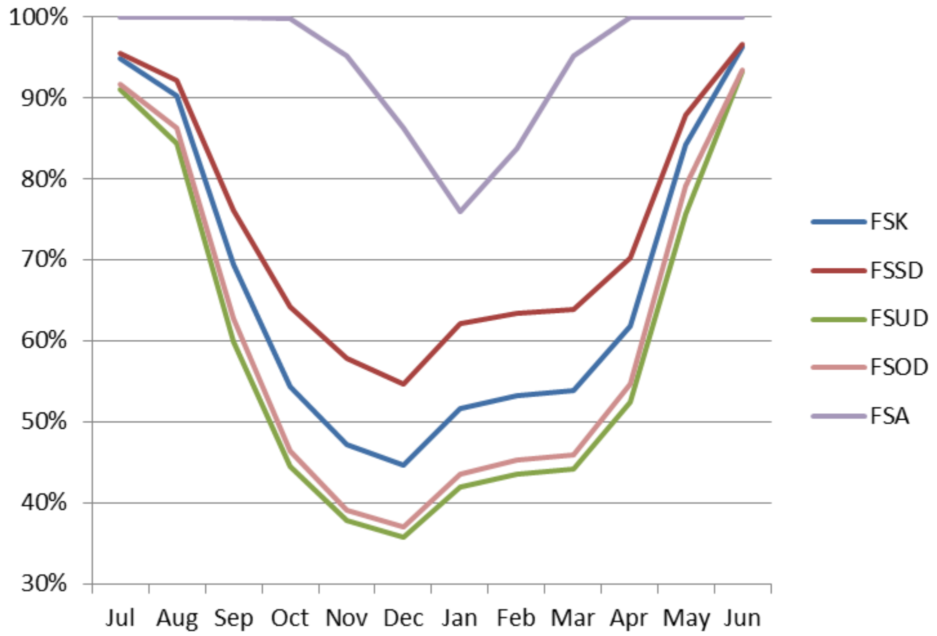
(b) We commissioned this report to cover Darwin and Alice Springs, as well as the other capital cities for comparison. The report relied on our own metabolic rate assessment and labour data. The analysis was prepared based on International Standard ISO 7243 (*Ergonomics of the thermal Environment — Assessment of heat stress using the (WGBT) wet bulb globe temperature index*). Actual WGBT data was derived from BOM data provided through the Climate Chip data service.

[1] A study and paper - "Workability and Impact on Darwin and Alice Springs" was performed by Matt Brearley PhD, Managing Director, Thermal Hyperformance Pty Ltd.

[2] A study and paper - "Workability and Impact on Darwin and Alice Springs" was performed by Matt Brearley PhD, Managing Director, Thermal Hyperformance Pty Ltd.

Figure 3.7 focuses on our results for a selection of internal work groups. At the extreme level of assessment one group scored a low of 37% in December which equates to 37% work versus 63% rest.

Figure 3.7: Workability: the proportion of work vs rest at various metabolic work rates



(a) Sources: Thermal Hyperformance Pty Ltd. [3]

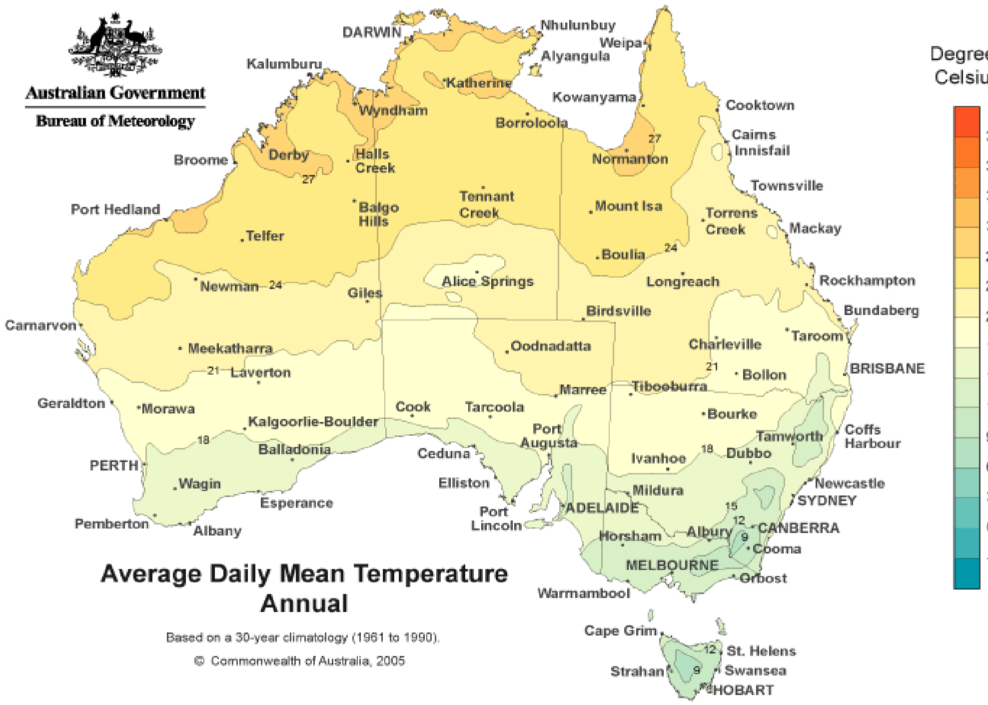
(b) The acronyms in the legend stand for our maintenance groups who have different work rates and locations including Katherine (FSK), substation Ssrvices (FSSD), Darwin Underground (FSUD), Darwin Overhead (FSOD), and Southern Region (FSA).

This highlights that the annual averages in figure 3.6 mask the extremes faced by us in the wet season.

The map in Figure 3.8 also demonstrates the difference geographically on an annual basis. It shows the vast majority of electricity customers in the NEM are located in areas with a daily mean temperature below 21 degrees (Celsius). This is compared to the NT where all but 14% of customers are in areas with a mean above 21 degrees and 84% above 27 degrees.

[3] A study and paper - “Workability and Impact on Darwin and Alice Springs” was performed by Matt Brearley PhD, Managing Director, Thermal Hyperformance Pty Ltd.

Figure 3.8: Average daily mean temperatures across Australia (Degrees Celsius)

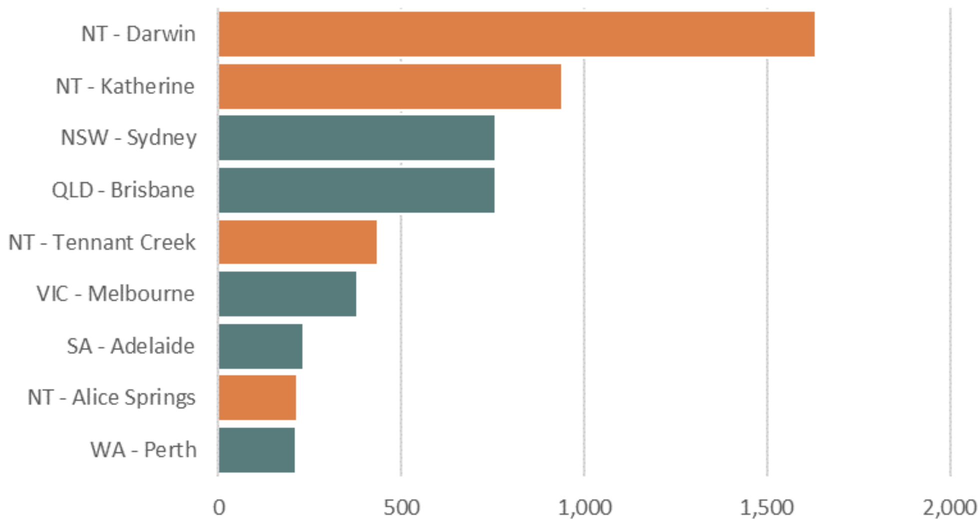


(a) Source: BOM.

3.1.3 High rainfall

Figure 3.9 shows parts of our network experience above normal amounts of rain.

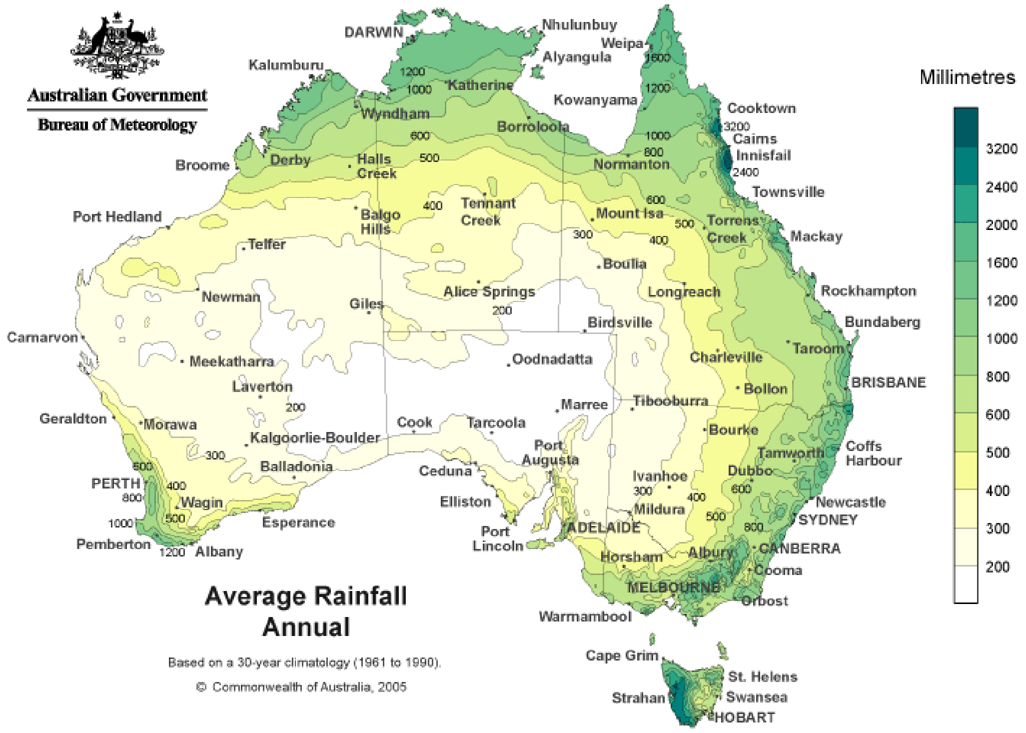
Figure 3.9: Mean rainfall (mm)



(a) For the months November through to May.
(b) Source: BOM.

The map in Figure 3.10 also demonstrates the difference in rainfall on an annual basis geographically. Most electricity customers in the NEM are located in areas with average annual rainfall well below the rainfall experienced in the northern region covering the Darwin and Katherine network.

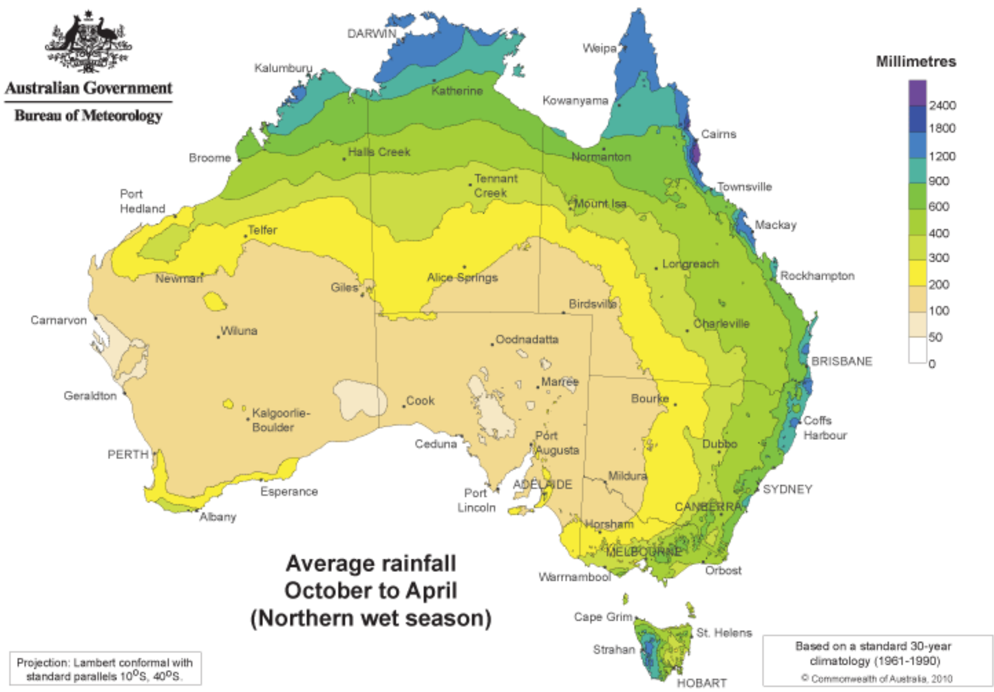
Figure 3.10: Mean rainfall across Australia (mm)



(a) Source: BOM.

Figure 3.11 demonstrates why, when discussing rainfall, it is important to distinguish between the wet and dry seasons, particularly in the north of the NT. In contrast to more general high annual rainfall, which facilitates vegetation growth, seasonally high rainfall creates unique network access and degradation issues which increase our costs.

Figure 3.11: Mean rainfall across Australia (mm), October through to April



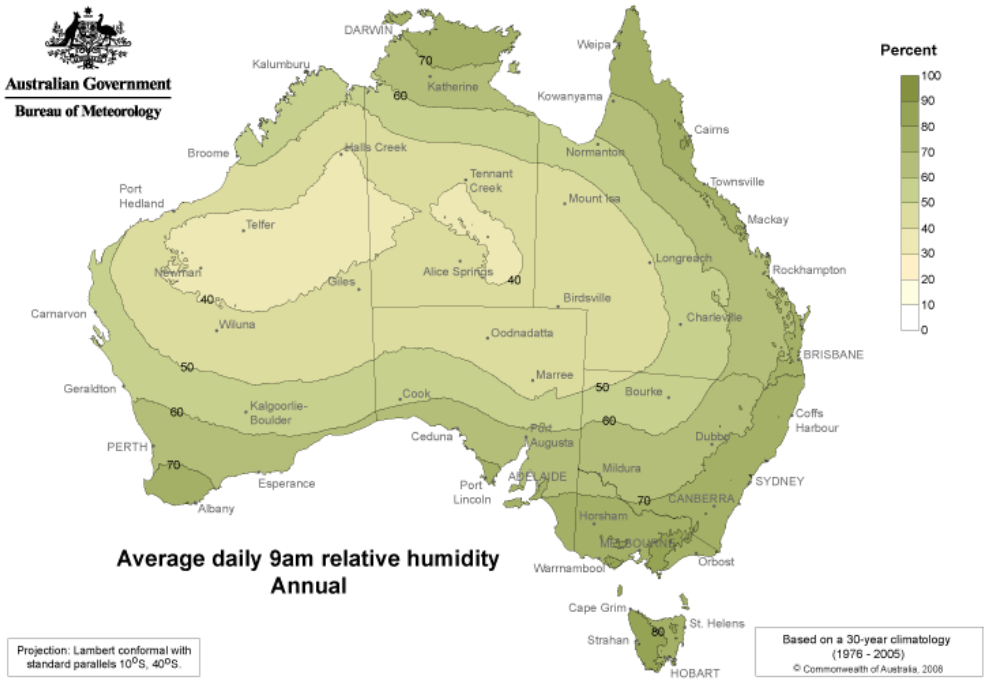
(a) Source: BOM.

From a maintenance perspective, periods of high rainfall promote fungal activity, corrosion and asset failures which leads to higher volumes of inspections. The extreme wet weather, including flooding, also restricts access to inspect assets, maintain lines, and conduct vegetation management while increasing vehicle operation costs.

3.1.4 High humidity

Figure 3.12 shows the NT experiences high humidity during the wet season, even early in the day.

Figure 3.12: Mean 9am relative humidity (per cent, annual)



(a) Source: BOM.

Although humidity is also high along the eastern seaboard it is the combination of extreme heat, high rainfall and humidity which creates challenges for us:

- High humidity supports fungal activity, corrosion and asset failures leading to a higher volume of inspections and increased vegetation growth rates.
- The combination of high humidity and high temperatures during the wet season also increases the risk of heat stress among staff who require frequent rest/work breaks. This generally increases the number of staff required to attend faults and may extend the work time.

For example, Darwin experiences 284 days per year where temperatures are above 30 degrees and relative humidity is often well above the 40% lower bound which feels greater than 33 degrees and individuals can only be fully productive for 22% of the time.

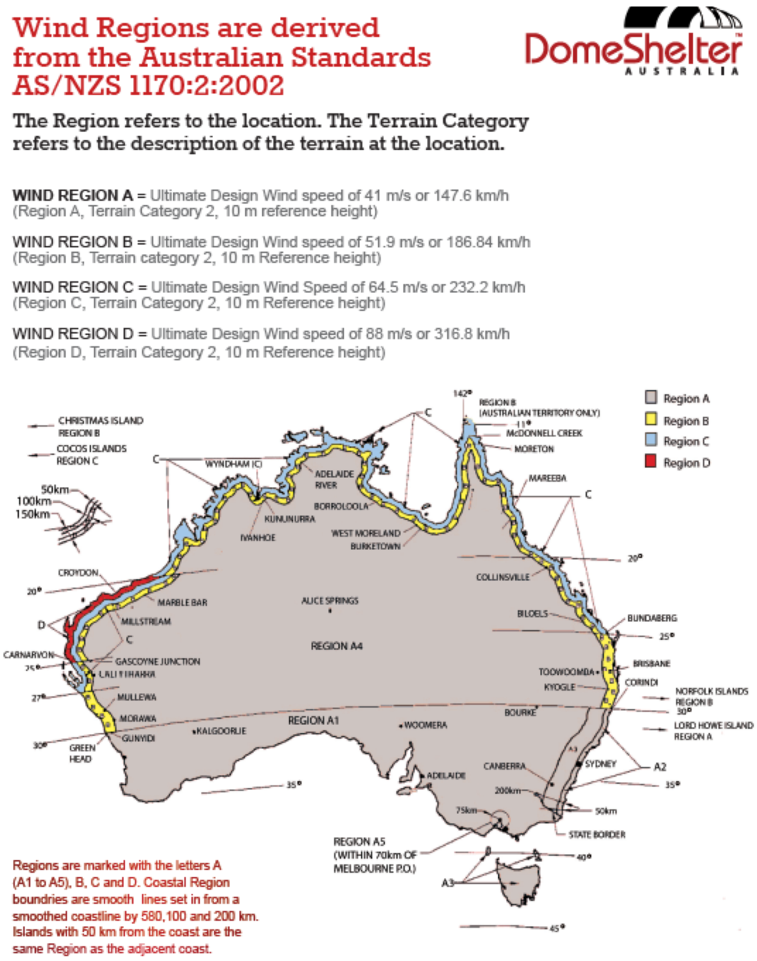
3.1.5 High winds

On the change of seasons there can be periods of strong wind gusts associated with frequent storm cells in the NT, which blow vegetation and other materials into infrastructure causing damage and emergency response requirements.

During the wet season, frequent “tropical lows” create similar adverse conditions for extended periods. While direct cyclone impact in heavily populated areas is rare (but with significant impact), the northern region is frequently influenced by cyclones developing or passing through the Arafura Sea.

Figure 3.13 shows high winds are specific to the northern region, including Darwin, which contains 83% of our customers. We have the second highest category of Australian building standards as the northern coastline can be exposed to winds of up to 232 km/h.

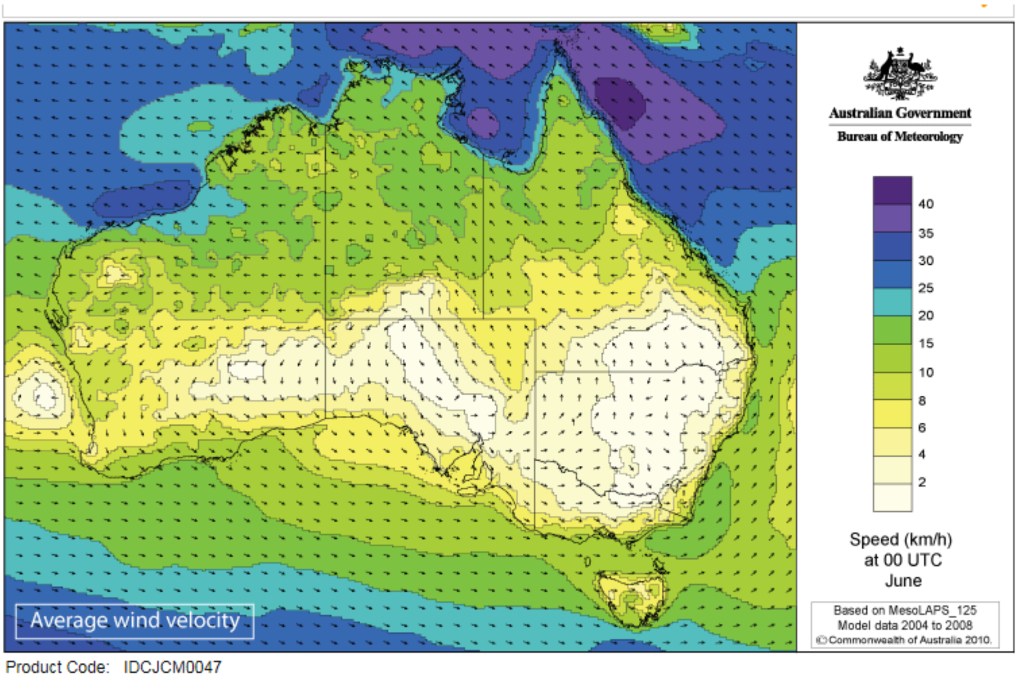
Figure 3.13: Australian wind regions



(a) Source: DomeShelter Australia.

Average wind velocity maps also show that the inland southern region experiences relatively high winds throughout the year.

Figure 3.14: Australian average wind velocity



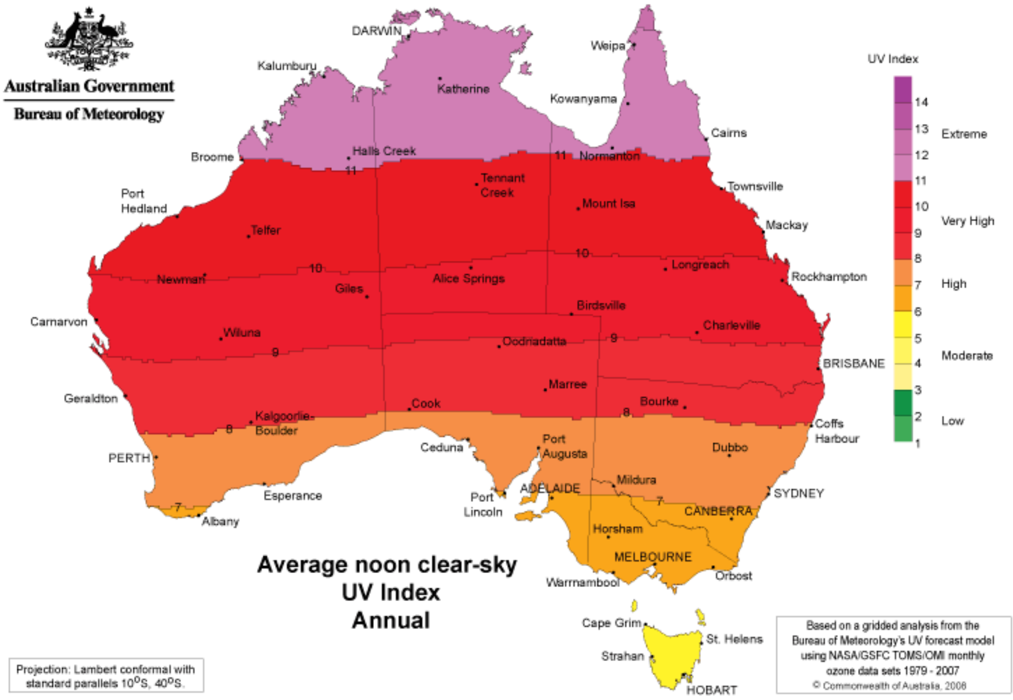
(a) Source: BOM.

3.1.6 High Ultra Violet (UV) exposures

The extreme UV environment of northern Australia accelerates the deterioration of plastics, polymers, and cellulose construction materials particularly conductor insulation or covers and plastic components commonly used by other networks for animal protection and in overhead line switchgear.

We are therefore required to use better quality or different materials – and therefore more expensive – components on our network to withstand the UV environment where we can, or otherwise be faced with the risk of replacing those components earlier than other networks.

Figure 3.15: Average annual UV index



(a) Source: BOM.

This deterioration often leads to insulation failures and subsequent interruptions leading to higher emergency response and maintenance costs. An increasing trend in incidents related to pillar box cover degradation, including electric shocks to members of the public, has caused us to increase the level of inspections performed on these assets.

High UV exposure is also an occupational health and safety issue which ultimately leads to lower workforce productivity.

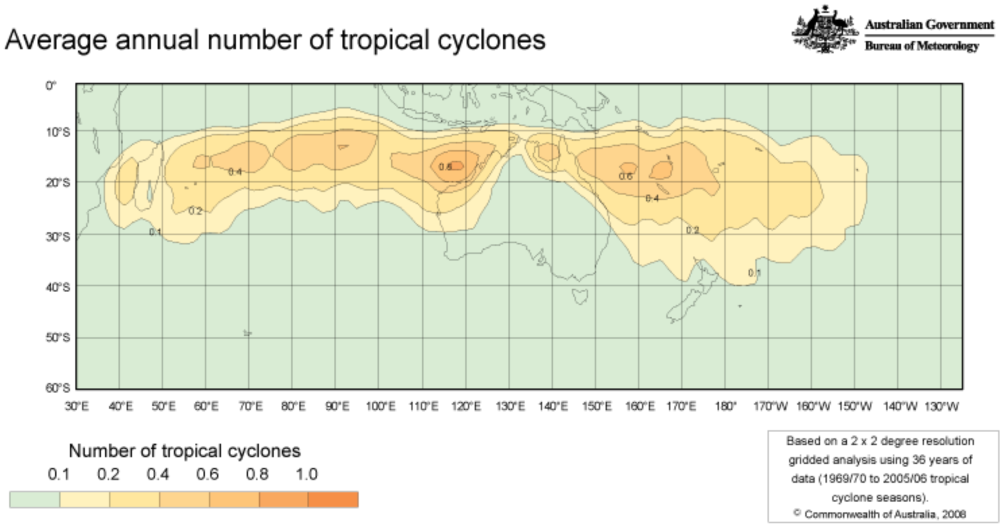
3.1.7 Storms and cyclones

The northern tip of Australia is more prone to cyclones and lightning strikes than the rest of Australia.

The small size of Darwin's network means that severe storms, including lightning, can affect a significant proportion of the customer base at any one time. Typical storm activity in the wet season can result in multiple simultaneous faults across a wide area. For example, lightning data from a severe storm in 2016 shows that lightning activity impacted most of the Darwin region.

Even if a cyclone does not directly impact the network, the associated concentrated rainfall and wind can cause extensive damage to the network.

Figure 3.16: Average annual number of tropical cyclones



(a) Source: BOM.

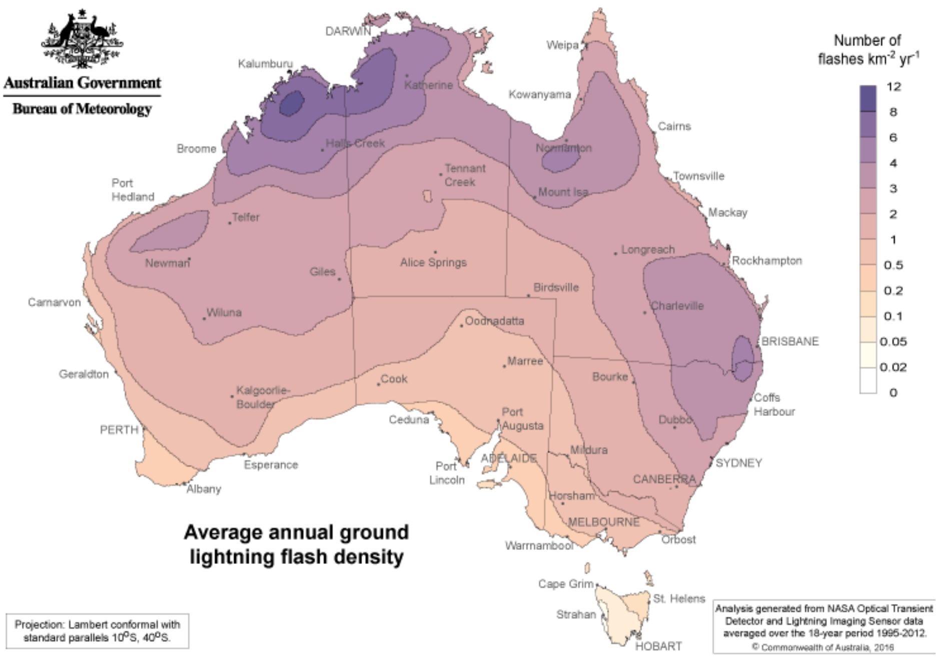
We undertake intensive pre-cyclone season work (inspection and remediation) each year to mitigate the possible effects of cyclones. Following a cyclone, we must clear the debris from the infrastructure and surrounds, inspect the network and perform repairs and maintenance as required to restore supply.

To perform preparation and restoration activities, field crews, supervisors, managers, asset managers/engineers, network planners and business management resources are diverted from other operational tasks.

3.1.8 Lightning strikes

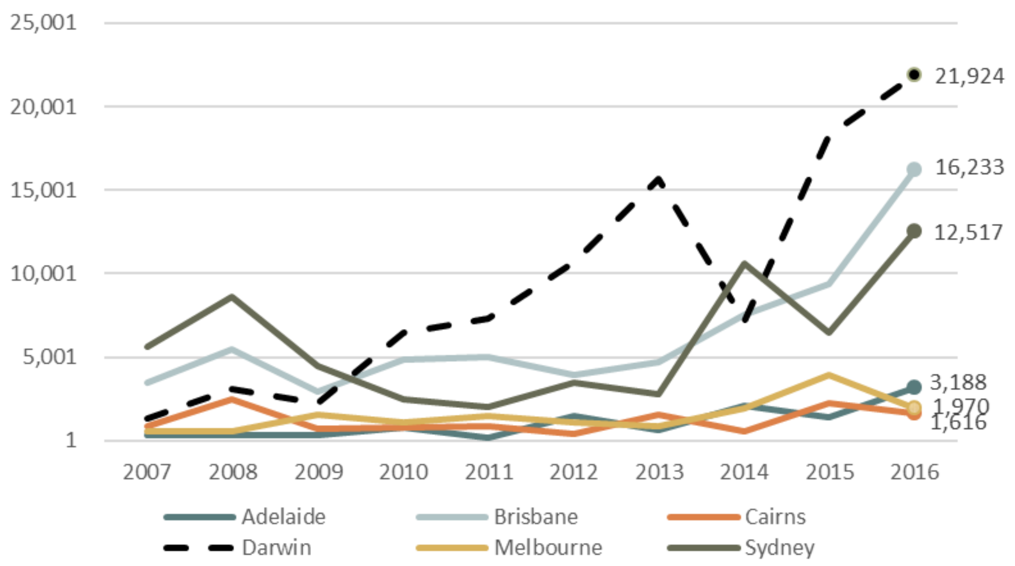
The Darwin and Katherine regions have the highest frequency and intensity of lightning in Australia as shown by figure 3.17 and 3.18.

Figure 3.17: Average annual ground lightning flash density



(a) Source: BOM.

Figure 3.18: Annual volume of observed lightning strikes by Australian city



(a) Source: GPATS system.
(b) Note that accuracy of data has improved over recent years due to more sensors being used to identify lightning strikes in Northern Australia. This may explain some of the uptick in observations over more recent years.

In the north of the NT, lightning generally occurs early in the wet season, around November, during the build-up and before the rain commences in earnest.

Figure 3.19: Example of the severity of Darwin lightning strikes

(a) Source: www.dailymail.co.uk/news/article-3970326/Cooking-storm-Chef-captures-breathtaking-lightning-strikes-Darwin-enjoying-evening-beer-balcony.html.

Lightning also occurs, to a lesser degree, at the end of the wet season in March.

Lightning strikes lead to significant stresses on network equipment, frequent operations of protection equipment and drive the high emergency response rate and expenditure in the wet season months.

Surge arrestors are installed on all overhead substations, switchgear and transitions to minimise the damage associated with lightning. Direct lightning strikes are still common, leading to a significant rise in equipment failure rates during the wet season, including distribution transformers, surge arrestors, conductors, and pole tops (insulators, connectors).

Conductor and pole top hardware failures are often related to previous lightning damage evidenced by obvious aged arcing damage to conductor strands and subsequent corrosion.

Figure 3.20: Example of conductor corrosion and lightning damage from NT network

(a) Source: Power and Water Corporation (Power and Water).

The high concentration of lightning activity also raises the risk of injury to field crews during repair activity which in some instances delays response activity and/or extends the time taken to complete the required work.

3.2 Adverse network characteristics

3.2.1 Lack of scale

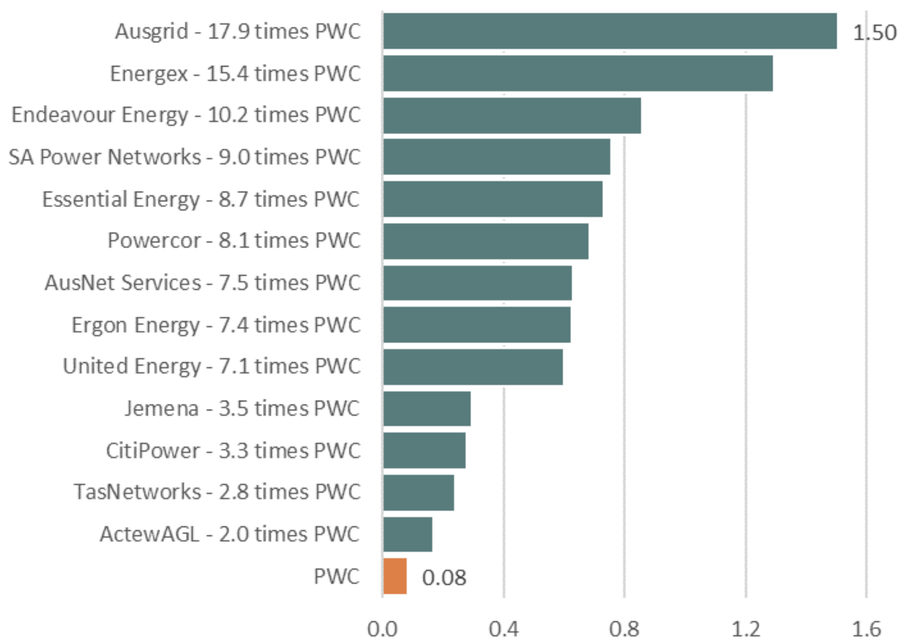
We are a relatively small distribution business, consisting of three micro networks servicing customers with relatively high energy demand. The networks deliver 1,779,501 MWh of energy to 85,710 customers via 4,580 kilometers of route line length.

This means the fixed costs required to manage and operate networks within the NEM cannot be spread across as many customers or kilometres of line making us look more expensive relative to our peers on a unit rate basis.

We have the fewest customers

We have a small number of customers and connections who share the fixed and variable costs of operating the three micro networks. The next smallest network amongst our Australian peers, in terms customer numbers, is twice the size of ours and the largest peer is almost 18 times our size.

Figure 3.21: Network Customers. Millions



(a) Source: 2016 and 2015-16 Economic Benchmarking RINs.

Our population growth is the slowest

This lack of scale based on customer numbers is likely to remain an issue for us, based on the low ABS population growth forecasts for the NT.

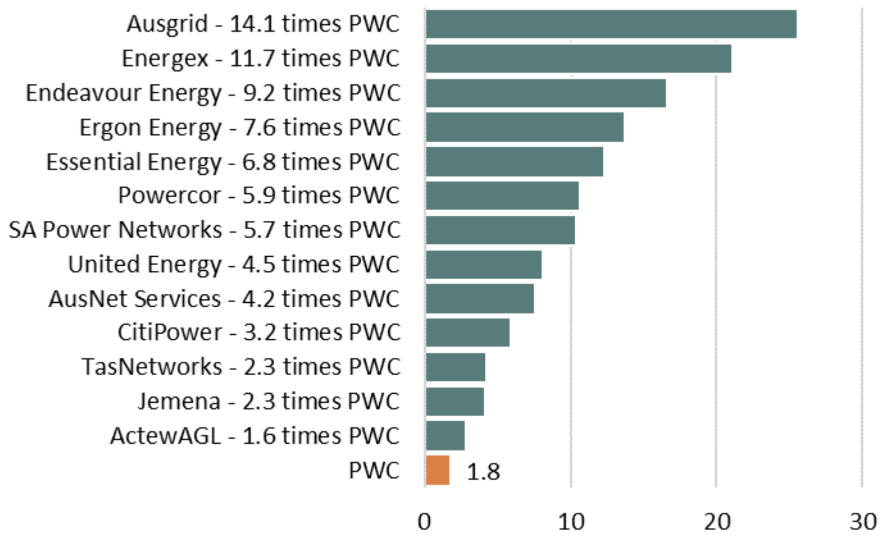
Figure 3.22: Forecast population growth. Thousands, Persons

(a) Source: ABS - Population forecasts - 31010DO001_201612 Australian Demographic Statistics, Dec 2016 - Table 9 Projected resident population–States and territories.

We deliver the least amount of energy

Due to our relatively small number of customers, we also deliver a relatively small amount of energy compared to our peers. The next smallest network amongst Australian peers, in terms of energy delivered, is 1.6 times the size of us and the largest peer is 14.1 times our size. Although energy consumption is not a significant driver of our costs, serving the least amount of energy among our peers means that we do not benefit from the same consumption-based economies of scale that our peers do.

Figure 3.23: Energy delivered by network. TWh

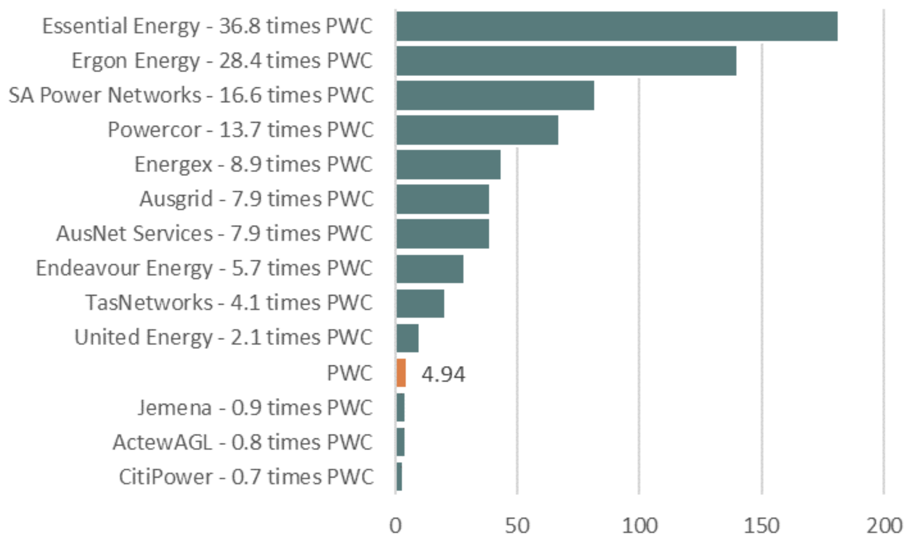


(a) Source: 2016 and 2015-16 Economic Benchmarking RINs.

Our network is one of the shortest

We are not the smallest network in terms of route line length, given the requirement to service three micro networks made up of large urban and rural regions. However, Figure 3.17 clearly shows that most networks are at least double the length of ours with the largest network being 37 times our size.

Figure 3.24: Route Line Length. Thousands, Kilometers



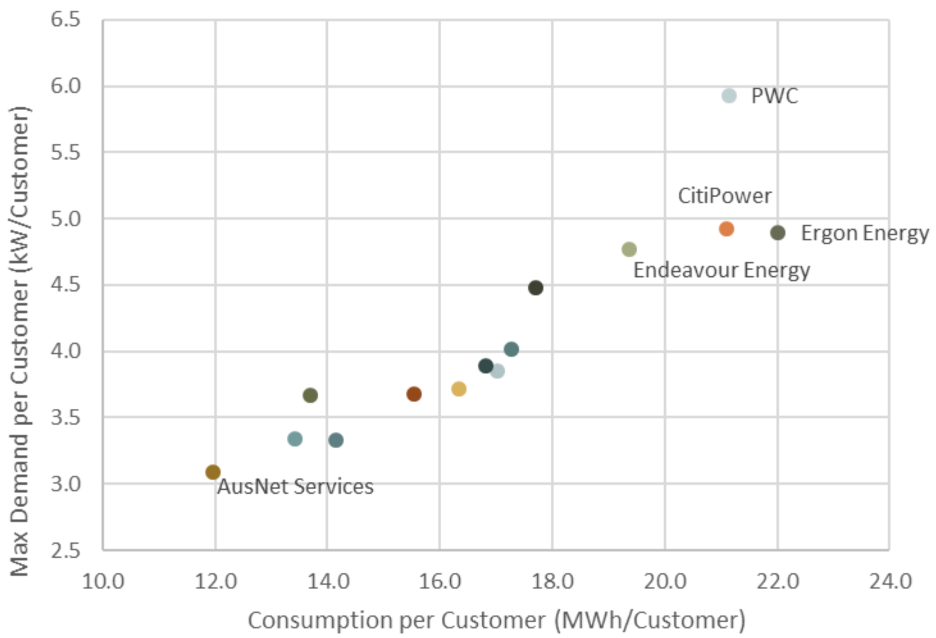
(a) Source: 2016 and 2015-16 Economic Benchmarking RINs.

Yet, our customers consume a lot

From a residential perspective the extreme heat drives customers to use air conditioners a lot, usually at the same time, which increases both consumption and peak demand.

Our commercial-sized customers are also large users of energy which is significantly influenced by air conditioner load too.

Figure 3.25: Consumption and maximum demand per customer

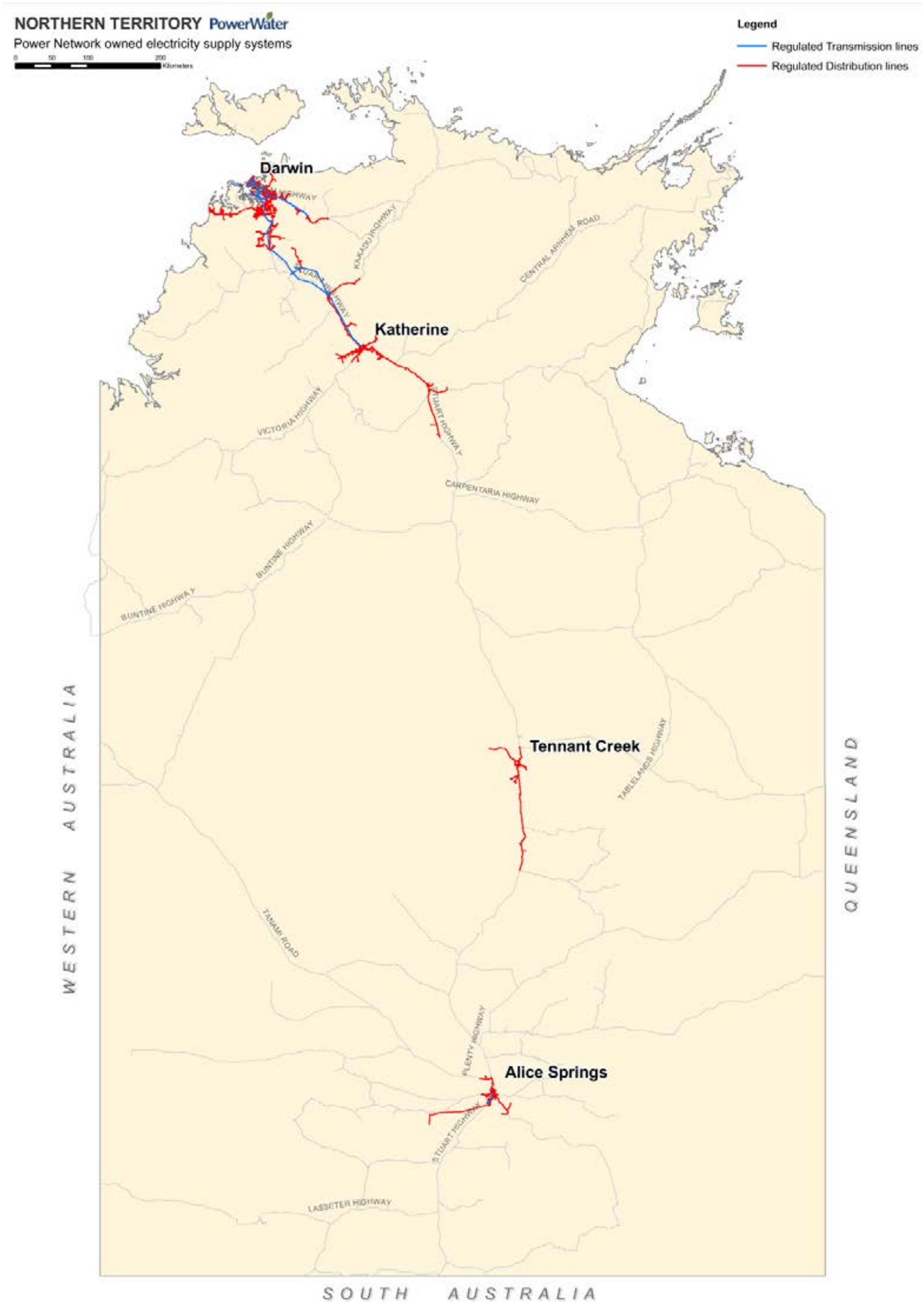


(a) Source: 2016 and 2015-16 Economic Benchmarking RINs.

3.2.2 Dispersed and diverse micro networks

Our three diverse networks Darwin-Katherine, Alice Springs and Tennant Creek are shown in figure 3.26 below. The location and distances associated with each micro network influence our response to incidents and the associated costs.

Figure 3.26: Map of Power and Water electricity networks



(a) Source: Power and Water.

We operate and facilitate connections to a transmission network, a distribution network, an urban network, and rural networks. Therefore, our personnel require a wider range of skills to provide our services.

Maintaining operations in each of the three networks is more expensive than operating a single inter-connected network due to the need to provide management, remote technical support and develop and maintain technical standards for each network.

There is high variability in temperature, rainfall, and humidity over time and between geographic areas; including, and because of, tropical and desert areas and wet and dry seasons (in the north). The high intra-network variability increases the complexity of developing optimal maintenance schedules and resource allocations.

Other factors impacted by three micro networks include staff spending longer to travel between networks and higher material costs due to the smaller volumes in each order, especially when the order is from interstate and includes high travel and freight costs.

The size and location of the three networks does not facilitate strong competition and we face choosing from a limited number of suppliers, charging premiums for services offered. These points have been recognised previously by industry consultants including the comments below by Sapere Research Group.

Observations from Sapere Research Group:

- "We acknowledge there may be some specialised technical resources that may be required to be located at remote networks to maintain supply reliability to an acceptable level. The requirement to locate resources in areas where these resources may be under-utilised is driven by the need to respond to fault conditions in acceptable time[4]"
- "Based on the Rawlinson's construction cost data referenced, it seems likely that Power and Water will experience higher procurement costs[5]"

3.2.3 High labour costs

Labour costs in the NT are higher than other states and territories due to the remoteness and high cost of living, which makes attracting skilled labour difficult. We must offer incentives to attract and retain employees and suppliers, which increases the costs associated with all AER cost categories.

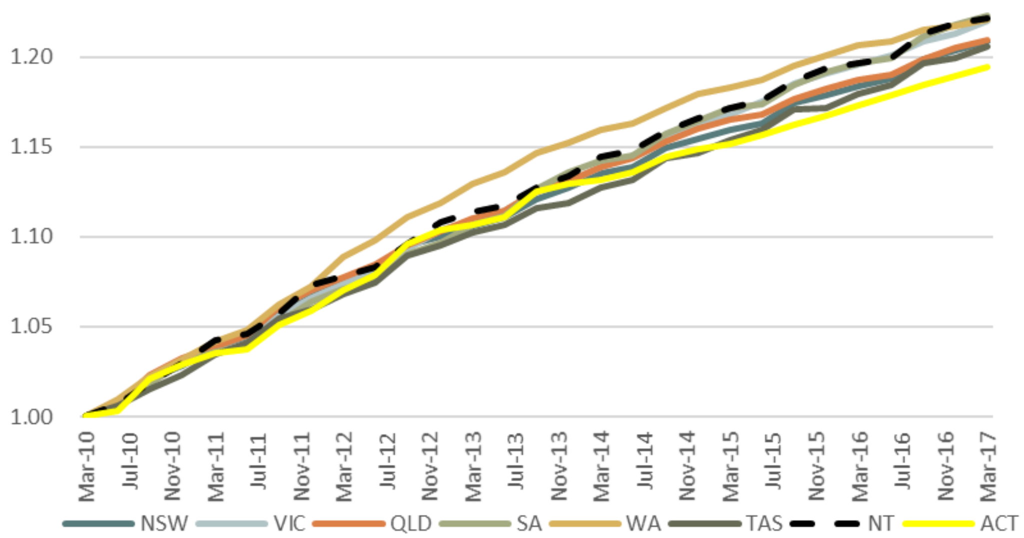
[4] Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking, Sapere Research Group, December 2017, page 64

[5] Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking, Sapere Research Group, December 2017, page 65

This point is acknowledged by Sapere Research Group where they state "Based on Australian Bureau of Statistics Wage Price Index NT public service labour cost are 20% higher than East Coast states. This suggests that higher labour unit rates are a factor that needs to be considered in the overall economic benchmarking". [6]

Figure 3.27 shows that since March 2006 the NT has experienced the second highest growth rate in total hourly rates of pay (excluding bonuses), which partially explains Sapere's finding.

Figure 3.27: Growth in total hourly rates of pay excluding bonuses by state. Index (March 2010 = 1)



(a) Each state index relative to their index value in March 2010 (starting index = 1.0).
(b) Source: ABS Data - WPI - 6345.0 Wage Price Index, Australia - All WPI Series: Original (Quarterly Index Numbers).

3.2.4 Unique rules, laws, and compliance

Like other DNSPs, we have licence and reporting obligations and must comply with environmental regulations. For example:

- Travel to and from sensitive environmental areas requires mitigation practices which reduce productivity.
- The NT has many sites of cultural significance and all programs of work need to assess and mitigate against adverse cultural heritage impacts leading to additional administration costs.

[6] Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking, Sapere Research Group, December 2017, page 65

- We must comply with more onerous building regulations and standards than other distributors due to a harsher, more extreme climate. Buildings, including substations, are inspected regularly and maintained to a high standard to ensure they can withstand cyclones, extreme weather, lightning, flooding, and corrosion.

4. Routine and non-routine maintenance opex

This section describes routine and non-routine maintenance opex activities; explains how the expenditure has evolved over the current period; and analyses how our 2016-17 expenditure compares to other networks.

4.1 Activities included

Our activities include operational repairs and maintenance of the distribution system including high voltage and low voltage assets, plus testing, investigation, validation, and correction costs not involving capital expenditure.

Routine and non-routine maintenance obligations[7]

- The network operator shall arrange for:
  - management, maintenance and operation of the electricity network such that in the satisfactory operating state, electricity may be transferred continuously at a connection point up to the agreed capability; and
  - management, maintenance and operation of its network to minimise the number of interruptions to agreed capability at a connection point on or with that network by using good electricity industry practice.

4.1.1 Routine maintenance

Routine maintenance (RM) activities include:

- inspection, survey, audit, testing, repair of assets (a pre-defined interval may be based on the number of times the asset has operated, or any other measure, if the future timing of the maintenance based on the measure can be predicted with a reasonable level of certainty);
- functional and intrusive testing of assets, including spares and equipment;
- helicopter, vehicle, and foot patrols, including negotiation of landowner access;
- environmental testing;
- indoor and outdoor maintenance of substations including lawn mowing, weed control, fire breaks, fencing; and
- load monitoring and switching activities attributable to routine asset maintenance.

[7] NT NER, Clause 5.2.3.e1. (1 and 3).

RM, or preventative maintenance (PM) activities, fall into the following categories, as defined in the Power Networks maintenance policy:

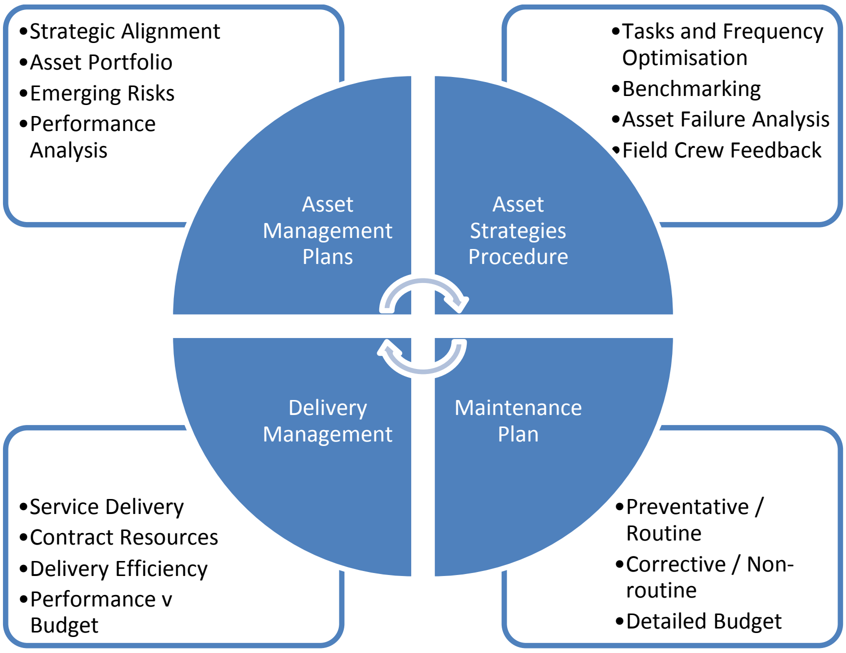
- Time-based:
  - recurrent and predominantly directed at discovering changes to asset condition that are not directly measurable and that would otherwise go undetected until failure resulting in an interruption or loss of system security; and
  - frequency has historically been based on industry benchmarking, failure trends and investigations as well as defect find-rates. The maturing asset management approach is expected to further optimize these activities based on contemporary risk management approaches and improved asset data.
- Condition Based:
  - restoring/replacing an asset to required performance levels or replacing components with a known or predictable "wear-out" period; and
  - assessing measurable asset condition indicators or asset components with a high consequence of failure if allowed to deteriorate.

In general, PM activities seek to maintain asset condition and/or to maintain the capacity of the distribution system to distribute electricity, and where the activities are:

- routine in nature;
- indiscriminately carried out for a pre-defined set of assets; and
- scheduled to occur at pre-defined intervals.

RM or PM plans are reviewed and updated annually in line with our Maintenance Management process, represented in Figure 4.1. This process ensures routine maintenance strategies are continually monitored and improved based on the latest Asset Management Plans including changes to the asset portfolio, condition trends, industry benchmarking and failure investigation outcomes.

Figure 4.1: Our maintenance governance and implementation processes



(a) Source: Power and Water.

4.1.2 Non-routine maintenance

Non-routine maintenance activities generally include:

- inspection, survey, audit, testing, repair, alteration, or reconfiguration of assets;
- functional and intrusive testing of assets, including spares and equipment; and
- load monitoring and switching activities attributable to non-routine asset maintenance.

Non-routine or corrective maintenance is defined as activities that:

- are predominantly directed at restoring asset condition or performance; or rectifying defects (excluding emergency call-outs). The timing of these activities depends on asset condition and decisions on when to maintain or replace the asset, which may vary over time and across DNSPs;
- maintain asset condition and/or maintain the capacity of the distribution system to distribute electricity; and where the activities are not routine in nature; and
- may be undertaken in a discriminate manner for individual assets.

4.1.3 Our management approach

Our approach to routine and non-routine maintenance is based on the principles of “objective need” and risk management. In other words, we optimise maintenance activity by prioritising activity based on asset condition.

Routine activities performed are described as PM within our asset management systems, policies, and processes. They are principally in place to achieve the following outcomes:

- prevent asset failure through regular maintenance activities that restore asset condition, particularly where asset components have a demonstrated wear-out or time-based failure risk. Examples include lubrication of mechanisms, insulation cleaning and corrosion prevention;
- confirm an asset's condition is acceptable based on defined performance criteria that directly impacts the safe operation of the network. Examples of this include protection system operation time and insulation condition across a variety of asset classes; and
- identify assets that are approaching end-of-life or in a condition where failure risk is above acceptable risk tolerance. These assets are then treated appropriately through a non-routine repairs or replacement.

Triggers for non-routine maintenance activities include defects identified during routine maintenance or non-routine maintenance, customers, follow on work from emergency responses activities and programs to correct asset "type-issues" which do not meet capitalization criteria.

Typically, any non-routine activity request is vetted prior to commitment to ensure the activity is prudent based on the risk associated with the particular asset defect or condition(s). This ensures activities associated with rectifying low risk conditions are deferred or completed in conjunction with other unavoidable activities on the same asset if it is efficient to do so.

Management and Resourcing

The maintenance activities for all regions is managed through our enterprise asset management system, Maximo, with planning and scheduling being performed within each of the networks through six service delivery depots. Planning for transmission and distribution primary asset maintenance is centralized to maximize efficiency opportunities related to equipment access, outage planning and resourcing between depots in the Darwin region.

Within each location, staff are rostered onto work teams which then perform the appropriate work supported by planner/scheduler and works management staff. Technical support is provided through asset management as appropriate.

We seek to provide an appropriate mix of flexibility and control consistent with the need for response and cost control. Being a small organisation, we do not maintain specialist teams and the staff in the depots are trained to perform the full range of activities although they may be rostered periodically for tasks such as emergency response.

Seasonal considerations play an important part in overall annual planning work cycles. Special consideration is required for:

- access to maintenance locations (wet season restrictions i.e. flooding, saturated ground conditions preventing vehicle access);

- access to Network (access to network during high load periods may be restricted); and
- intensity of work (high intensity work is preferred in the cooler dry season).

The small scale and generalist work regime means that efficiencies due to scales of economy and more specialised work regimes are not able to be realised.

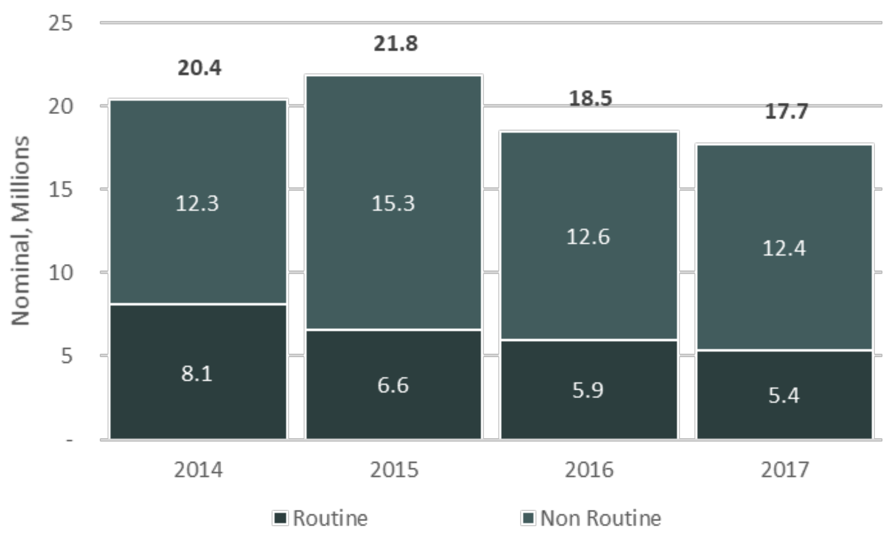
4.2 Current period opex

4.2.1 Historical performance and trends

Over the last four years, we have spent an average of $19.6 million per year on maintenance opex equating to 25% of total opex with $5.4 million and $12.4 million from routine and non-routine activities respectively. Maintenance comprises approximately 67% non-routine and 33% routine activities.

Maintenance expenditure has reduced by 13% between 2013-14 and 2016-17, mainly because of lower routine maintenance.

Figure 4.2: Historical maintenance opex. Nominal, $Million



(a) Source: CA RIN, 2.8 Maintenance.

Our maintenance costs are determined by the number of assets in a network, the rate of repair of these assets and the costs of conducting each repair. The key drivers for these are:

- Assets numbers – customer numbers, connection location and consumption and network design;
- Rate of intervention – maintenance policy considers asset condition, rates of deterioration or failure and operating environment; and
- Repair costs rates – size and organisational cost structure, economies of scale, input costs, efficiency and repair times.

Routine maintenance expenditure has declined significantly from $8.1 million to $5.4 million but the rate of decline has smoothed out over the last two years. Routine reductions have been achieved through optimization of PM activities driven by the Maintenance Management process which are based on asset condition, and a still maturing risk-based approach in alignment with industry best practice and ISO55000 suite of asset management standards.

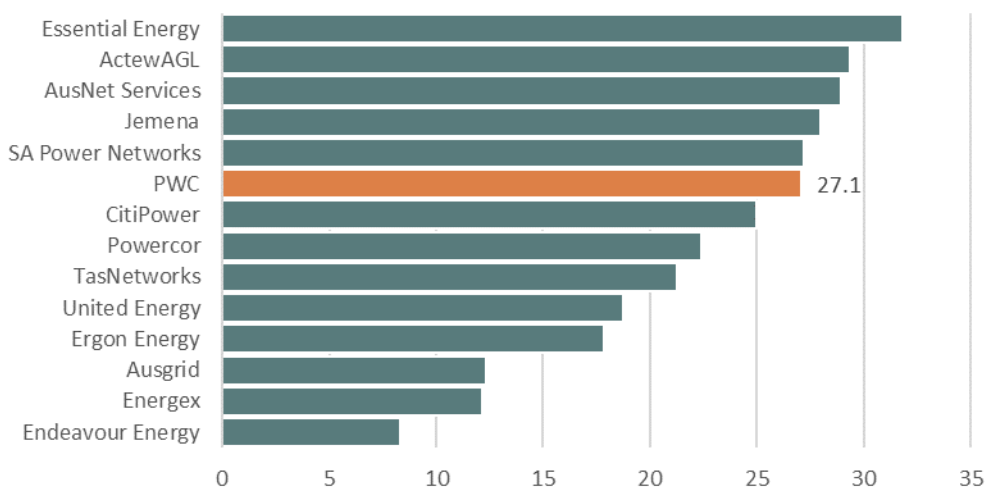
Over the last four years, non-routine expenditure has slightly decreased from $12.3 million to $12.4 million with a peak of $15.3 million in 2014-15. Non-routine maintenance efficiencies have been achieved through better asset reliability. This has been achieved through a less reactive approach to maintenance, supported by a combination of improved delivery of annual maintenance plans, improved asset management maturity and development of a risk-based approach to prioritisation of corrective action, and the reduced effect of a milder wet season plus limited cyclone activity over the last few years.

Approximately 90% of the maintenance spend occurs in the Darwin- Katherine part of the network with 8% in Alice Springs and 2% in Tennant Creek. The number of maintenance interventions varies from about 1,100 per month during the dry season to a peak of 1,400 per month in the wet.

We have several legacy issues that increase the cost of maintenance activities. For example, the proportion of 11kV and 22kV lines are driven by historical network designs. A historical decision to operate at 11kV in urban areas has resulted in a larger number of lower capacity zone substations, particularly in Darwin.

We also tend to replace fewer assets – or leave them until later to replace – than other networks, which leads to higher maintenance expenditure comparatively as our assets tend to be older. As shown in Figure 4.3, we have older network compared to many of our peer networks.

Figure 4.3: Relative age of network, Years



(a) Sources: EB RIN (3.3 Assets (RAB)).
(b) The average age for each network was calculated by first calculating the RAB-weighted average standard and remaining lives and then subtracting the latter from the first.

There are several programs that are emerging or have emerged for specific issues that have influenced the planned work. The main areas where there have been significant changes are:

- repair of conductor damaged by legacy animal protection throughout the Katherine region and some rural areas of Darwin;
- increasing failure rate of cables in the Darwin region and associated response affecting resource availability for cable repairs and subsequent restrictions to network access for maintenance during repairs and replacement;
- establishment of baseline condition information for most of our power transformer fleet and bushings to ensure replacement planning is evidence based and maintaining safe access for maintainers and security of supply;
- pole inspection and treatment increased in Alice Springs due to pole bases rusting and in increase in failures during major rain events;
- establishment of pillar cover UV degradation and calcium Adipate inspection and correction;
- insulation condition issues with a legacy type of HV underground switchgear used widely in the network preventing safe access for maintenance and operation, and an associated increase in switchgear termination failures; and
- corrosion and response to oil leaks in Darwin's northern suburbs.

4.3 Comparison to other networks

4.3.1 Points of difference

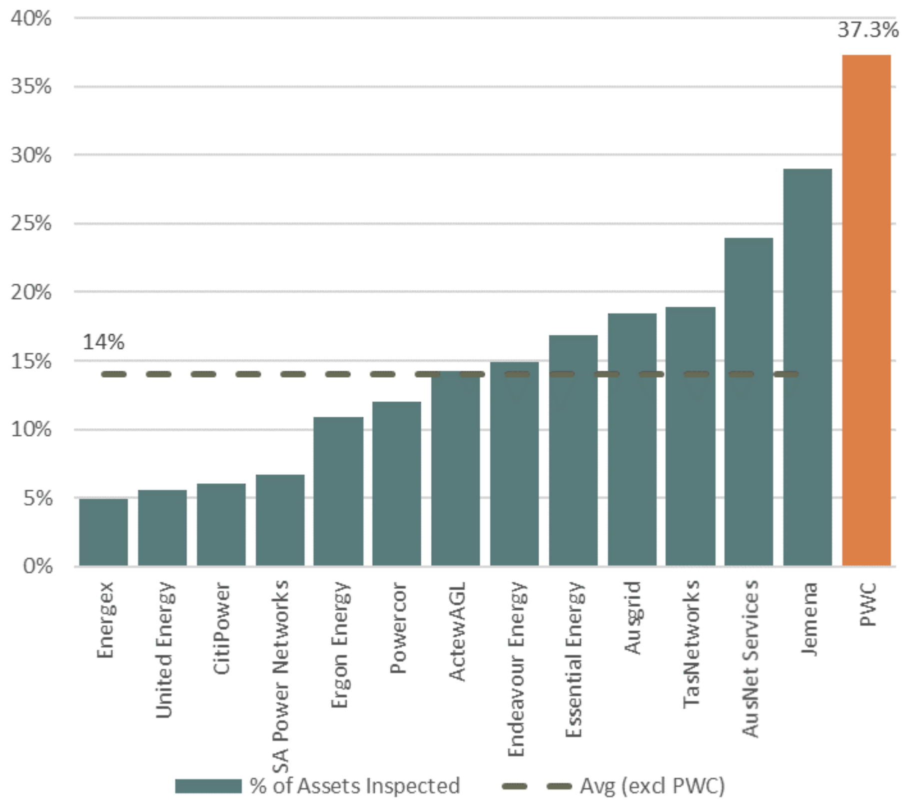
Volumes

Frequency of intervention

However, we maintain this smaller number of assets more intensely than the other networks given the extreme weather the assets are exposed to. This is driven by the need to provide more intensive maintenance activities to support accelerated degradation and repair due to tropical weather conditions, and the need to maintain the resilience of the network with the relatively smaller number of assets over a relatively large area.

On an average basis, the other utilities report maintenance interventions on about 14% of their overall assets and we report interventions an about 37% of its assets.

Figure 4.4: Percentage of assets inspected



(a) Source: CA RIN, 2.8 Maintenance, 2016.

To demonstrate the issue at an asset level, we focused on the maintenance activities specified in the CA RIN (2.8 Maintenance) and presented the rate of inspection and unit cost analysis by the proportion of our spend. Table 4.5 confirms:

- in general, we are maintaining more assets relative to peers in the higher spend categories, largely because our maximum demand per customer is high; and
- unit rates are high for about half the activity types but typically when activity levels are mid pack suggesting efficiencies are limited by lower volumes.

Table 4.5: Summary of our maintenance ranking relative to other networks

Maintenance activity	Inspection rate	Cost per inspection	Proportion of our costs (%)
Distribution substation transformers	***Top 3 (1st)***	Mid pack (8th)	17.0%
Zone substations – other equipment	Mid pack (8th)	Top 3 (2nd)	15.2%
Pole tops and overhead lines	***Top 3 (1st)***	Mid pack (11th)	10.9%
Transformers – zone substation	***Top 3 (1st)***	Mid pack (8th)	10.9%

Maintenance activity	Inspection rate	Cost per inspection	Proportion of our costs (%)
Distribution substation switchgear (within-substations and stand-alone switchgear)	***Top 3 (1st)***	Mid pack (9th)	10.5%
All zone substation properties	Mid pack (7th)	Top 3 (3rd)	7.8%
Network underground cable maintenance: by voltage: LV - 11 to 22 KV	Mid pack (5th)	Mid pack (4th)	6.7%
SCADA & network control maintenance	Mid pack (9th)	Top 3 (1st)	6.5%
Network underground cable maintenance: by location: Non-CBD	Mid pack (6th)	Top 3 (2nd)	6.5%
Protection systems	Mid pack (6th)	Top 3 (1st)	5.0%
All overhead assets	***Top 3 (2nd)***	Mid pack (11th)	1.5%
Service lines	Mid pack (10th)	Top 3 (1st)	1.5%

(a) Source: CA RIN, 2.8 Maintenance, 2016 data.
(b) Inspection rate = % of assets inspected = (Asset Quantity - Inspected / Maintained (#)) / (Asset Quantity - At Year End (#)).

Unit rates

Differences in unit rates are likely to be explained by the common external cost drivers.

Common external cost drivers

Extreme weather – extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

Our operating area is situated in the hot humid tropics and falls at the extreme end of conditions within Australia particularly for high temperature and humidity, cyclones, high wind occurrences, lightning strikes and high rainfall.

With some 71% of the network consisting of overhead lines, the weather occurrences in the tropics – particularly during the wet season in the north of the NT – is a significant cause of maintenance activities through line patrols after lightning and wind and the resultant maintenance repairs.

These climatic extremes exacerbate the rate of asset deterioration which in turn influences routine maintenance inspections and interventions as well as increasing the number of actual maintenance interventions required.

Extreme seasonality compounds our maintenance challenges. The dry season involves six months without rain and leads to accumulation of dust, dirt and contaminants on equipment and insulation surfaces plus causes shrinkage and/or expansion of the ground affecting cables and joints. The subsequent six months of high rainfall results in water flooding and moisture penetration through the contaminants.

Occurrences of lightning strikes, blown vegetation and animal related events, require numerous line patrols and inspections to detect damage and ensure proper operation of the network.

The extent and urgency of repairs can also add costs to the activity. High temperature and humidity also coincides with lightning activity and the corresponding outages increase the urgency of emergency restoration activities. We are very conscious that our more vulnerable customers, such as the young or the elderly, suffer more from heat and can become a medical emergency if network issues are not resolved quickly.

Network characteristics – lack of scale, dispersed and diverse micro networks, high labour costs and unique rules, laws, and compliance

Factors which influence costs and activity duration include, the large distances which need to be supported, access to the remote areas, depot location, the size and composition of the crews to support the diverse areas serviced and disruption to the efficient planning of work due to scale and need to support emergency response activities.

There is a loss of economies of scale due to the requirement for localised specialist resources to respond to fault and outage conditions to maintain supply reliability within acceptable limits. The acceptable time is often detailed in local customer quality of supply regulation. Given the small scale of the local asset base, these specialist resources may not be economically utilised on an ongoing basis.

The Rawlinsons' Construction Cost Index is a useful indicator of the comparative costs associated with general construction and infrastructure construction which relates to maintenance activities across Australia. It covers a range of costs inputs such as labour, materials and subcontractor costs. It confirms that the cost of doing business in the NT is high compared to other capital cities.

Figure 4.6: Rawlinsons' Construction Cost Index[8]

(a) Source: Rawlinsons Publishing, Australian Construction Handbook.

Specific maintenance cost drivers

Network configuration

The Victorian DNSPs have a cost advantage because their networks are predominantly 22kV. This is because an 11kV network requires more 11kV feeders to service the same customer loads and more lower capacity zone substations to service those feeders.

The operation and maintenance of the "sub-transmission" network will be more aligned with transmission network practices, because the behaviour and associated risks of those network elements align more with transmission network elements. Our sub-transmission / transmission lines are 11.68% of our total circuit length. This higher proportion is a result of historical decisions made by Government, especially for the Darwin-Katherine 132kV line. Our 132kV and 66kV power lines are more expensive to operate and maintain than those of lower voltages.

[8] The capital city index shows costs in each capital city relative to Sydney. It is derived annually from a review of building costs across all buildings, tender returns, market conditions and discussions with contractors, consultants and suppliers. It covers all construction activity including roads and transport projects. Rawlinsons has confirmed the capital city indices are derived in a consistent manner across States and can be used for interstate comparison. Source: Australian Government, Commonwealth Grans Commission. A capital cost index, 2015 review, Staff discussion paper CGC 2014-02-S, March 2014

Network density

The NT has low density communities which occur in clusters separated by significant unpopulated areas implying the network density is not uniform. This increases the complexity of efficient allocation of resources.

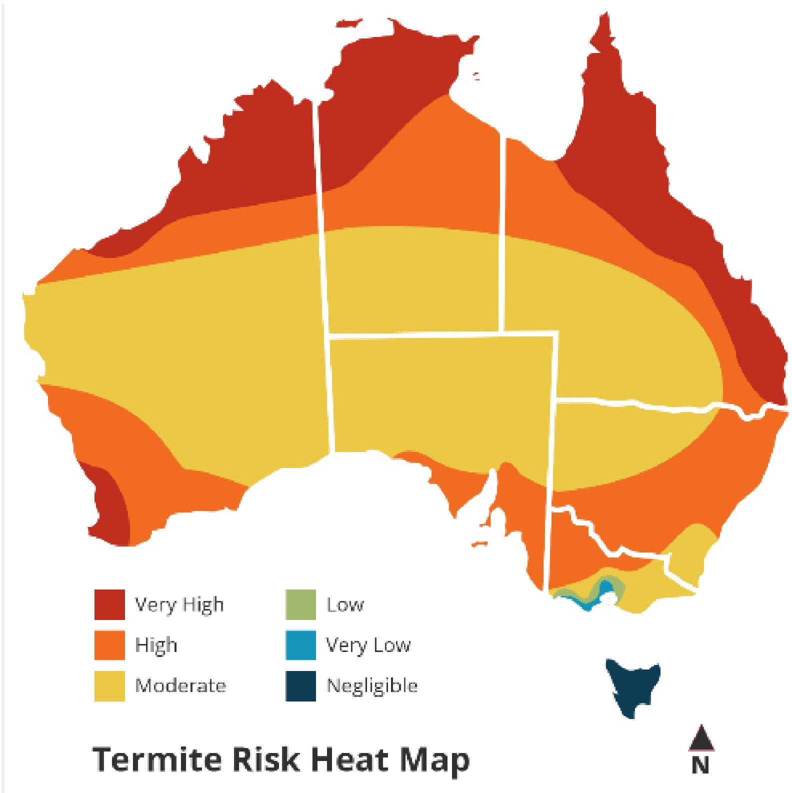
We have customer density of 17 customers per kilometre with an average of the utilities being 28. It should be noted that our customers are spread over four geographically separated networks and supported by six service depots. This structure further impacts on any scale of economy.

Therefore, we have reduced opportunity for efficiency given we have both low asset density and customer density. Fewer assets per kilometre per customer also implies less ability to "mesh" the networks which leads to lower resilience, higher numbers of outages and increase outage durations.

Termites

The northern region of the NT is a high termite hazard zone, which is a problem given termite exposure increases the volume of inspections and repairs and maintenance work.

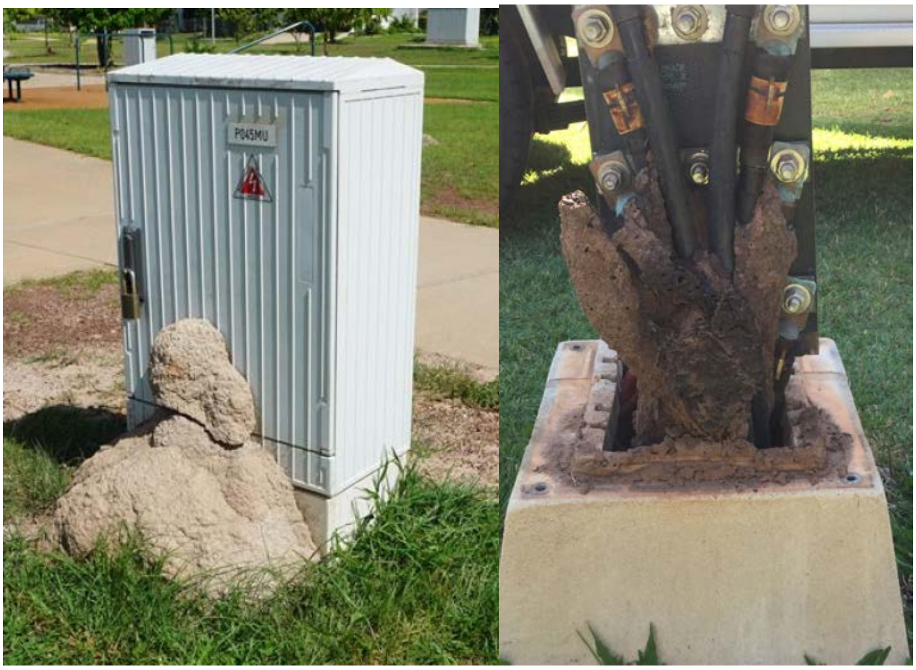
Figure 4.7: Termite risk heat map



(a) Jeffrey Hills and Associates (Building consulting services), Resource Centre.

Termites and ants build nest against structures, invade cables and equipment. Their building activity tends to attract moisture and interruptions then occur during the wet season.

Figure 4.8: Illustration of termite damage to the NT network



(a) Source: Power and Water.

Inspections of underground equipment and pillars are scheduled once every three years in the NT relative to once every 15 years in the southern states.

The rapid destruction effects of termites on materials, especially underground wiring, requires the use of sheathed underground cables and special procedures during installation, maintenance and repair. This higher specification of materials increases the cost of maintenance activities.

Figure 4.9: Illustration of termite damage to underground cables within the NT network

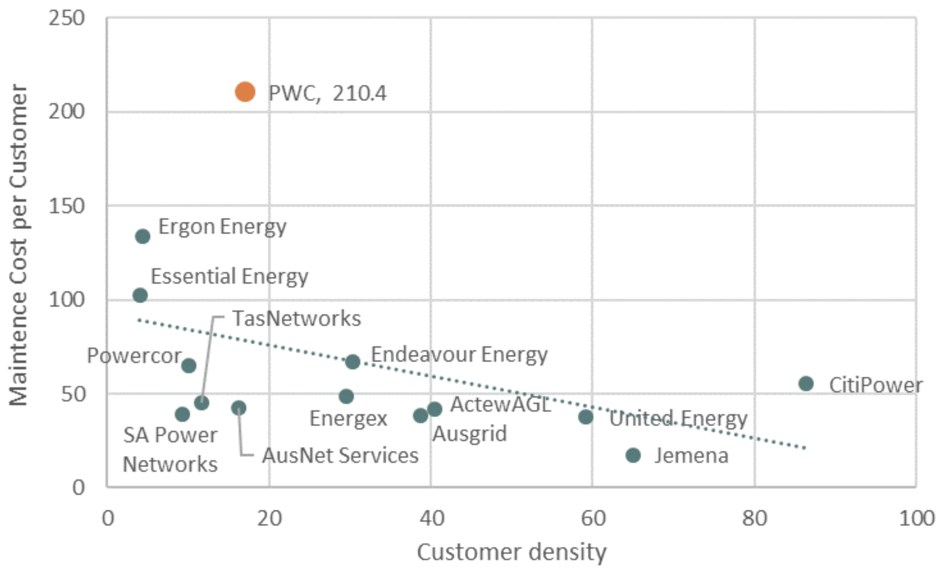
(a) Source: Power and Water.

Otherwise, we minimise the impact of termites by using steel rather than wood poles which are also more expensive to purchase.

4.3.2 How we look

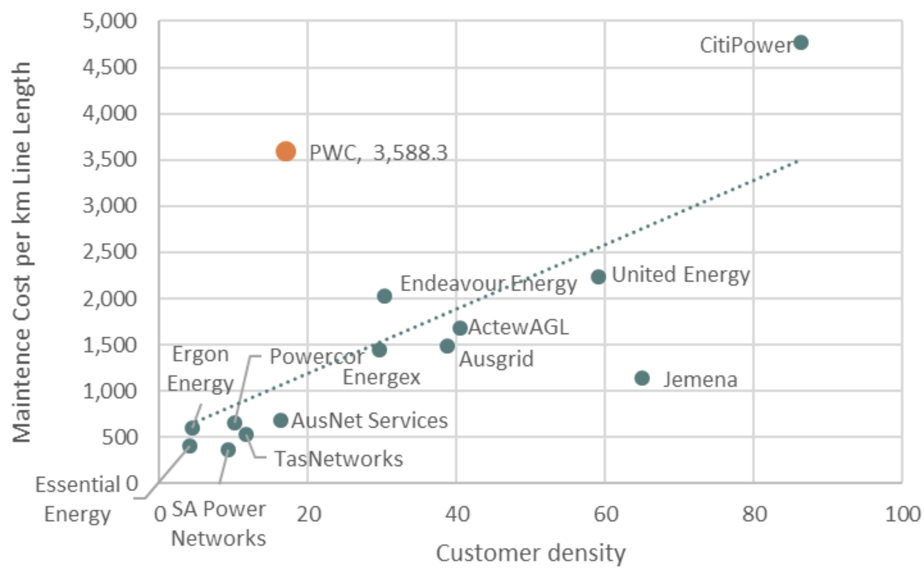
Relative to larger networks we do not perform well on basic benchmark comparisons such as cost per customer, cost per kilometre of line length and cost per dollar of RAB as shown by the following three charts.

Figure 4.10: Maintenance costs per Customer. Nominal, Dollars



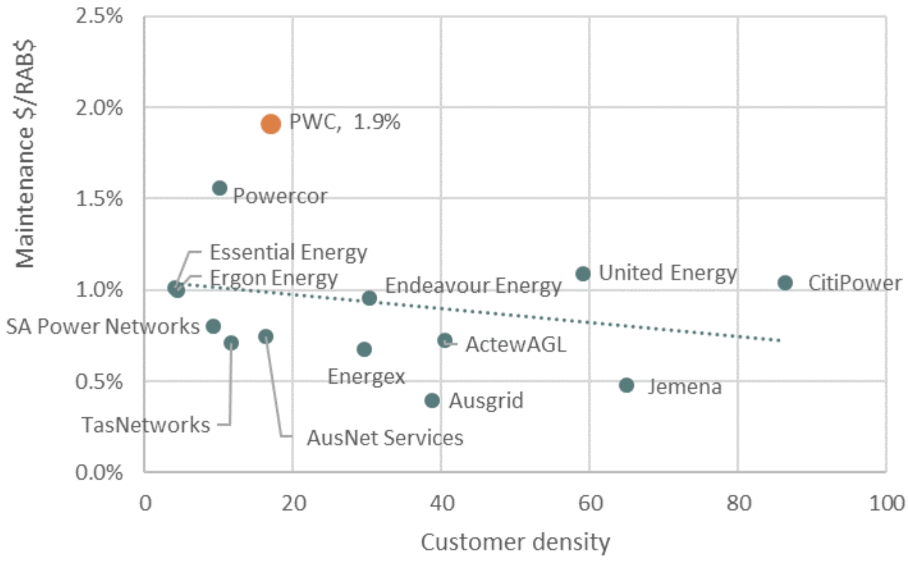
Sources: CA RIN (2.8 Maintenance), EB RIN (3.4 Operational Data).

Figure 4.11: Maintenance costs per Km route line length. Nominal, Dollars



(a) Sources: CA RIN (2.8 Maintenance), EB RIN (3.4 Operational Data).

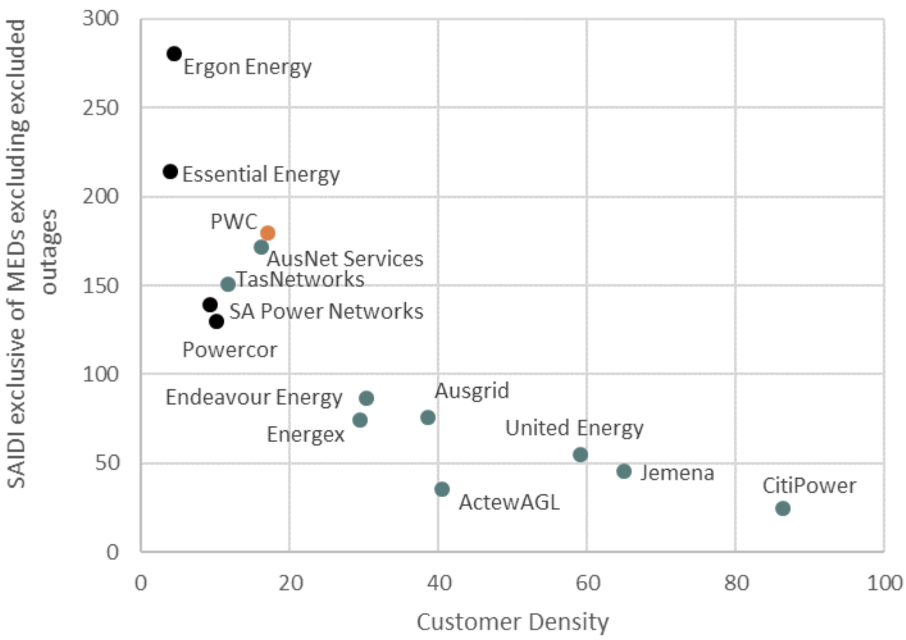
Figure 4.12: Maintenance costs relative to RAB. Nominal, Dollars



(a) Sources: CA RIN (2.8 Maintenance), EB RIN (3.3 Assets (RAB)).

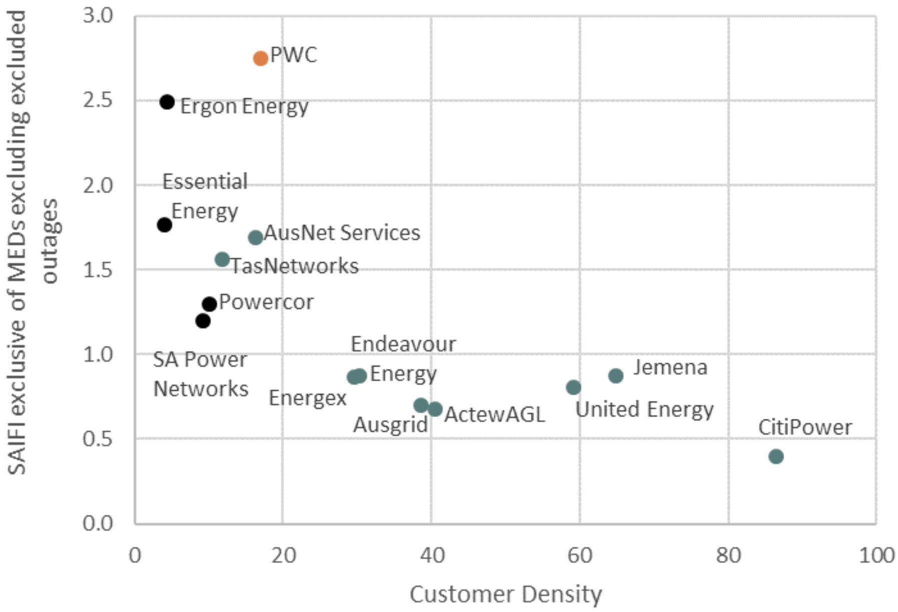
We need to spend more on maintenance is required to maintain current system performance levels. As the following SAIDI and SAIFI figures demonstrate, outages are usually longer than most other networks and more frequent on a per customer basis.

Figure 4.13: SAIDI performance by network. Minutes per customer



(a) Source: EB RIN (3.6 Quality of service).
(b) The black markers indicate our network peers including Ergon Energy, Essential Energy, SA Power Networks and Powercor

Figure 4.14: SAIFI performance by network. Number of outages



(a) Source: EB RIN (3.6 Quality of service).
(b) The black markers indicate our network peers including Ergon Energy, Essential Energy, SA Power Networks and Powercor

It should be noted that we, with the smallest number of customers in the NEM, will always struggle to perform well on these measures, particularly when weather related outages are out of our control.

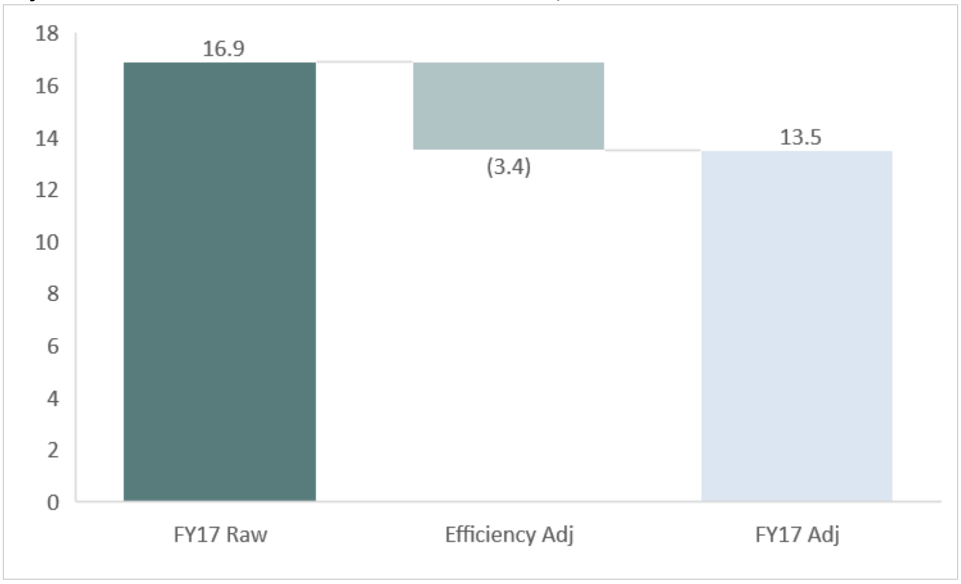
4.4 Base year efficiency

As identified in section 4.3, when compared to other networks, there appears to be some room for improvement regarding maintenance. However, prior to making any base year efficiency adjustments we should recognise that:

- although on some measures our base year may look higher relative to other networks, the targeted efficiency only needs to be modest because most of the differences are explained by our unique circumstances; and
- to propose a reasonable level of base year expenditure we have already achieved 13.1% cost reductions over the last four years – in part due to the identified cost initiatives, including:
  - recent routine reductions have been achieved through better targeting of PM activities through AMPs based on risk and asset condition. As the PM plans are further optimised there is likely to be additional improvements in these activities; and
  - non-routine maintenance reductions have been achieved through better asset condition, however, we are still exposed to variability in the intensity of future wet seasons.

As part of the overall 10% efficiency target included in our proposal it is likely that maintenance costs will reduce. Given the outcome of peer comparisons, and execution considerations we have assumed for presentation purposes that 50% of the total efficiency adjustment (in dollar terms) will come from a reduction in maintenance expenditure as shown in the figure below.

(a) **Figure 4.15: Indicative change in maintenance costs after 10 per cent efficiency adjustment. Nominal, $Million**

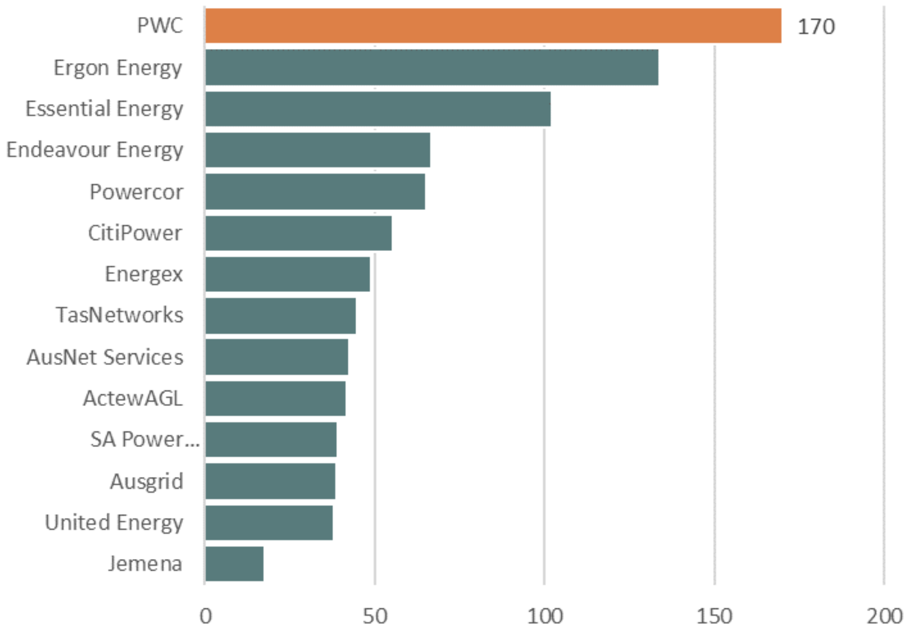


Efficiency adjustment based on maintenance absorbing 50% of the total opex reduction resulting from the 10% saving included in this proposal.

(b) Sources: CA RIN (2.1 Expenditure summary) and supporting material.

Implementing the indicative outcome above would mean maintenance costs per customer would drop from $210 to $170, which – although still high – is largely explained by our unique external cost drivers.

Figure 4.16: Maintenance Costs per Customer. Nominal, Dollars



(a) Source: CA RIN (2.8 Maintenance), EB RIN (3.4 Operational data).

5. Emergency response opex

This section describes emergency response opex activities, explains how the expenditure has evolved over the current period and analyses how our 2016-17 expenditure compares to other networks.

5.1 Activities included

Emergency response expenditure is limited to the expenditure associated with our initial response to outages and other high-risk events that require the immediate dispatch of crews. In accordance with our policy, emergency response is required:

- where there is an incident that results in actual or imminent danger to personnel or equipment;
- where there is an actual or imminent likelihood of an outage; and
- to assist emergency services in the performance of their duties.

Activities generally include:

- response to customers reporting outages;
- response to events in the system such as network faults and urgent alarms associated with network assets e.g. fire alarm; and
- response to internal or external reports to dangerous conditions such as trees touching lines or car accidents, which may not directly cause an outage but present a risk to the public, personnel, equipment or facilities.

Emergency response obligations[9]

• A Network Service Provider must ……arrange for: restoration of the agreed capability at a connection point on or with that network as soon as reasonably practicable following any interruption at that connection point.

5.1.1 Wet and dry seasons

The extreme weather conditions in the NT are characteristic of the tropical/monsoonal north of Australia which is typically considered to have two seasons, “wet” and “dry”. The organisation of emergency response crews are tailored to the season and the region depending on circumstances.

The number of responses varies from about 1,000 per month during the dry season to a peak of 2,000 per month in the wet. The number of responses is highly correlated to the weather – which is not something that we can control.

[9] NT NER, Clause 5.2.3.e1.(4).

Wet season

During the wet season, emergency response activities increase significantly in each of the areas depending on the circumstances. Often multiple crews are required to respond each night during extended monsoon or storm periods. The number of "on call" crews are increased to ensure that there are relief crews available to manage fatigue and respond to emergencies in a timely manner. This increases our costs.

The number of repairs and associated costs for seasonal response is highly dependent on the prevailing weather conditions and is influenced by longer climatic cycles and trends. The main drivers are:

- lightning activity, rainfall and wind that directly impacts on the assets through weather and some general asset failures;
- increased humidity and temperature that results in increased use of air-conditioning and impacts on overload faults; and
- wet season growth cycles that promote rapid vegetation growth and impact through vegetation related failures.

During extreme events such as a cyclone, we enact our cyclone management plan and at this time, all resources are organised to support the emergency action.

Dry season

The volume of emergency responses activity during the dry season is relatively low due to stable weather conditions and low system loads. Access to the system infrastructure is not impeded by weather and road conditions, and crews are not at risk from transferred voltages due to lightning activity.

When there is less of an impact from weather, internal resources shift focus on the completion of routine maintenance (to ensure reliable, secure supply) and capital works.

However, animal activity is counter cyclic, as more activity is observed in benign weather periods as animals seeking shelter and roosting positions lead to animal related failures.

Shoulder seasons

Prior to the wet season, an intense "build-up" period leads to a significant rise in system loads as air conditioner demand peaks and there are often periods of severe evening thunder storms.

Additionally, bushfires, traditional burning activities and controlled burns affect a significant proportion of the landscape and lead to an increase in bushfire related outages due to trees falling on lines and movement of animals.

5.1.2 Our management approach

Emergency response activities for all regions are reported to, and dispatched by, the system operators located at system control operating under a service level agreement.

In Katherine, Tennant Creek, and Alice Springs a single depot exists for each region and personnel are dispatched from these depots for all emergency response activity in the respective region. Darwin has three depots spread throughout the greater Darwin region.

Personnel rostered to perform emergency response outside of business hours can home garage call-out vehicles to ensure response times are minimised. Call-out vehicles contain a sufficient range of repair parts, tools, and equipment to repair the most common range of faults. Where more extensive repairs are required, the on-call supervisor is contacted, and additional crews are dispatched with the required repair parts, tools, and equipment.

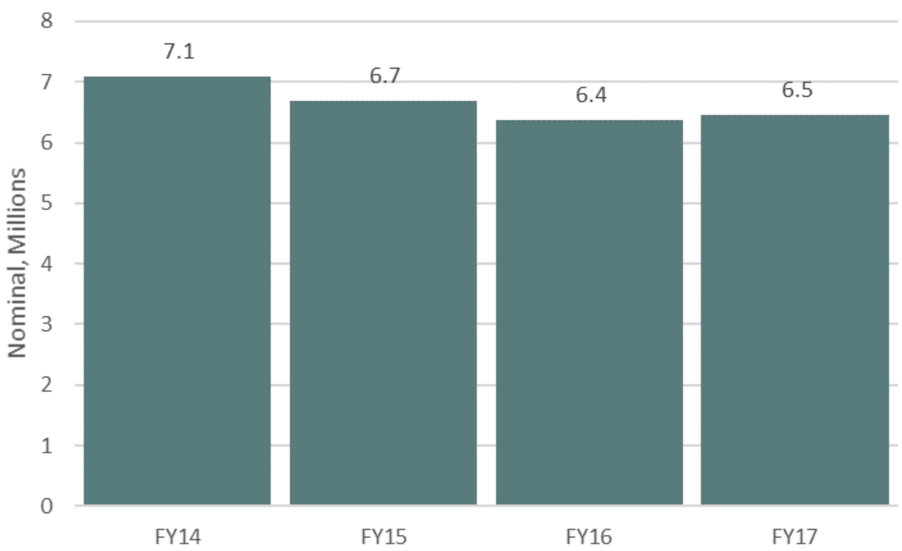
5.2 Current period opex

5.2.1 Historical performance and trends

Over the last four years, we have spent an average of $6.6 million per year in relation to emergency response opex. After achieving an 8.9% reduction between 2013-14 and 2016-17 our emergency management costs make up 9.5% of total opex in 2016-17

Overall, expenditure in recent years has been reasonably consistent noting that rainfall during the wet season in the north returned to normal after two relatively calm wet seasons in 2014-15 and 2015-16.

Figure 5.1: Historical emergency response opex. Nominal, $Million



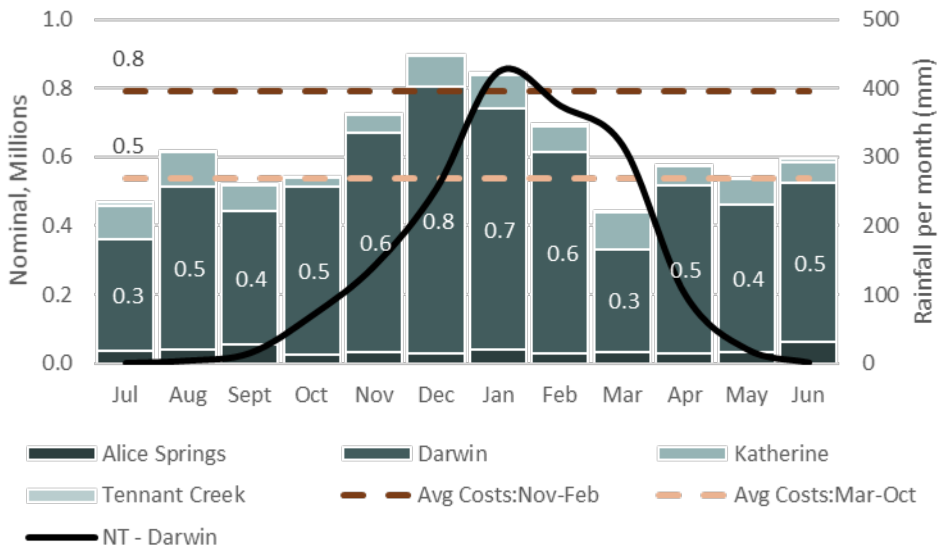
(a) CA RIN (2.1 Expenditure summary).

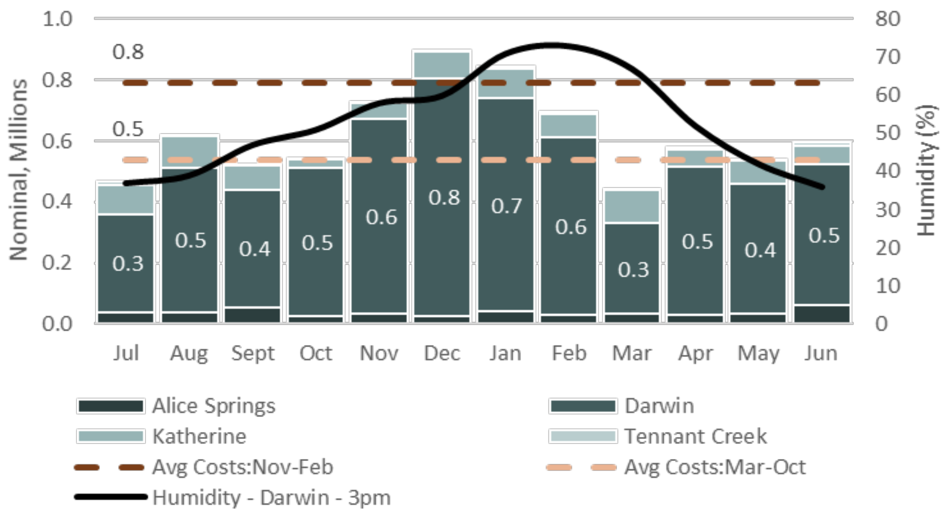
Recent expenditure is relatively efficient and represents expected ongoing operations in the short term, given that variability is typically associated with the intensity of weather conditions during the northern region wet season. Figure 5.2 highlights the seasonal relationship between expenditure and weather conditions using rainfall as the proxy for extreme weather events. We note that other proxies such as lightning, humidity and wind could have been used.[10]

Figure 5.2: Our emergency response costs by network. Nominal, $Million

[10] While rainfall is a useful indicator it tends to lag faults and failures during the wet season. The relationship between observable weather attributes – rainfall, wind gusts, temperature, humidity and lightning strikes – and the occurrence of faults is much more complex. For instance, humidity drives the use of air-conditioning-based peak loads and leads to overload type faults. Wind gusts drive failures relating to blown vegetation. Lightning leads to lightning strikes and related failures. Peaks in these weather occurrences are often interrelated.

2016-17 Opex Base Year





(a) Sources: PWC internal analysis, BOM.

There have been no significant changes to emergency response activities and costs in the last four years. Rather we have focused on preventative maintenance activities as our experience shows that being up to date with maintenance activities reduces the volume of faults and emergency outages.

5.3 Comparison to other networks

5.3.1 Points of difference

Common external cost drivers

In the absence of extreme weather events and adverse network characteristics our benchmarking performance would improve.

Extreme weather – extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

Extreme weather impacts have been discussed in detail in section 5.1.1 other than high UV which is not relevant.

Network characteristics – lack of scale, dispersed and diverse micro networks, high labour costs and unique rules, laws, and compliance

The higher volumes of activity increase our cost because the activity is being paid for with relative high labour rates.

The overhead network extends over a relatively wide area for a small team to cover and travel time to the extreme ends may take some hours, particularly in wet weather where access to remote areas can be limited.

Specific emergency response cost drivers

Animals seeking shelter and roosting positions in the dry season lead to animal related failures. Snakes, lizards, and frogs tend to occupy equipment to escape climatic extremes and cause shorts. Bats are a particular problem as they roost in colonies and may cause periodic interruption.

As the waters rise during the wet season field crews must deal with reduced access to assets plus the increased likelihood of crocodiles appearing near the assets as the animals take advantage of the changing water systems.

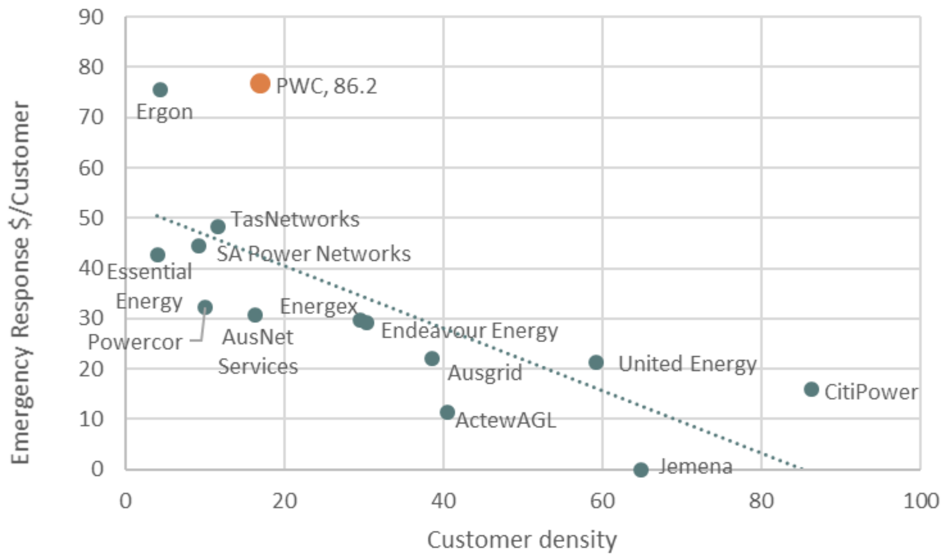
Figure 5.3: Example of animals impacting the network

(a) Source: Power and Water

5.3.2 How we look

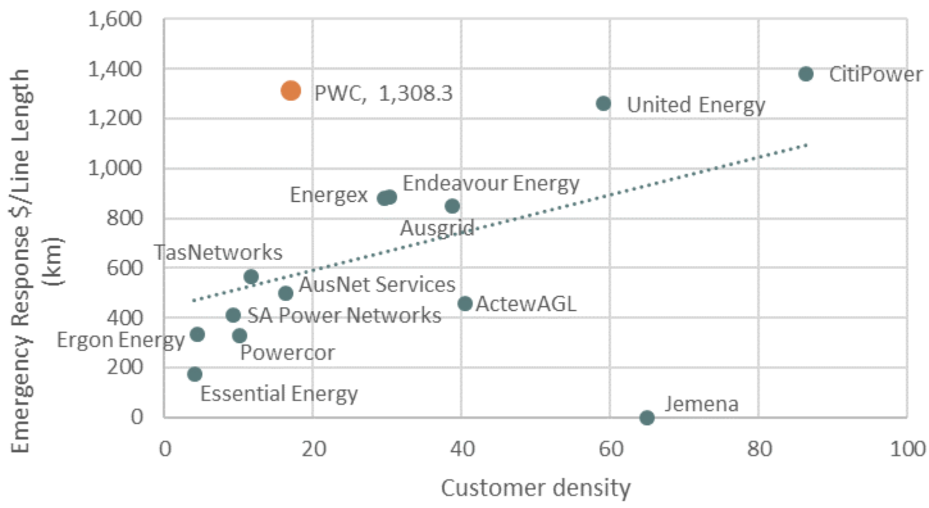
Relative to other larger networks our expenditure looks high using basic benchmark comparisons such as cost per customer and cost per kilometer of line length due to the unique weather conditions discussed in 5.3.1.

Figure 5.4: Emergency response costs per customer. Nominal, Dollars



Sources: CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data)

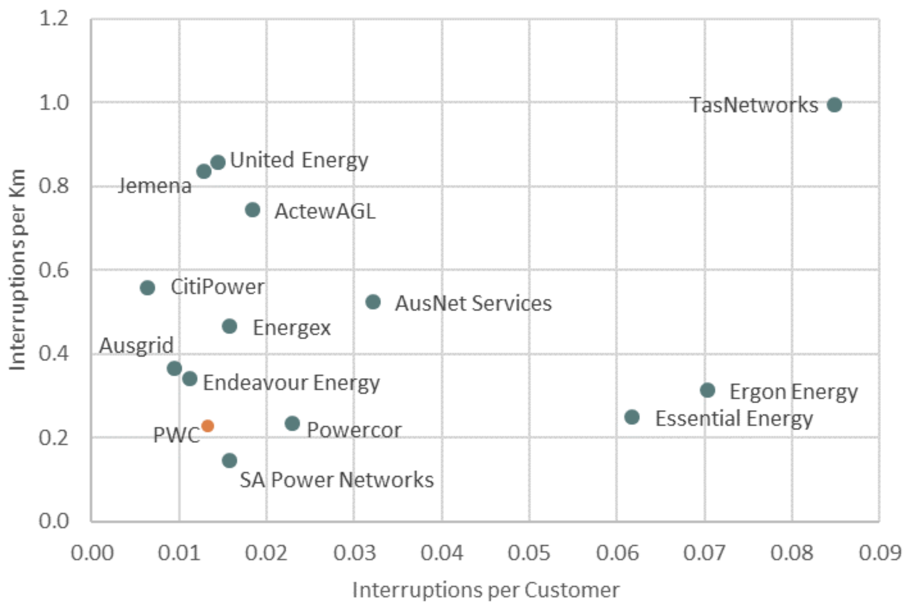
Figure 5.5: Emergency Response Costs per Km route line length. Nominal, Dollars



Sources: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

Figure 5.6 shows that we have a relatively high number of interruptions per customer and interruptions per kilometer due to the uncontrollable extreme weather, which largely explains our higher emergency response expenditure.

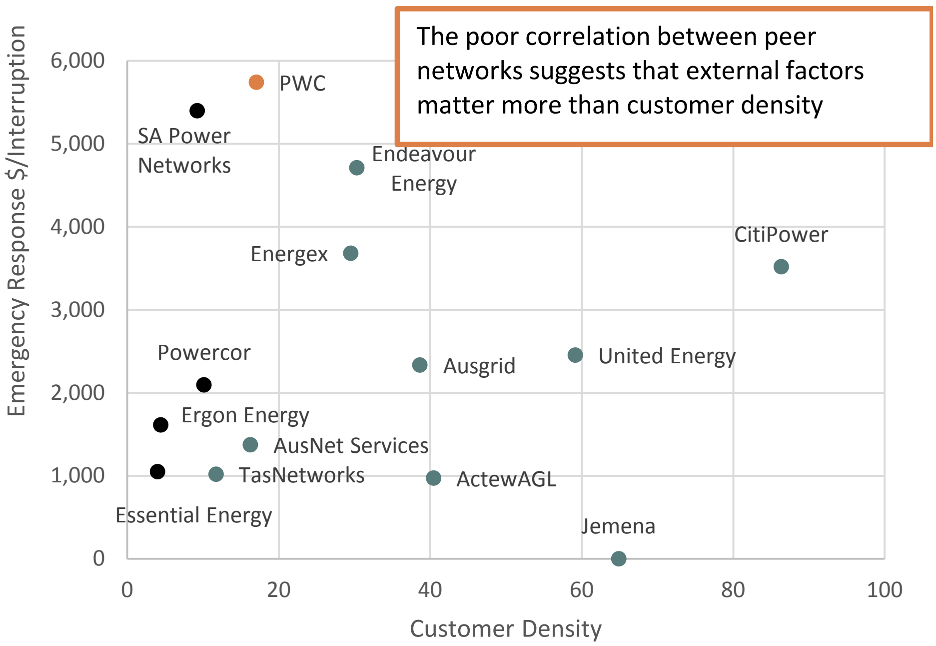
Figure 5.6: Standardised peer comparison of network interruptions. Number



(a) Sources: EB RIN (3.7 Operating environment), EB RIN (3.4 Operational data), CA RIN (6.3 Sustained interruptions).

The higher volumes explain some of the variation shown in figure 5.4 and 5.5. Our cost per interruption also benchmark poorly given a significant proportion of events that occur during the wet season and during storms, making them difficult to access, hazardous due to the risks associated with lightning and heavy rain or extreme heat when not raining.

Figure 5.7: Emergency Response Costs per Interruption. Nominal, Dollars



(a) Source: CA RIN (2.1 Expenditure summary), CA RIN (6.3 Sustained interruptions).
(b) Interruptions include animal, asset failure, weather, third party vegetation, overloads and other but excludes planned outages.
(c) The black markers indicate our network peers including Ergon Energy, Essential Energy, SA Power Networks and Powercor

As explained above, the volume of activity associated with emergency response is largely out of our control and the nature of the work makes it difficult to control unit costs.

5.4 Base year efficiency

As identified in section 5.3, when compared to other networks, there appears to be no need for an emergency response efficiency adjustment – our base year costs, adjusted for volumes, are comparable to other networks and have reduced over time.

We note that:

- after adjusting for our unique circumstances, we are comparable with other distribution networks; and
- to propose a reasonable level of base year expenditure we have already achieved cost reductions of 8.9% over the last four years – in part due to better processes and we continue to look for more savings.

Given this, it is not likely that emergency response cost reductions will be a key contributor to achieving our proposed 10% opex efficiency target.

6. Vegetation management opex

This section describes vegetation management opex activities, explains how the expenditure has evolved over the current period and analyses how our 2016-17 expenditure compares to other networks.

6.1 Activities included

We are responsible for maintaining safe clearance of all vegetation in proximity to power lines we own and operate. Typical vegetation management activities include:

- removing, altering, or managing vegetation to maintain safe or regulated clearances from distribution or transmission assets; and
- tree cutting, undergrowth control, root management, waste disposal, use of herbicide and growth retardants, and encouragement of low-growth vegetation to prevent the establishment of high-growth vegetation.

Vegetation management does not include "beautification" works, lawn mowing e.g. from natures strips, or office gardens, interior plant and aesthetic vegetation works, or any work done in proximity to non-network assets.

Our tree trimming obligations stem from the NT NER.

Vegetation management obligations[11]

• A Network Service Provider must…..arrange for: management, maintenance and operation of its network to minimise the number of interruptions to agreed capability at a connection point on or with that network by using good electricity industry practice

6.1.1 Northern and Southern regions

We have historically applied a cyclic approach to vegetation management activities with a frequency of six months applied to the Darwin/Katherine region and 18 months to the Southern regions. This is primarily based on the differing growth rates between the two regions, and maximizing the accessibility to the network due to wet season constraints for crews and equipment.

[11] NT NER, Clause 5.2.3.e1.(3).

Vegetation in the proximity of powerlines varies greatly within and across regions of the NT. The vegetation treatment data[12] shows that the highest density and highest growth rates exist in high rainfall areas of the northern region (Darwin and Katherine), particularly urban areas and some semi-rural and rural areas with the more fertile soils. These are the primary drivers for the 6-month cutting cycle.

Activity in the northern region is also aligned to the wet and dry seasons due to the limited access for vegetation equipment for a significant proportion of the year outside of urban areas and very high growth rates experienced during and after the wet season.

Slower vegetation growth rates and different types of vegetation in the southern regions mean a longer period between cutting cycles is adequate.

6.1.2 Our management approach

Vegetation is managed on an individual feeder-by-feeder basis. Each feeder is scoped by the vegetation management contractor to identify trimming requirements and cutting is then carried out to establish clearances to last at least until the next cycle or longer where practical. All scopes are reviewed and approved by the appointed Vegetation Management contract superintendent prior to trimming. Additional activities including hazard tree cutting, removals, corridor clearance inspections and vegetation audits are also individually scoped and approved by the contract superintendent.

Trees that are not able to be removed or trimmed to maintain sufficient clearance until the next cycle are also identified for additional management activity. Where possible, traditional trimming activities are augmented by tree removals, ground based mulching, and slashing to reduce future trimming requirements. This often requires negotiation with tree owners including traditional owners, private land owners, councils, etc.

6.1.3 Personnel and contracts in place

The scoping and trimming activities are carried out by a contractor engaged by us through a competitive tender process, typically on a regional basis and split between Urban and Rural in the Darwin regions. During the current period all contracts have been awarded to a single contractor. All cyclic scoping and trimming activities are carried out under a lump sum contract awarded for three years, with an option to extend to five years. This approach has meant that the cost of cyclic trimming activities has been reasonably consistent regardless of annual increases and decreases of trimming requirements each year. Growth rates are influenced by seasonal rainfall, although to a lesser extent than other DNSP's due to the more

[12] CA RIN 2.7.1 Veg Mgmt. Vegetation Management Analysis conducted by ArborPro.

consistent, albeit more extreme, tropical weather conditions. Additional tree removals and corridor clearance are performed as required based on a schedule of rates settled through the tender process and are individually scoped and approved by our contract superintendents in the Southern and Northern regions.

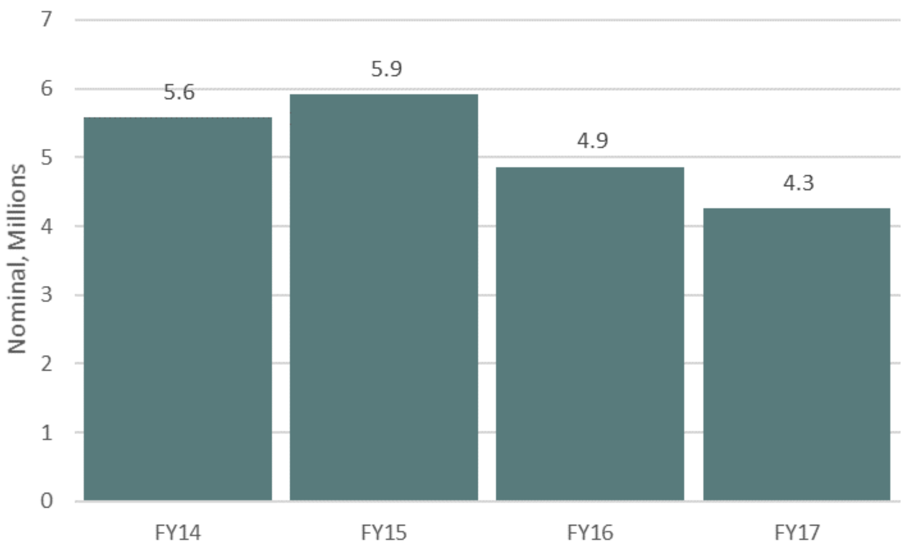
We have one dedicated contract liaison officer in the Darwin area. Liaison activities in all other regions are performed by staff whose primary role is not focused on vegetation management due to the lower volume of work performed.

6.2 Current period opex

6.2.1 Historical performance and trends

Over the last four years we have averaged $5.2 million (nominal) of expenditure on vegetation management activities. After achieving a 23.5% reduction between 2013-14 and 2016-17 our vegetation management costs make up 6.8% of total opex in 2016-17.

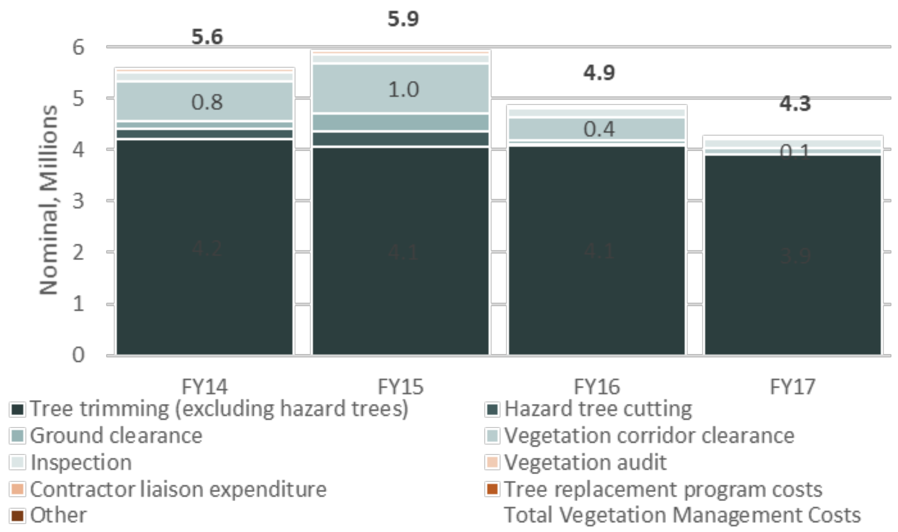
Figure 6.1: Historical vegetation management opex. Nominal, $Million



(a) CA RIN (2.1 Expenditure summary)

Vegetation management costs are predominantly attributed to tree trimming activities which account for approximately 79% of the overall cost and have reduced slightly over the last four years.

Figure 6.2: Breakdown of vegetation management opex. Nominal, $Million



(a) CA RIN (2.7 Vegetation Management).

A further 11% of activity relates to vegetation corridor clearance where expenditure has decreased significantly in the last two years. Being a discretionary activity, we have made conscious decision to reduce expenditure in the area over the period as opposed to a historically "cyclic" approach and have sought to improve our understanding of minimum level of activity required. We plan additional corridor clearance in 2018/19 to address growth in corridors not cut in recent years.

The remaining 10% of expenditure comes from inspections, ground clearance, hazard tree cutting and vegetation audits. These costs in 2015-16 reduced in comparison to previous years, due to a reduction in hazard tree cutting and a conscious choice to reduce discriminatory activities.

Vegetation management expenditure has varied over the period due to a combination of changes in weather and contract management. In particular:

- **Revised contract management** – cyclic trimming costs have reduced through the cessation of specific contracts for the Southern regions and Katherine with all activity now performed under a single contract based from Darwin. This has reduced costs for contract staff being permanently based in Katherine, Alice Springs and Tennant Creek, which proved to be less efficient based on the lower volumes of work required in these centres.
- **Higher rainfall reduced access** – In the Northern region, consecutive years (2013-14 and 2014-15) of lower average rainfall during the wet season enabled access to areas requiring significant amount of removals to be undertaken and therefore an increase in overall vegetation management expenditure. This was largely due to water ways, swampy areas and creek crossings becoming accessible enough to allow the removal of dense vegetation such as bamboo which requires heavy machinery. Similar activity was unable to be performed in 2015-16 and 2016-17.

- **Reduced clearance** – in 2015-16 and 2016-17 the conditions discussed above also reduced the opportunity to perform significant corridor clearance as accessibility declined. This is likely to lead to higher vegetation management expenditure in future years to clear the backlog.

The following sections detail the drivers of these costs and how we compare to other Australian electricity distributors.

6.3 Comparison to other networks

6.3.1 Points of difference

Common external cost drivers

Extreme weather conditions – extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

Weather patterns in the NT provide favourable tree growth conditions. The combination of the highest average temperatures, highest rainfall and highest humidity during and after the wet season all contribute to high growth rates leading to higher frequency of trimming across most of the network area. Over 80% of the overhead network is in the Darwin and Katherine regions and subject to these conditions. During the wet season, as water levels rise and crocodiles migrate inland, the rural parts of the network face limited accessibility.

Figure 6.3: Example of lack of accessibility

(a) Source: Power and Water.

The significant storm activity experienced in Darwin and Katherine each year is also a driver of trimming volumes that are needed to reduce their potential impact to network reliability and safety. Clearances maintained ensure that high winds experienced in annual storms do not cause widespread outages. This is also a consideration when targeting trees for removal; however, this often depends on customers.

Network characteristics – lack of scale, ddispersed and diverse micro networks, high labour costs and unique rules, laws and compliance

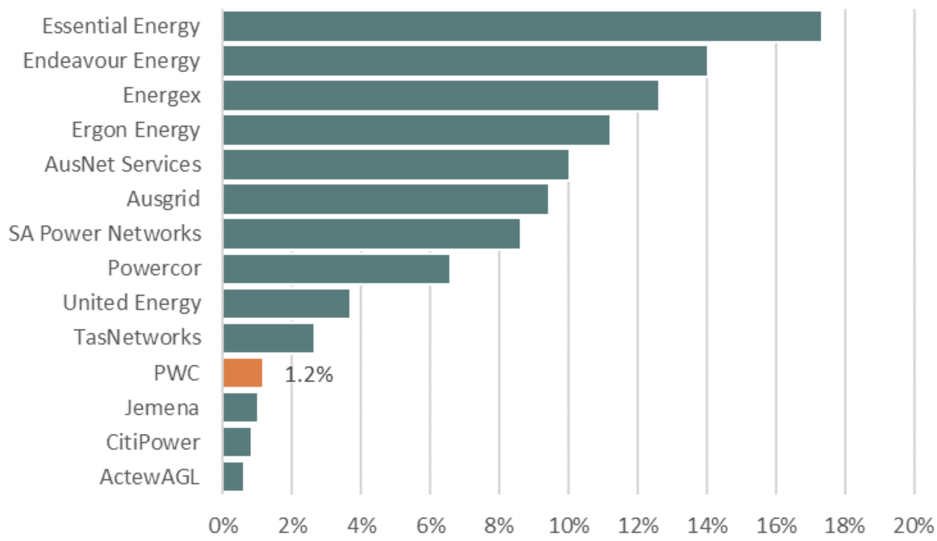
The extreme heat occurs from late autumn, through summer and into early spring. These conditions have a significant impact on field crew productivity, as demonstrated through the ongoing research that we are working on with Thermal Hyperformance.[13]

Effectively managing the health and wellbeing of both employees and contractors is a core value of Power and Water. The increased breaks that we impose increase costs by reducing working time and limits the efficiency of crews performing outdoor work in all but the coolest 2-3 months of the year. Acclimatisation for vegetation workers is often limited by the high turn-over of the workforce, and if not effectively managed, can exacerbate the impact of heat on workers' health for much of the year. We have worked closely with vegetation management contractors to increase the utilisation of purpose-built machinery to limit manual trimming activities where possible.

The low volume of vegetation management work, based on 1.2% of total vegetation management expenditure, places us at a significant disadvantage when exploring the market for vegetation management service providers. This makes it harder to attract competition to the Northern Territory than networks operating on the east coast of Australia.

[13] A study and paper - "Workability and Impact on Darwin and Alice Springs" was performed by Matt Brearley PhD, Managing Director, Thermal Hyperformance Pty Ltd.

Figure 6.4: Share to total vegetation costs in the NEM by network. Per cent



(a) Source: CA RIN (2.1 Expenditure summary).

The remoteness from other major centres requires a significant investment in mobilisation by any service provider willing to enter the NT market, increasing their premiums charged to provide services.

Specific vegetation cost drivers

Vegetation types

The fast-growing African Mahogany trees were planted throughout Darwin after Cyclone Tracey to restore vegetation. These are now approaching the end of their life and present a significant hazard to many distribution and transmission lines and require high frequency trimming, but are unable to be removed due to their value to the community. In 2011 during the category 1 cyclone “Carlos” many trees were blown over into lines and the size of African Mahogany’s presented a significant challenge to repair of the network.

Figure 6.5: Illustration of the damage caused by African Mahogany trees in the NT

(a) Source: http://www.abc.net.au/news/2011-02-16/a-tree-lies-across-somerville-gardens-road-in-parap/1946610.

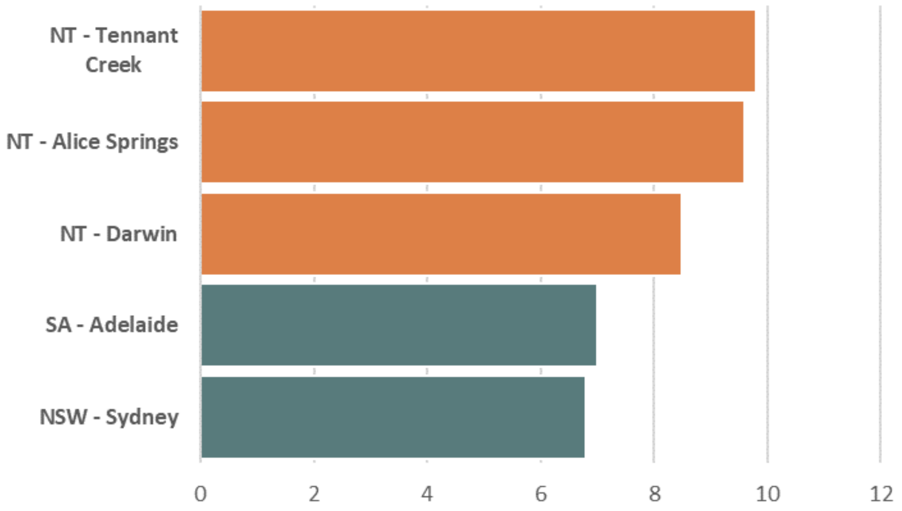
Other introduced species that are prevalent in rural areas and that present challenges to vegetation managers include Bamboo, Palms and Neem trees that require extensive root removal to prevent regrowth and grow rapidly in the northern tropical regions. In particular, palm trees are extensively planted throughout Darwin's urban area and are highly valued by the community. Only limited trimming can be performed on palms without damaging the trees, resulting in a high cutting frequency.

Both native and introduced grass species also present challenges in the rural areas and corridors, particularly during the northern region dry season where bushfires occur in most grassed areas in most years and are a significant hazard to maintainers accessing the network. Many grass species in established vegetation corridors also grow higher than light vehicles after each wet season making any travel both slow and hazardous. Where possible, we avoid extensive slashing of grasses unless required for maintenance activities planned; however, action must eventually be taken when fast growing shrubs and trees approach minimum clearances.

Sunshine hours

A relatively high number of sunshine hours that are favoured by many plant varieties also facilitate vegetation growth along with the high temperatures, high rainfall and high humidity in the NT.

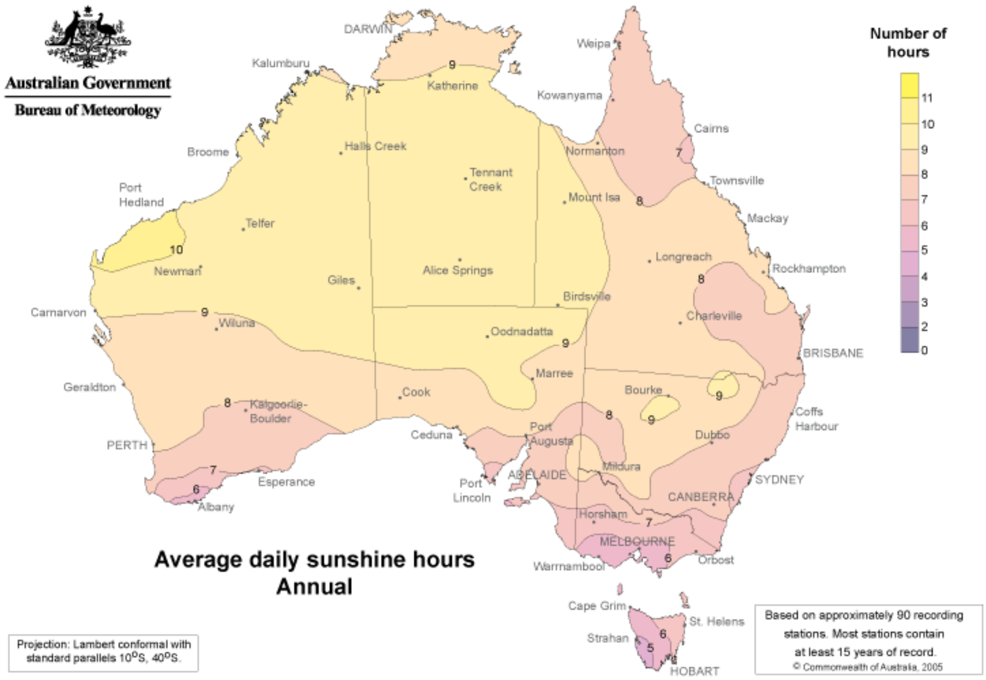
Figure 6.6: Mean daily sunshine (hours)



(a) Source: BOM.

Figure 6.7 demonstrates that the eastern states experience lower levels of daily sunshine compared to the NT and the northern regions of Western Australia.

Figure 6.7: Average daily sunshine hours (annual) across Australia

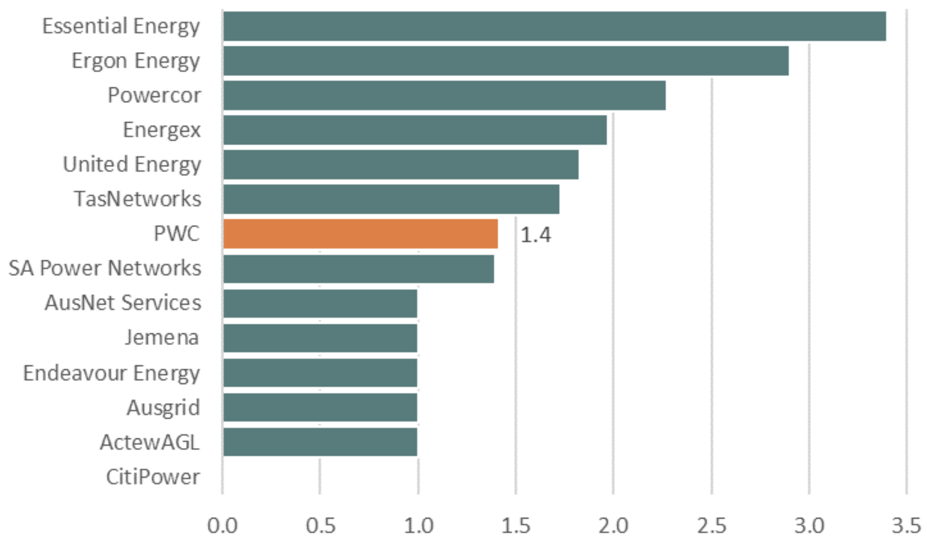


(a) Source: BOM.

Frequency of cutting cycles

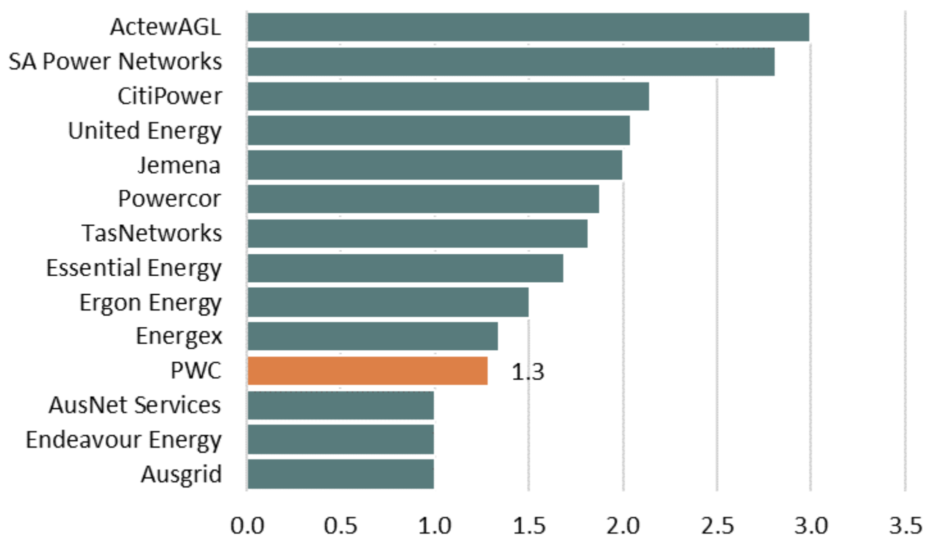
These climatic conditions have required us to increase the average frequency of cutting cycles, which increases our overall vegetation management costs.

Figure 6.8: Frequency of rural cutting cycle (years)



(a) Source: EB RIN (3.7 Operating environment).
(b) Although frequency of rural cutting for us is shown as 1.4 cycle per year, we have different cycles across our network with Darwin and Katherine having 6-monthly cycles (because of high vegetation growth in those areas) and the southern parts of our network with 1.5 year cycles (given the more arid environment).

Figure 6.9: Frequency of urban cutting cycle (years)



(a) Source: EB RIN (3.7 Operating environment).

Rules, Laws and Compliance

We have responsibility for managing all vegetation – it is the last resort vegetation manager (s.64 of the Electricity Reform Act). This leads to higher vegetation management costs because we face more extensive vegetation management responsibilities than other networks, such our Victorian counterparts.

We do not share any vegetation management responsibility with land owners such as councils. Land owners have no responsibility defined under any legislation or regulations in the NT. The ability to remove vegetation that requires high trimming frequency is also limited and requires extensive negotiation with the land or tree owners that have no obligations to manage trees in proximity to lines. An example of this is the significant population of African Mahogany trees across Darwin. Despite the challenges, given our obligations, we have no choice but to incur the expenditure.

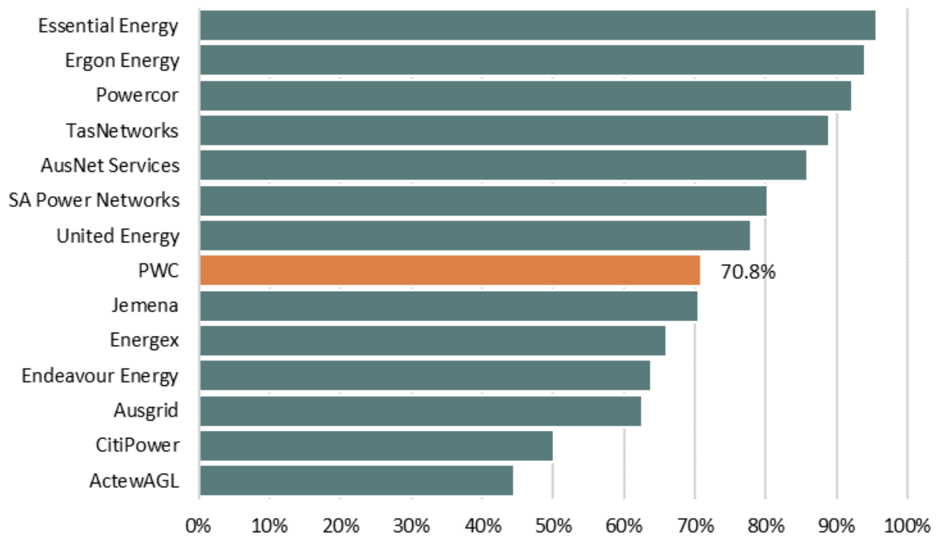
Legislation related to land management also places significant obligations on us to responsibly manage vegetation corridors to reduce the risk of spreading weeds.[14] As maintainers traverse significant proportions of the NT that are subject to weed control measures, the management of vehicles to reduce the transfer of weeds, as well as identification and reporting of weeds also requires additional tasks to be performed by vegetation contractors.

Proportion of overhead lines

Network characteristics such as the high proportion of overhead versus underground lines also contribute to vegetation management costs.

From a volume perspective we have a relatively high proportion of overhead lines (71%) relative to other businesses which means that a high proportion of our network is exposed to above ground vegetation. This leads to higher vegetation management activity and associated costs compared to those networks with higher proportions of underground cables.

Figure 6.10: 2016-17 Proportion of overhead lines. Per cent



(b) Proportion of overhead lines = overhead lines / (overhead lines + underground lines).

[14] For instance, see: https://legislation.nt.gov.au/Legislation/WEEDS-MANAGEMENT-ACT.

(c) Source: EB RIN (3.5 Physical assets).

Lack of standard vehicle access

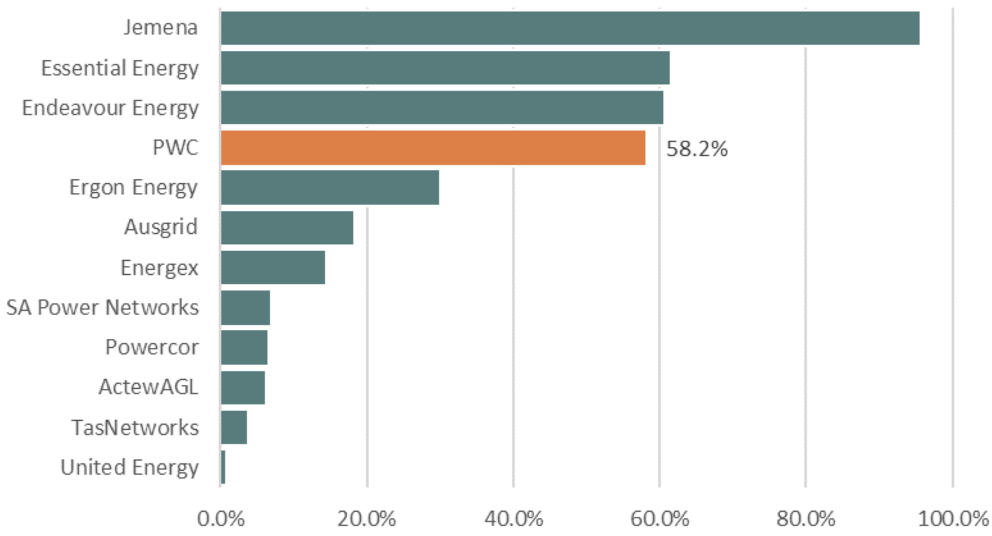
Access to all areas of the network can vary by season. During the wet season many vehicle tracks become difficult to pass and require special vehicles and crew configurations which increase costs, especially for tracks that are not sealed.

Figure 6.11: Example of non-standard vehicle access

(a) Source: Power and Water

Vehicle access data from the benchmarking RINs shown below in figure 6.12 does not capture the issue as it is most likely interpreted as an average for the year. Unlike other networks our range of access swings between the wet to dry seasons. In the wet season, extended and flash flooding of major roads is very common – and this is not reflected in our numbers shown below.

Figure 6.12: Standard vehicle access. Per cent



(a) % of standard vehicle access = standard vehicle access (km) / Line length (km).
(b) Source: EB RIN (3.7 Operating environment).

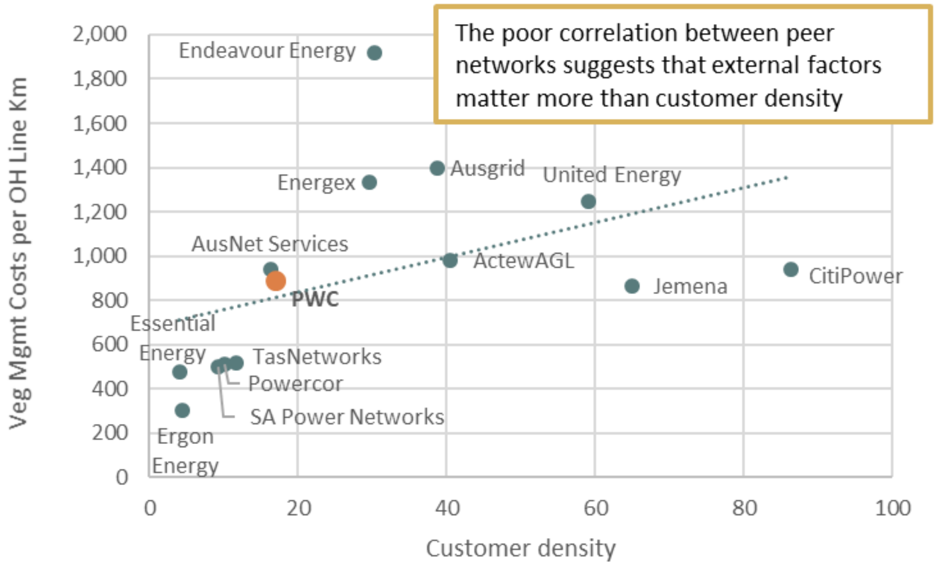
6.3.2 How we look

The unique environment in the NT contributes to the higher costs that are incurred relative to other networks. Therefore, we expect our vegetation management costs to be higher than some other networks on a cost per tree or cost per span basis.

The relevant measures to compare us to other networks include cost per kilometre of overhead line, cost per tree and cost per span. When looking at cost per tree and cost per span it is important to distinguish between urban and rural areas because vegetation types and asset density varies by location.

Despite extreme weather factors, from a unit rate perspective, we are the 5th highest among our peers in terms of dollars per kilometre of overhead line length. Figure 6.13 shows that Endeavour Energy, Ausgrid and Energex have notably higher costs than us.

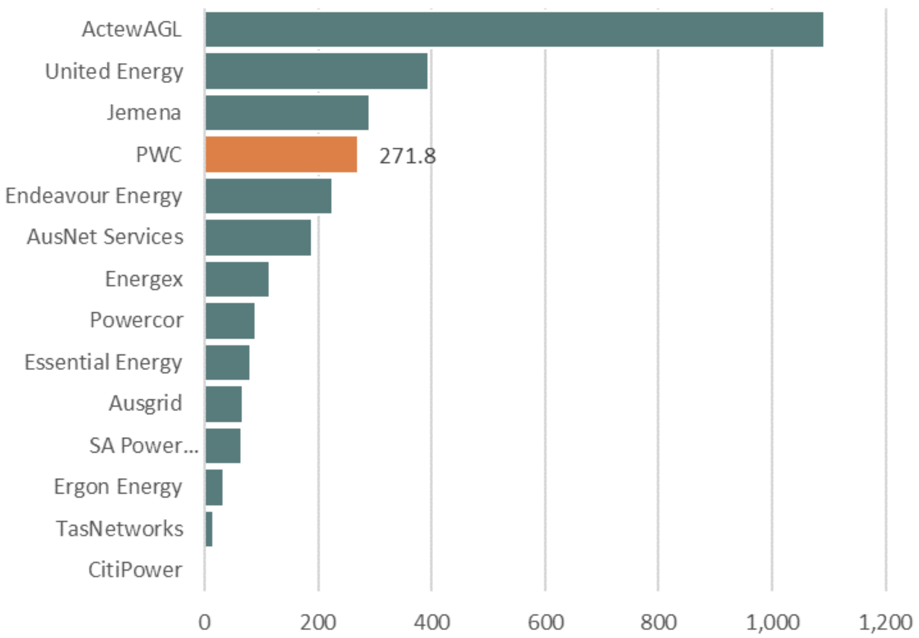
Figure 6.13: 2016-17 vegetation management costs per overhead line compared to other networks. Nominal, Dollars



(a) Source: EB RIN (3.5 Physical assets), CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data).

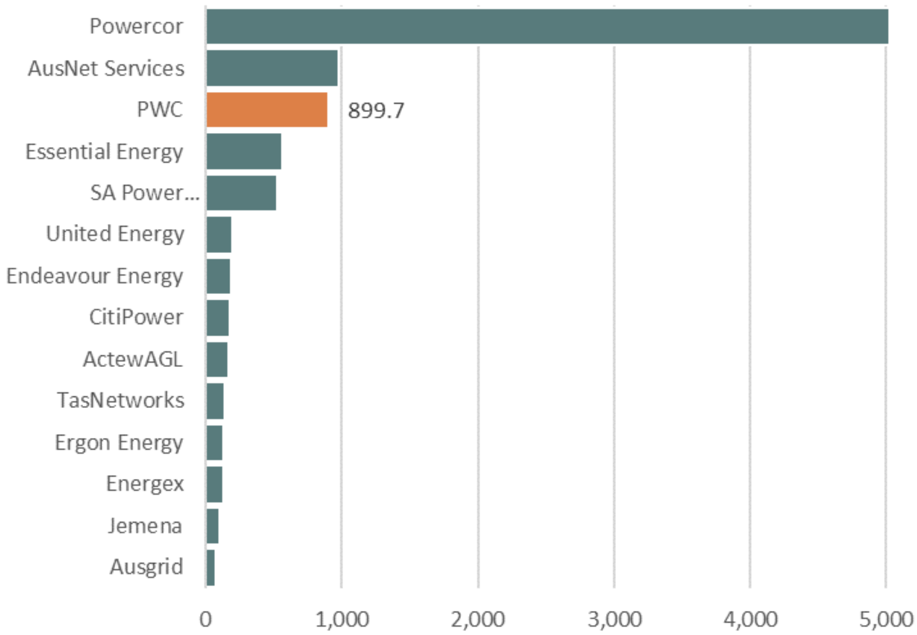
We are in the top three of comparator networks in terms of cost per tree in both rural and urban areas due to our network characteristics such as lack of scale and high labour costs. There is also likely to be differences in the methods used by networks to count the number of trees.

Figure 6.14: 2016-17 vegetation management costs per tree in rural areas compared to other networks. Nominal, Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

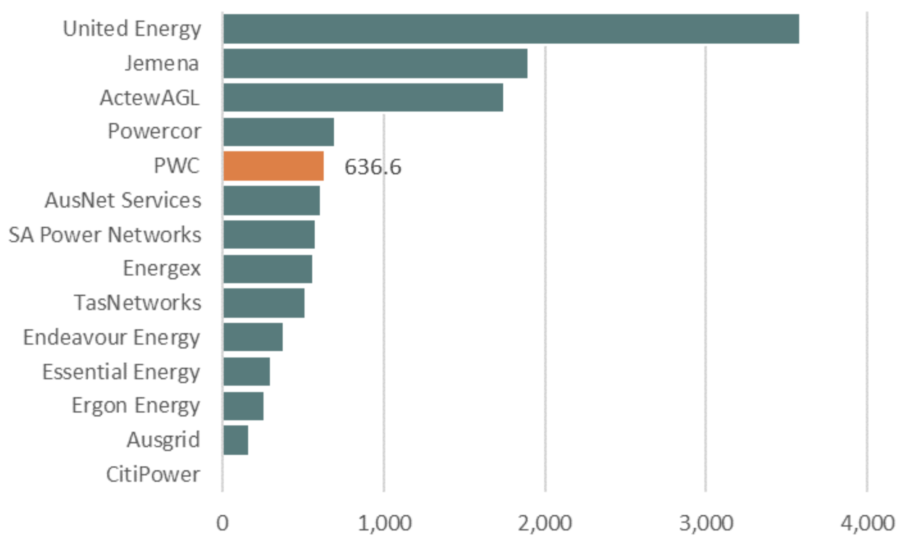
Figure 6.15: 2016-17 vegetation management costs per tree in urban areas compared to other networks. Nominal, Dollars



Source: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

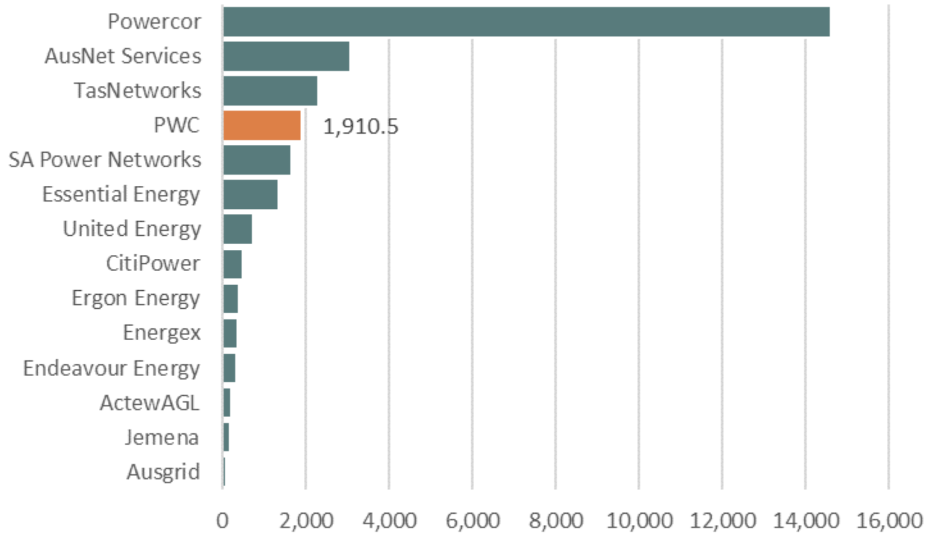
We are also among the top four in terms of cost per span in both rural and urban areas due to its network characteristics such as lack of scale and high labour costs.

Figure 6.16: 2016-17 vegetation management costs per span in rural areas compared to other networks. Nominal, Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

Figure 6.17: 2016-17 vegetation management costs per span in urban areas compared to other networks. Nominal, Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment) .

6.4 Base year efficiency

As identified in section 6.3, when compared to other networks, there appears to be some room for improvement in the efficiency of our vegetation management expenditure.

However, prior to making any base year efficiency adjustments we should recognise that:

- although on some measures our base year may look comparable or higher relative to other networks, the targeted efficiencies only needs to be modest because most of the difference is explained by our unique circumstances; and
- to propose a reasonable level of base year expenditure we have already achieved 23.5% in cost reductions over the last four years – in part due to the identified cost initiatives, including:
  - not renewing regional contracts;
  - removing permanent contract crews in Katherine and Alice Springs;
  - taking advantage of relatively low rainfall years to re-establish corridor clearance and remove problem vegetation in 2013-14 and 2014-15; and
  - working with the vegetation contractor to extend vegetation clearance where possible to reduce cutting frequency without increasing annual lump sum trimming costs.

Given the outcome of peer comparisons, and execution considerations we have assumed none of the total efficiency adjustment will come from a reduction in vegetation management expenditure. As such, implementing the indicative outcome above would mean no change to vegetation costs per kilometre of line.

Nevertheless, we plan to embed the efficiencies achieved to date. For instance, a significant data analysis project was undertaken in 2016-17 to help us, and potential suppliers, make more efficient decisions about vegetation management activities in the future.

7. Non-network opex

This section describes non-network opex activities, explains how the expenditure has evolved over the current period and analyses how our 2016-17 expenditure compares to other networks.

7.1 Activities included

Non-network expenditure is directly attributable to the replacement, installation, maintenance, and operation of non-network assets, excluding motor vehicle assets, building and property assets and IT and communications assets.

Typical activities included in this category are:

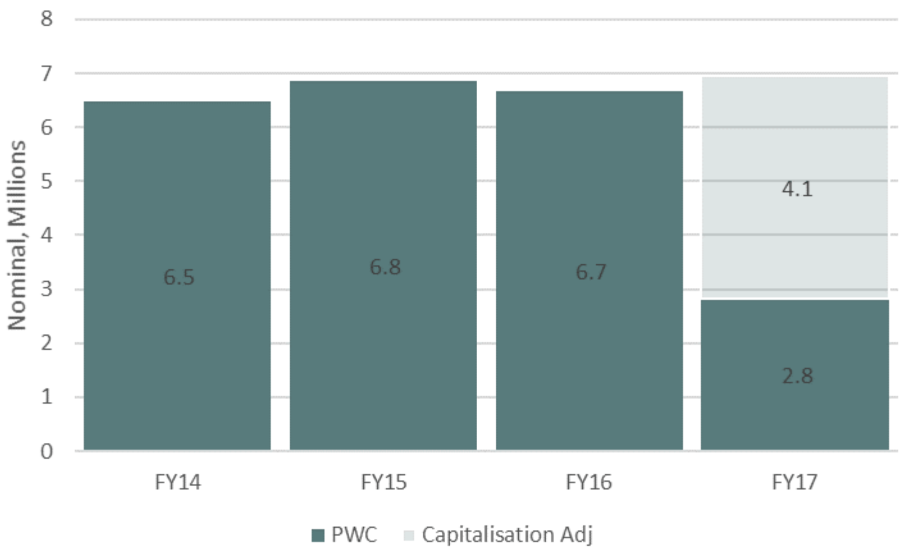
- non-road motor vehicles (e.g. forklifts, boats etc.);
- mobile plant and equipment; tools; trailers (road registered or not);
- elevating work platforms not permanently mounted on motor vehicles; and
- mobile generators.

7.2 Current period opex

7.2.1 Historical performance and trends

On average we spend $5.7 million per annum on non-network activity which has been relatively stable over the last four years if the $4.1 million capitalisation adjustment in FY17 is ignored. Non-network expenditure now represents 4.2% of total opex in the RY17 base year.

Figure 7.1: Non-network expenditure, Nominal, $Millions



(a) CA RIN (2.1 Expenditure summary).

7.3 Comparison to other networks

7.3.1 Points of difference

Common external cost drivers

Extreme weather conditions – extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

This section is not applicable to non-network expenditure as weather patterns do not contribute to the purchase and maintenance of non-road vehicles, equipment, tools, trailers and generators.

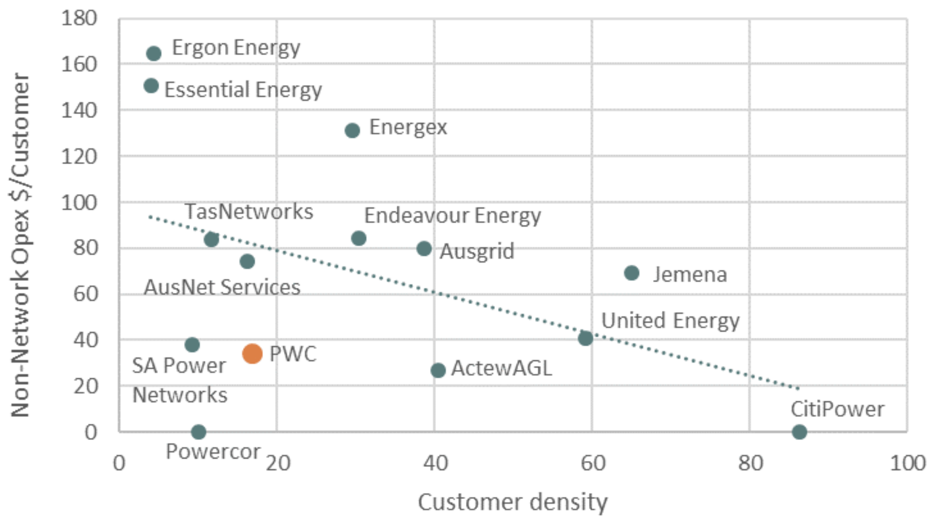
Network characteristics – lack of scale, dispersed and diverse micro networks, high labour costs and unique rules, laws, and compliance

Dispersed and diverse micro networks are more complex to manage than stand-alone networks and typically require more equipment to be purchased, maintained and stored locally.

7.3.2 How we look

For non-network expenditure, we perform well on a cost per basis after adjusting for lack of scale via customer density.

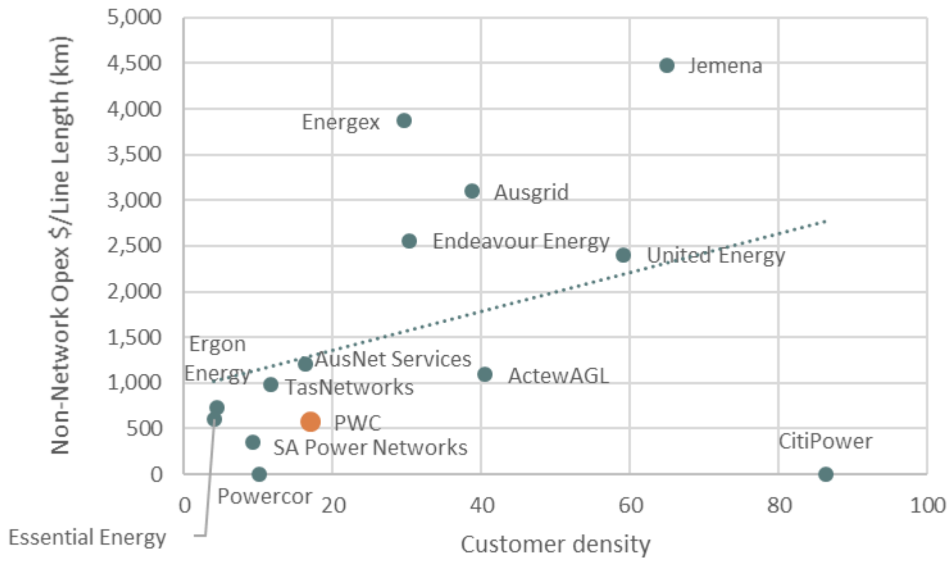
Figure 7.2: Non-network expenditure per customer. Nominal. Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data).

We also perform well on a cost per kilometer of route line length after adjusting for lack of scale via customer density.

Figure 7.3: Non-network expenditure per km of route line length. Nominal. Dollars



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data), EB RIN (3.7 Operating environment).

7.4 Base year efficiency

As identified in section 7.3, when compared to other networks, there appears to be little room for improvement regarding non-network expenditure.

However, prior to making any base year efficiency adjustments we should recognise that to propose a reasonable level of base year expenditure we have taken steps to capitalise items which no longer make sense to expense fully in one year.

Given the outcome of peer comparisons we have assumed none of the total efficiency adjustment will come from a reduction in non-network expenditure.

8. Network overheads opex

This section describes network overhead opex activities, explains how the expenditure has evolved over the current period and analyses how our 2016-17 expenditure compares to other networks.

To enable meaningful comparisons of operating expenditure, lease costs have been excluded from our operational expenditure in this document. The leasing of corporate headquarters is standard practice amongst DNSPs and ,as such, they have been incorporated in the analysis below.

8.1 Activities included

Indirect expenses were reviewed and classified into one of four network overhead categories – management, network control, network planning, and other.

Table 8.1: Allocation of work areas to network overhead categories

Network overhead category	Activities covered
Management	• Executive and Business management
Network control	• Service delivery
Network planning	• Strategy and planning
Other	• Southern region network • Professional fees associated with price reviews

Below are descriptions of the main work areas within the Power Networks business unit. Each area will have a portion of their costs allocated to network overhead charges.

8.1.1 Strategy and planning

The main areas of this group are:

- **Network development and planning** – responsible for the network system planning, including transmission and distribution system planning and augmentation needs. This team also manages emerging technology, large connections including generators and large customers where significant network augmentation may be required. The team also develops the major capital investment program, following the corporate governance processes.
- **Asset management** – responsible for the network asset information, equipment standards, strategic and annual maintenance and replacement planning, and monitoring the delivery of these plans and underlying performance of the network and network assets. The team also provides direct engineering support to service delivery across all asset classes. This includes:

- Transmission, distribution, substation and secondary system design and equipment standards, including technical advice and support to internal field crews as well as external developers and contractors.
- Monitoring, analysis and reporting on activities including maintenance and replacement delivery and cost performance, network system performance indices and reliability related Guaranteed Service Level (GSL) measures.
- Network asset condition, risk and subsequent asset replacement planning.
- Development of maintenance strategies, and monitoring of maintenance costs and investigation of asset failures to continually improve the effectiveness and efficiency of these strategies.
- Replacing, and upgrading strategies for all secondary systems, including protection system design and engineering for both the transmission and distribution network.
- Network asset data creation and maintenance including updating asset systems for new assets, asset upgrades and audit.
- Reporting and mapping services to internal and external stakeholders,

- **Major projects** – management of the delivery of major and complex projects, via internal and external resources. This includes large customer connection projects.
- **Network engineering** – responsible for routine customer connections work, including PV connections, developer/real estate developments, and commercial customers. The team is also responsible for delivering distribution and transmission projects and minor works, maintaining network system diagrams that are critical for network operations performed by system control, and maintaining asset drawings to support maintenance activities.

8.1.2 Service delivery

The service delivery team plans, schedules and executes maintenance and capital works. They are made up of the following groups:

- **SCADA and communication services** – responsible for the maintenance of these systems, including monitoring performance of critical systems that facilitate the operation of the NT’s transmission and distribution network. The team also undertakes most of the testing and commissioning of our SCADA and communications equipment to ensure secure and reliable system operations in compliance with the various network technical codes and System Control Service Level Agreement.
- **Substation services** – responsibilities are to assess the condition and maintain key strategic substation plant and equipment to provide a safe and reliable electricity supply. The team also delivers small asset replacement projects within substations and manages the deployment of our mobile 66kV substation (NOMAD) for network contingency response including substation asset failures.

- **Test and protection services** – responsibilities are to assess the condition and maintain the integrity of the various network protection systems. This includes periodic testing of transmission and distribution protection devices and schemes to ensure they operate reliably during abnormal system conditions including asset failures, major weather events, supply/generation failures and public contact with assets i.e. vehicle accidents. These systems are critical to network safety, security and reliability. The team also provide most testing and commissioning services for new plant and equipment to ensure these systems meet the stringent technical and quality requirements expected of these critical systems and as defined in applicable technical codes.
- **Field Services –** responsibilities include all inspection, maintenance, emergency response and minor capex in the northern regions (Darwin and Katherine) of underground and overhead:
  - transmission lines
  - distribution lines, transformers and switchgear
  - service lines.

  The team is also responsible for switching activities in the network to allow safe access to network assets for inspection, maintenance or replacement activities in line with core systems and processes to ensure the safety of crews and the public interacting with network assets.
- **Works Management** – responsibilities include the centralised delivery planning of the Darwin-region network's related maintenance and minor capex activities performed by both internal field crews and contractors, including vegetation management. The team is also responsible for direct engagement with developers related to inspection, testing and final acceptance of gifted assets (new real estate developments and large customers) and their final connection to the network.

8.1.3 Business management

This group is responsible for a variety of business support activities, direct support of network activities through its inventory and warehousing function, as well as monitoring, reporting and improving our health and safety performance and culture.

Core functions of the team include:

- Operational budget management and business reporting, project management administration contract administration associated with both major projects and maintenance contracts, including invoicing and payments.
- Support for capitalisation of all network and non-network assets acquired by the network business.
- Stores and warehousing functions including inventory procurement and contract management, physical management and storage of consumables, parts and complete assets and strategic spares, monitoring, analysis and optimisation of inventory.

- Developing, maintaining and advising on work practices and procedures, safety, investigation of incidents and near misses, development of safety culture and supporting processes. The team also performs routine auditing and inspection of internal and contract field crews to ensure the ongoing safety and health of crews working on hazardous equipment associated with an electricity network, but also in the context of the often-extreme environment and weather conditions.

As explained in section 9.1, some business management related functions are allocated to Power Networks through the corporate cost allocation process.

8.1.4 Southern region network

This small team covers the large geographic and technical areas that service the separate and very remote micro networks in Alice Springs and Tennant Creek, located 1,500 km and 1,000 km from Darwin respectively.

Responsibilities include all inspection, maintenance, emergency response and minor capital projects in the northern regions (Darwin and Katherine) of underground and overhead:

- transmission lines
- distribution lines, transformers and switchgear
- service lines

The team is also responsible for switching activities in the network to allow safe access to network assets for inspection, maintenance or replacement activities in line with core systems and processes to ensure the safety of crews and the public interacting with network assets, for both capital and maintenance works.

The remoteness of these micro-networks means that a basic level of support staff, plant and equipment and inventory warehousing are required to provide essential and reliable services to customers in these centres. Environmental conditions are vastly different from the Northern region meaning procedures, equipment standards and asset strategies require additional consideration to ensure they are fit for purpose for the expected environmental conditions.

The small size of these networks does not translate to the complexity and technical engineering requirements needed to ensure these systems are as safe and reliable as any other networks. Specialised field crews from SCADA and communications services, Substation Services and Test and Protection services need to travel regularly to these locations to support network maintenance, asset testing and commissioning and often emergency response.

The frequency of these skills being required means it is not efficient to maintain these skills permanently in these centres. However, local field crews need to maintain training and skills to work on and respond to a wide variety of asset types to ensure reliable system performance and minimise travel for specialist crews located in Darwin, or contractors from other major centres in Australia.

8.2 Current period opex

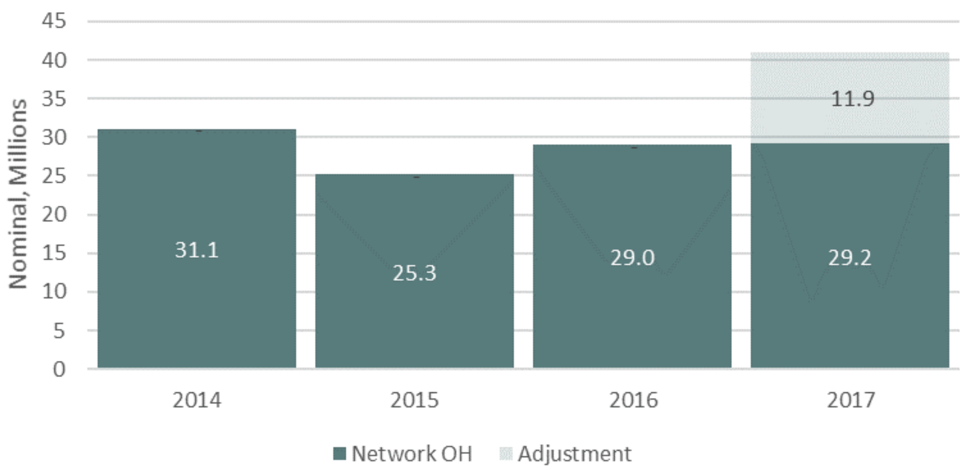
8.2.1 Historical performance and trends

On average we spend $28.6 million per annum on network overheads which has decreased by 6.2% over the last four years, or increased by 32.2% ignoring the recent change in capitalisation for regulatory reporting purposes.

A key driver of the (pre-capitalisation) step up from 2015-16 to 2016-17 was the costs of transitioning to the NT National Electricity Rules and preparing our regulatory proposal, which accounted for $3.0 million of our 2016-17 network overheads. These regulatory costs are largely expected to repeat every five years.

Network overheads contribute 43% of total opex in our 2016-17 base year – making it our largest opex category.

Figure 8.2: Network overheads, Nominal, $Millions



(a) CA RIN (2.1 Expenditure summary).
(b) The adjustment refers to the change in capitalisation approach.

The top five components of network overheads are personnel costs (40%), corporate allocations (14%), professional fees (12%), service level agreement expenses (9%) and vehicles (5%) within the network planning and network control categories.

Personnel costs

Personnel costs have steadily increased over the years at an average of 6.5% per year, primarily due to staffing increases and enterprise bargaining agreement (EBA) salary increases and bonuses.

However, for regulatory reporting purposes, personnel costs have varied due to labour recoveries. For example, labour recoveries from capital projects increased by 15.2% in 2014-15 as staff members improved their time writing. Since January 2014, staff members who did not populate timesheets in the past started to do so.

In 2016-17, a range of indirect costs – including labour – were capitalised that were not capitalised in previous years. This reduced personnel costs reported in network overheads.

Corporate allocations

Corporate allocations consistently contribute at least 10% each year to network overhead costs. Corporate allocations also contribute to corporate overheads, which are discussed in more detail in the next chapter.

Professional fees

Professional fees increased in 2016-17 as consultants and contractors were engaged to develop material for the AER price review process. These costs are likely to be incurred in the future as we continue to engage with the AER.

Service level agreement (SLA) expenses

The bulk of Power Networks' SLA expenses relate to system control. The amount captured in network overheads decreased in 2016-17 due to the new regulatory capitalisation policy applied in the year.

Vehicles

The reduction in 2016-17 vehicle expenditure is due to the capitalisation of motor vehicle operating leases. We have advanced to the new accounting standard (IFRS16) requiring operating leases of motor vehicles and property assets to be capitalised from 1 July 2019.

Expenditure in the current period has varied from 2013-14 to 2016-17 due to:

- new accounting standards regarding capitalisation of motor vehicle and property leases applied in 2016-17 for regulatory reporting and forecasting purposes;
  - Historically leases, overheads and depreciation of IT have been recovered through opex, which has meant recovery of costs in a single year rather than over the life of the asset.
- an increase in professional fees in 2016-17 due to consultants and contractors being engaged to develop material for the AER price review process;
- a higher proportion of staff populating timesheets from January 2014, leading to an increase in labour recoveries from capital projects; and
- capitalisation of some overheads beginning in 2016-17 after review of our regulatory capitalization approach.

8.3 Comparison to other networks

8.3.1 Points of difference

Common external cost drivers

Extreme weather – extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

Climate materially affects network costs because we have to cater for a wide range of different operating environments. The dispersion of the population and the islanding of our systems has a material cost impact relative to other networks in Victoria and Tasmania that do not face such circumstances.

Typically, an increase in direct costs typically comes with an increase in network overheads. For instance, if there is a big storm, then network management will need to get involved in managing the response to it.

Network characteristics – lack of scale, dispersed and diverse micro networks, high labour costs and unique rules, laws, and compliance

Network characteristics impact network overheads for the following reasons:

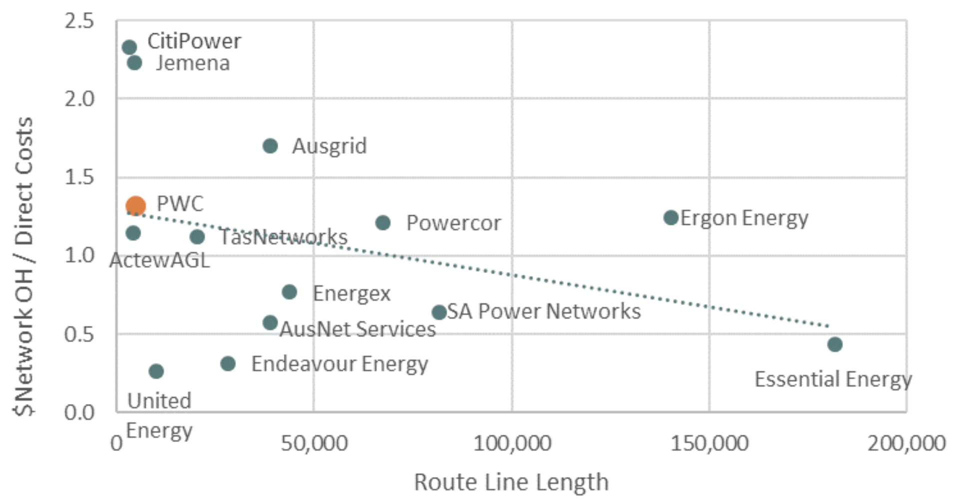
- dispersed and diverse micro networks are more complex to manage than stand-alone networks as subtle differences between networks lead to additional processes, dedicated contracts and a range of personnel issues which increase the time required to manage the business;
- network overheads primarily relate to labour activities so our exposure to high labour rates – as discussed above – is comparatively unfavourable; and
- the business management team is responsible for implementing unique rules, laws, and compliance obligations. Some examples of NT differences include:
  - Building regulations are onerous due to the harsher, more extreme climate;
  - Environmentally sensitive areas are dispersed through the urban and rural areas;
  - Implementation of OH&S rules arising from regular extreme heat; and
  - Incorporating the impacts of sites of cultural significance into each project or program.

8.3.2 How we look

We do not benchmark favourably from a cost per customer perspective given that we have the fewest customers of all DNSPs regulated by the AER. Network overheads are in the order of $486 per customer, which is the second highest value amongst the other networks. However, this is not a particularly useful measure, as customer numbers have only an indirect effect of network overheads.

Better measures – as shown below – are network overheads per dollar of direct costs, per kilometre of line length (as a proxy for scalability) and per unit of labour (as a measure of labour costs).

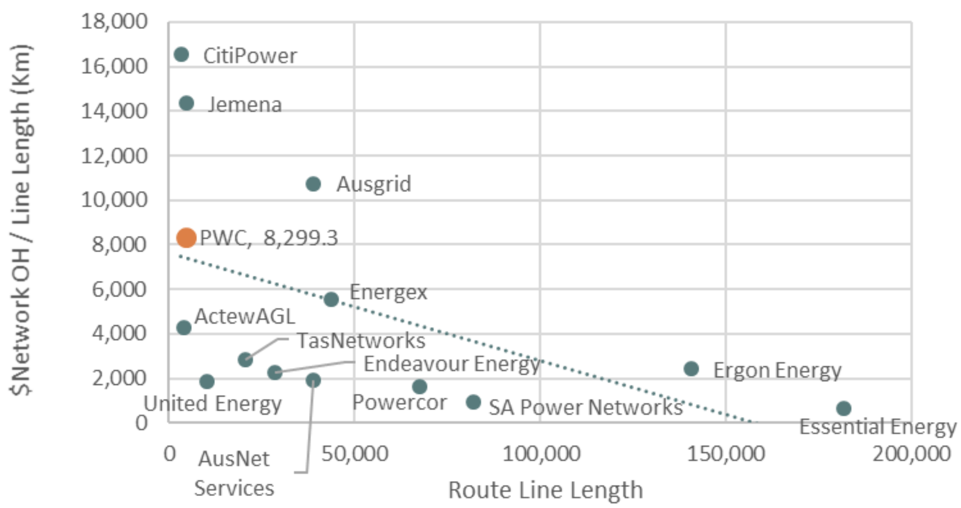
Figure 8.3: Ratio of network overheads (opex and capex) to direct costs, Multiple, 2016



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data).

We appear comparable to other networks after adjusting for the lack of scale via customer density and using an alternative measure of cost per kilometer of line length. Our network overhead per kilometre of line length is $8,299 which is comparable to Ausgrid, Jemena and CitiPower.

Figure 8.4: Network overheads (opex and capex) per km of line length, Nominal, Dollars, 2016



(a) CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data), EB RIN (3.7 Operating environment).

8.4 Base year efficiency

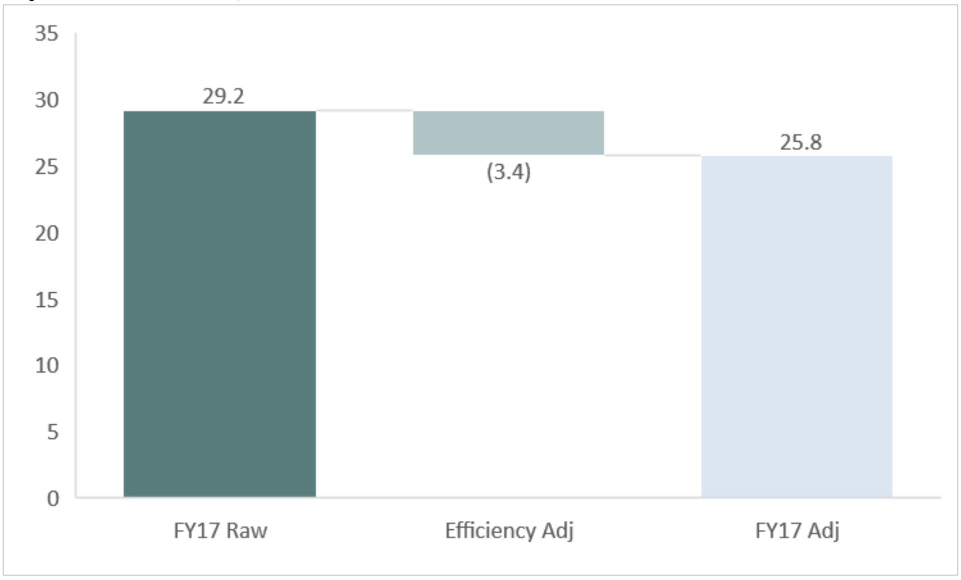
As identified in section 8.3, when compared to other networks, there appears to be some room for improvement regarding network overheads. However, prior to making any base year efficiency adjustments we should recognise that:

- although on some measures our base year may look comparable or higher relative to other networks, the efficiency target only needs to be modest because most of the difference is explained by our unique circumstances; and

- to propose a reasonable level of base year expenditure we have already achieved 6.2% in cost reductions, if we include the change in capitalisation approach (or alternatively, exclude the recent regulator costs), over the last four years in part due to the identified cost initiatives and we continue to look for more.

As part of the overall 10% efficiency target included in our proposal network overheads will need to reduce. Given the outcome of peer comparisons, and execution considerations we have assumed for presentational purposes that 50% of the total efficiency adjustment (in dollar terms) will come from a reduction in network overheads expenditure.

Figure 8.5: Indicative change in network overhead costs after 10 per cent efficiency adjustment. Nominal, $Millions

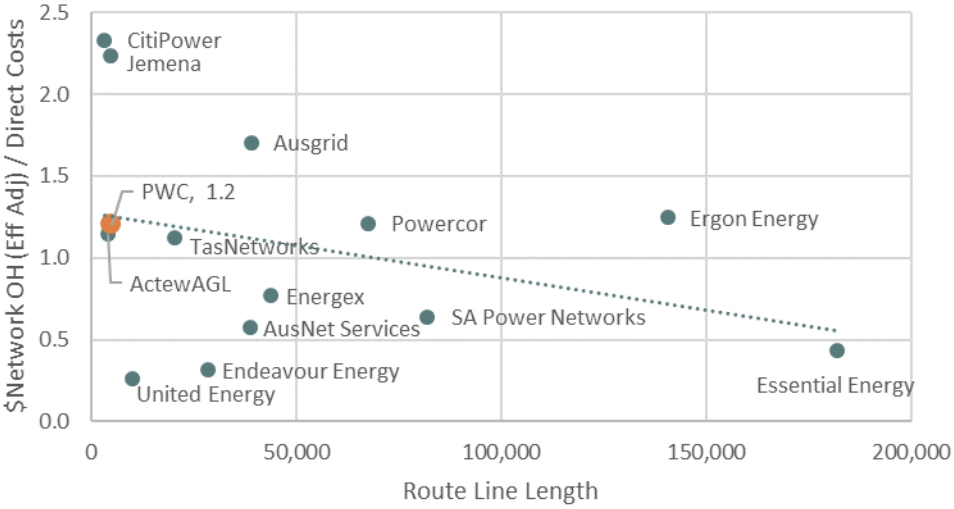


(a) Efficiency adjustment based on network overhead absorbing 50% of the total opex reduction resulting from the 10% saving included in this proposal.

(b) Sources: CA RIN (2.1 Expenditure summary) and supporting documents.

Implementing the indicative outcome above would mean network overheads per customer would drop from $486.6 to $462.3.

Figure 8.6: Ratio of network overhead to direct costs. Multiple



(a) Adjusted network overheads are based on the value in CA RIN (2.1 Expenditure summary) less the indicative value of the efficiency adjustment allocated to network overheads.
(b) CA RIN (2.1 Expenditure summary), EB RIN (3.7 Operating environment).

9. Corporate overhead opex

This section describes corporate overhead opex activities, explains how the expenditure has evolved over the current period and analyses how our 2016-17 expenditure compares to other networks.

9.1 Activities included

Corporate activities are carried out by several corporate functions within Power and Water. The costs of those activities are allocated to business units – including Power Networks – according to our corporate cost allocation process.

Determining Power Networks share of corporate overheads

Power Network's share of corporate overheads – and corporate *costs* that form part of network overheads – for 2016-17 was determined using long-standing principles, amended (as necessary) to:

- better reflect a more appropriate allocation of costs to our subsidiary, Indigenous Essential Services Pty Limited; and
- capitalise those corporate costs that could be attributed to capital activities.

These principles are described in Appendix A.

Our corporate cost allocation method has been revised for the 2017-18 year to apply refreshed causal cost drivers at a more granular level to our current corporate structure, and is applied using a structured corporate cost allocation model. This model uses underlying drivers – such as headcount, time, cost, and square metres – to allocate corporate costs to business units.

The model also splits corporate costs allocated to business units between opex and capex for statutory reporting purposes, which underpins the capitalisation applied for regulatory reporting purposes. The cost allocation process applying to the 2017-18 year is described further in the AER-approved cost allocation methodology.

The activities undertaken by our corporate functions are summarised in the table below, along with the causal allocators that will be used to allocate those costs to business units for the 2017-18 and subsequent years. These include all categories of 'corporate overheads' and some categories of 'network overheads', as defined by the AER's regulatory information notice.

Our approach to allocating these corporate costs for the 2016-17 year is explained further in our basis of preparation in response to that notice.

Table 9.1: Corporate overhead activities and causal allocators

Activity	Description	Causal allocator
Human resources	Work in partnership across business units to effectively manage the employment life-cycle for our employees, and ensure that managers are provided with accurate and consistent advice relating to issues impacting their people	% of BU FTE's to total FTE's
Health and Safety	Provide specialist advice, support, and guidance on corporate safety matters	% of BU FTE's to total FTE's
Environment	Provide specialist advice, support, and guidance in environmental management	% of BU FTE's to total FTE's
Business information and business systems	Provides services and solutions that support and enhance the strategic and technical ability of the business to achieve core objectives via information technology	Number of licenses assigned to BU as % of total licenses
Facilities	Work in partnership across business units to ensure that corporate facilities and assets are reliably operated and maintained	% of BU FTE's to total FTE's
Project management office	Provide our board and executive with an enterprise-wide view of all significant projects across our company and to support improved governance, tracking and reporting of projects	% of BU FTE's to total FTE's
Office of the CFO	Responsible for all aspects of the financial management of our company, including financial compliance, management reporting, budgeting, and forecasting (including the statement of corporate intent), taxation and financial analysis	1) % of BU FTE's to total FTE's 2) number of AP invoices processed for BU activities is calculated as a % of the total AP invoices processed 3) Legal: - estimated number of PN legal activities as a % of total
Customer service centre	Provides customer and client services to Indigenous Essential Services, Power Networks and Water/Sewerage services.	% of BU FTE's to total FTE's

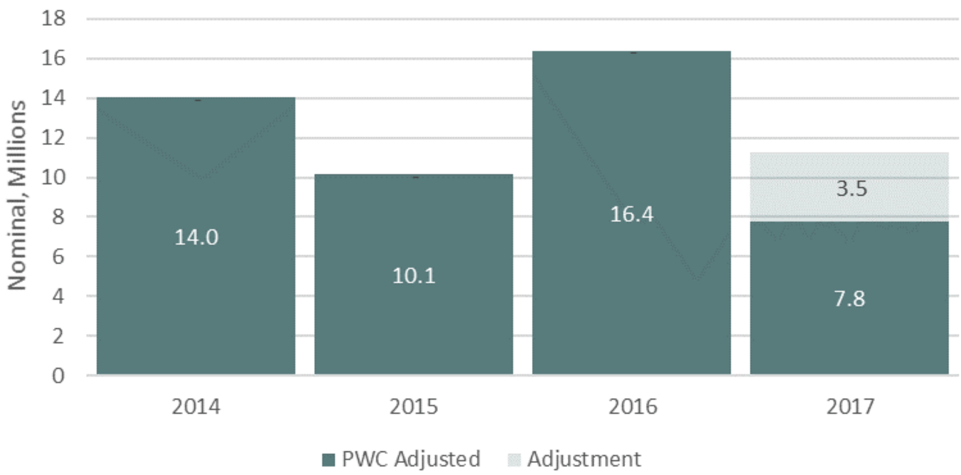
Activity	Description	Causal allocator
Learning and development	Work in partnership across our business to maximise training outcomes and build capability by providing specialist advice on strategies for skills development and effective coordination of training and delivery	% of BU FTE's to total FTE's
Procurement and inventory	Provides professional procurement services including procurement planning and advisory services as well as tender management services	1) % of BU FTE's to total FTE's 2) Estimated number of PN procurement activities as a % of total
Risk, audit, and compliance	Providing governance, risk, compliance, and audit services, which includes managing our risk framework and strategic risk register, internal audit program and audit recommendations, and legal compliance register	1) % of BU FTE's to total FTE's 2) Prof Fees: Engagement of external consultants to undertake risk, audit and compliance work for BU
Corporate communications	Responsible for core communication activities and initiatives for the whole of our company and groups across Power and Water to help them deliver communications for their projects	% of BU FTE's to total FTE's
Office of the CEO	Provides executive leadership, policy advice and corporate communications for management, staff, and key stakeholders, including engagement with Ministerial offices, our board, media, government, business, and community groups	% of BU FTE's to total FTE's

9.2 Current period opex

9.2.1 Historical performance and trends

On average Power Networks' share of corporate overheads is $12.1 million per annum, which has decreased by 44.5% over the last four years or 20.0% ignoring recent changes in capitalisation for regulatory reporting purposes (shown as the 'adjustment' in the figure below). Corporate overheads contribute 11.5 % of total Power Networks' opex in our 2016-17 base year.

Figure 9.2: Corporate overhead expenditure, Nominal, $Millions



(a) 2016-17 captialisation adjustment sourced from the supporting documents to the EB and CA RIN.
(b) Source: CA RIN (2.1 Expenditure summary).

The Power Networks business unit benefits from being able to share corporate overheads with other business units, such as IES, gas and water services. The share allocated to Power Networks' has fluctuated over the last four years for several reasons, including because:

- we refreshed our corporate cost allocation methodology for the 2016-17 year to better reflect cost drivers;
- we capitalised more corporate overheads in 2016-17 after a review of our regulatory capitalisation approach; and
- our business was restructured from the start of 2014-15 in to three separate NT government owned corporations – Power and Water Corporation (us), Jacana (a power retailer), and Territory Generation (a generator) – which lead us to temporarily under-allocate corporate overheads to our Power Networks' business unit.

9.3 Comparison to other networks

9.3.1 Points of difference

Common external cost drivers

Extreme weather –extreme heat, high rainfall, high humidity, strong winds, high UV exposure, storms and cyclones and lightning strikes

These external cost drivers are not directly applicable to corporate overhead expenditure.

Network characteristics – lack of scale, dispersed and diverse micro networks, high labour costs and unique rules, laws, and compliance

However, network characteristics impact corporate overheads for the following reasons:

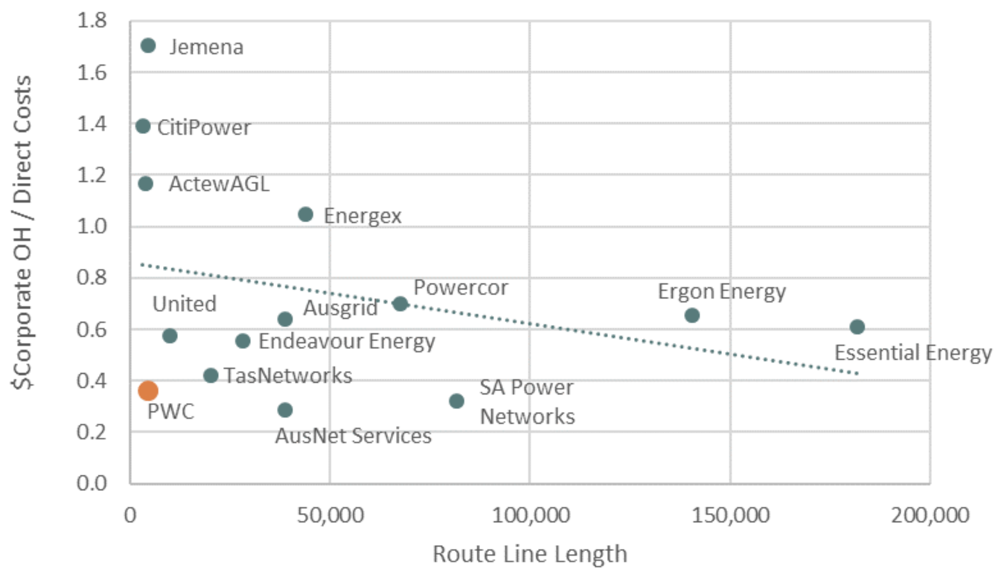
- corporate overheads primarily relate to labour activities so our exposure to high labour rates is unfavourable; and

- certain necessary corporate functions do not scale downwards smoothly, such as board and executive officers, legal, finance, HR, etc. – so, as the smallest DNSP regulated by the AER (based on several measures), we carry the costs associated with this fixed expenditure with a smaller cost base to allocate this across. Power and Water does have the ability however to spread these costs over other business units such as the water and gas services.

9.3.2 How we look

When looking at Power Network's share of corporate overheads, we benchmark well from a cost per customer perspective and from corporate overheads as a proportion of direct costs perspective.

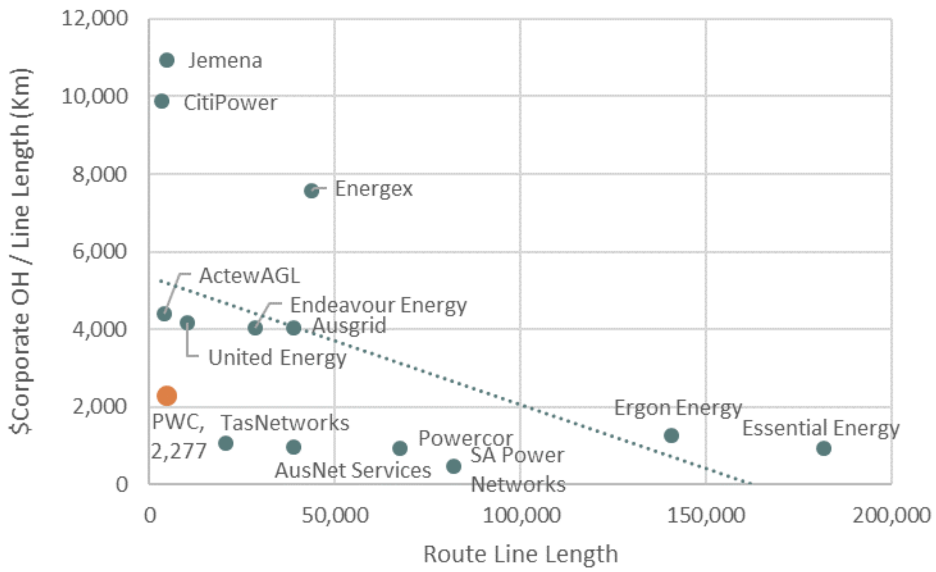
Figure 9.3: Ratio of corporate overheads (opex and capex) to direct costs, Multiple, 2016



Source: CA RIN (2.1 Expenditure summary), EB RIN (Operational data).

We also benchmark well in terms of cost per kilometer of line length. Our corporate overhead per kilometre of line length is $2,277, which is in the more efficient half of the Australian distributors.

Figure 9.4: Corporate overheads per km of line length, Nominal, Dollars, 2016



(a) Source: CA RIN (2.1 Expenditure summary), EB RIN (3.4 Operational data), EB RIN (3.7 Operating environment).

9.4 Base year efficiency

As identified in section 9.3, when compared to other networks, there appears to be little room for improvement regarding corporate overheads. We have already achieved a 20% cost reduction over the last four years, ignoring the capitalization adjustment – in part due to the identified cost initiatives.

Given this, we have assumed that none of the total efficiency adjustment will come from a reduction in corporate overheads expenditure.

Appendix A - Corporate cost allocation principles applying to 2016-17

Table A.5: Corporate cost allocation principles (2016-17)

Corporate business unit	Functions	Causal allocators
Managing Director	Managing Director	Allocated evenly to each business unit as it assumed that each would have this function separately as a stand-alone business.
Strategy, Economics & Regulation	Executive	Allocated based on an average of the other functions within the business unit.
	Strategic Planning & Analysis	Allocated evenly to each business unit as it is assumed that each would have this function separately as a stand-alone business.
	Economics & Regulation	Allocation based on staff allocation to business units.
	Sustainable Energy	Allocation based on the actual cost of projects that apply to each business unit.
Chief Financial Officer	Financial Services	Dependant on service type, allocation is based on: 1. The number of invoices processed for the business unit; 2. The number of capital, repairs and maintenance projects and total spend; 3. Staff allocation to business units; and 4. An even spread across business units, as it is assumed that each would have this function separately as a stand-alone business.
	Program Development	Allocation based on the average number of capital projects and total value of capital spend.
Governance & Corporate Services	Change Management	Allocated evenly to each business unit as it is assumed each would have this function separately as a stand-alone business.
	Regions	Allocation based on staff numbers in Alice Springs, Tennant Creek and Yulara.
	Employee & Organisational Services	
	Executive	Allocated based on an average of the other functions within the business unit in an attempt to align to effort involved in managing each business unit.
	Security & Emergency	Allocated evenly to each business unit as it is

Corporate business unit	Functions	Causal allocators
	Management	assumed that each would have this function separately as a stand-alone company.
	Corporate Communications	Allocation based on staff workload.
	Environmental Management	Allocated evenly to each business unit, except for system control and retail – which were excluded as they would not require this function if they were stand-alone businesses.
	Corporate Safety	Allocation based on level of risk and activity.
	Employee Relations	Allocation based on employee numbers.
	HR Operations	
	Training Unit	
Governance & Corporate Services continued	*Business Systems & Information Management*	
	Datamart	Allocation based on employee numbers.
	Records Management Unit	
	Finance Assets	
	Business Analysis	
	CIO Office	
	BSIM Contracts	
	Operations Training	
	BSIM Project Management	
	Service Desk	Allocation based on logged jobs to the service centre.
	BSIM Operations	Allocation based on registered system users in each business unit.
	Application Administration	
	Asset Management System	
	Core Services	
	Procurement	Allocation based on operating expenditure less energy, renewable energy credits and internal expenses.
	Facilities Management	Allocation based on building occupancy.
	Legal & Governance	
	Risk Assurance, Quality & Audit	Allocated evenly to each business unit as it is assumed that each would have this function

Corporate business unit	Functions	Causal allocators
	Legal	separately as a stand-alone business.
	Insurance	Allocation based on average of total assets value and personnel costs.
	Board	Allocated evenly to each business unit, except for remote operations which has a separate board of directors that governs operations.