TasNetworks Benchmarking Report

Regulatory Control Period: 1 July 2019 to 30 June 2024

Authorisations

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1. Introduction

This report outlines the benchmarking performance of TasNetworks using the Australian Energy Regulator **(AER)** models and techniques. Benchmarking of electricity transportation businesses is challenging due to the regional monopoly nature of the businesses and the imprecise practice of model specification. These issues make it difficult to isolate actual efficiency differences from the influence of exogenous environmental factors and statistical noise[1].

We consider our performance over time is a reasonably reliable indicator of the effectiveness of our transformation initiatives and efficiency improvement. Throughout this document it is evident that:

(i) The merger of our transmission and distribution networks has reduced the operating expenditure of the network businesses; and

(ii) Ongoing cost savings over recent years have improved our benchmarking position considerably.

It is important to maintain appropriate focus on the safety and reliability of our network for our customers and staff. This means that cost reductions must not invoke undue risk to the long-term interests of consumers. We have maintained the balance between cost efficiency and service levels through well-informed and considered cost reduction initiatives, evident through:

(i) Most of our efficiency gains having been achieved through a reduction in corporate overheads, with a 51 per cent improvement in these costs (transmission plus distribution) between 2010 and 2017[2];

(ii) Where necessary, making prudent decisions to absorb costs above our regulatory allowance to maintain safety and reliability, such as in 2017 due to improved information on asset and bushfire risks;

(iii) The confidence in the sustainability of our recent efficiency gains is reflected in our forecast opex for transmission and distribution, whereby we are not only maintaining underlying costs at the improved levels, but also anticipating further efficiency gains through absorption of some of the growth in the network and Consumer Price Index (CPI) increases.

As a result, our forecast 2022 operating expenditure for both transmission plus distribution is 21 per cent lower in real terms than the peak in 2010[3].

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[1] Exogenous environmental factors are network characteristics that influence a business's cost. If these factors aren't accounted for in the models used then their impact will be included in estimates of efficiency (omitted variable bias). Statistical noise refers to random fluctuations in the data used that can be caused by things such as anomalous weather events or measurement error.

[2] See **Error! Reference source not found.**.

[3] See **Error! Reference source not found.**.

2. The Role of Benchmarking

Key Points:

The availability of better information about the performance of regulated networks is a potentially useful tool for stakeholders, including customers, wanting to engage in the regulatory process. Benchmarking can also help network businesses understand the drivers of costs and their performance. However, caution must be exercised when interpreting the results of benchmarking, particularly when looking to compare networks, as statistical models and metrics frequently fail to capture the true complexity of electricity transportation in diverse operating environments.

TasNetworks is subject to benchmarking by the Australian Energy Regulator **(AER)** in its Annual Benchmarking Reports for transmission and distribution network services and also during each regulatory determination, as required by the National Electricity Rules **(Rules)**. The AER's Expenditure Forecast Assessment Guide lays out the AER's benchmarking framework and methodology, including the techniques that it may employ. This benchmarking is undertaken annually for both our transmission and distribution networks, with the results published in annual benchmarking reports. It is also relied upon by the AER during regulatory determinations as part of its assessment of efficient expenditure. In previous regulatory determinations and in the most recent Annual Benchmarking Reports, the AER has used:

- Multilateral Total Factor Productivity **(MTFP)** models (transmission and distribution);
- Multilateral Partial Factor Productivity **(MPFP)** models (transmission and distribution);
- Partial Productivity Indicators (transmission and distribution); and
- A number of statistical models (distribution only):
    - A Stochastic Frontier Analysis **(SFA)** model;
    - A Least Squares Estimate **(LSE)** Cobb-Douglas model; and
    - A Least Squares Estimate **(LSE)** Translog model.

2.1 Regulatory Obligation

Chapter 6 and Chapter 6A of the Rules address the economic regulation of distribution and transmission services. Clauses 6.5.6 (c) and 6A.6.6 (c) address distribution and transmission services respectively, and include the criteria the AER must consider to accept the proposed operating expenditure of a network services provider. Clauses 6.5.7 (c) and 6A.6.7 (c) include the criteria for acceptance of the capital expenditure forecasts for distribution and transmission respectively. In all cases, the AER's annual benchmarking reports are included in the matters which the AER must have regard to in assessing the prudence and efficiency of a regulated networks' expenditure forecasts[4].

2.2 Monitoring and Managing our Performance

Since commencing operations on 1 July 2014, we have utilised benchmarking internally to assess our performance in various functions against our peers and ourselves over time. We also support the use of benchmarking to supplement the appraisal of regulatory proposals.

However, benchmarking using economic models such as those employed by the AER has well documented limitations. Not the least of these is the sensitivity of the results produced by a model to the variables selected in the model's specification. The significant change in TasNetworks' transmission benchmarking results after a single variable change prior to publication of the 2017 Annual Benchmarking Report is a good example of this sensitivity[5]. Caution must therefore be exercised when using benchmarking to rank or compare the performance of one network against that of other networks.

Our own benchmarking includes detailed analysis of both costs and service performance against appropriate peers or reference points. Depending upon what indicators are used for benchmarking, the most appropriate peers can change. For example, at a macro level for distribution networks, SA Power Networks, AusNet Services and Powercor share the most similar customer density with TasNetworks. AusNet Services and Powercor could also be considered regional networks, like TasNetworks.

For simple, coarse indicators, these networks are potentially useful comparators. However there are many differences between these networks and our own, such as the asset design and operating conditions, which make comparison on other bases more difficult. Given this challenge, the small number of networks in Australia and the broad range of conditions in which they operate, assessment of our own performance over time is an important augmentation to any comparison with other networks.

[4] See clauses 6.5.6 (e) (4) and 6.5.7 (e) (4) for distribution capital and operating expenditure and clauses 6A.6.6 (e) (4) and 6A.6.7 (e) (4) for transmission capital and operating expenditure.

[5] This is addressed further in section 5.2

A practical approach to benchmarking ensures that whilst we continue to focus on cost efficiencies, we also maintain prudent levels of activity to ensure a safe and reliable network service and act in the long-term interests of the consumer, as required by the National Electricity Objective **(NEO)**.

3. Our Efficiency Journey

Key Points:

Prior to the merger that formed TasNetworks, the distribution network business of Aurora Energy had already embarked upon a transformation program that resulted in a significant reduction in its workforce.

The merger of Tasmania's transmission and distribution networks to form TasNetworks also provided a one-off opportunity to achieve a step-change reduction in costs, by eliminating duplication and generating some modest scale economies.

For a network business operating in the environment in which TasNetworks finds itself, connecting a large number of small renewable generators that serve a small but highly disaggregated customer base dominated by a small number of major industrial customers, TasNetworks is arguably already an efficient business.

We will continue to work hard to sustainably reduce the cost of providing our network services across our capital and operating programs, without reducing the safety or reliability of our network.

But with little opportunity to realise productive efficiency gains through increased business outputs, like on-island load growth or increasing customer numbers, TasNetworks must mainly rely on reducing inputs, relative to outputs, in order to realise productive efficiency gains. In the coming regulatory period, for example, we will be focussed on achieving efficiency savings that absorb the cost increases associated with the low growth expected in customer numbers.

The performance of TasNetworks' transmission network against the AER's MTFP benchmark has, under the first iteration of the AER's MTFP model, been the best of the five TNSPs making up the NEM, and even under the recently revised model, TasNetworks has been the leading TNSP for the last two years.

Since 2010, the performance of TasNetworks' distribution network against the AER's MTFP benchmark has trended up, whilst most networks' performance has been in decline – noting that there is a limit to how high TasNetworks' relative performance can be driven, because of the inability of the AER's MTFP model to fairly portray TasNetworks' unusual system structure.

At some point, however, TasNetworks will reach a point where there are no further material reductions that can be made to business inputs, and the business' productivity and efficiency, as assessed by the AER's benchmarking models, will decline relative to other networks which have greater scope for growth in their outputs.

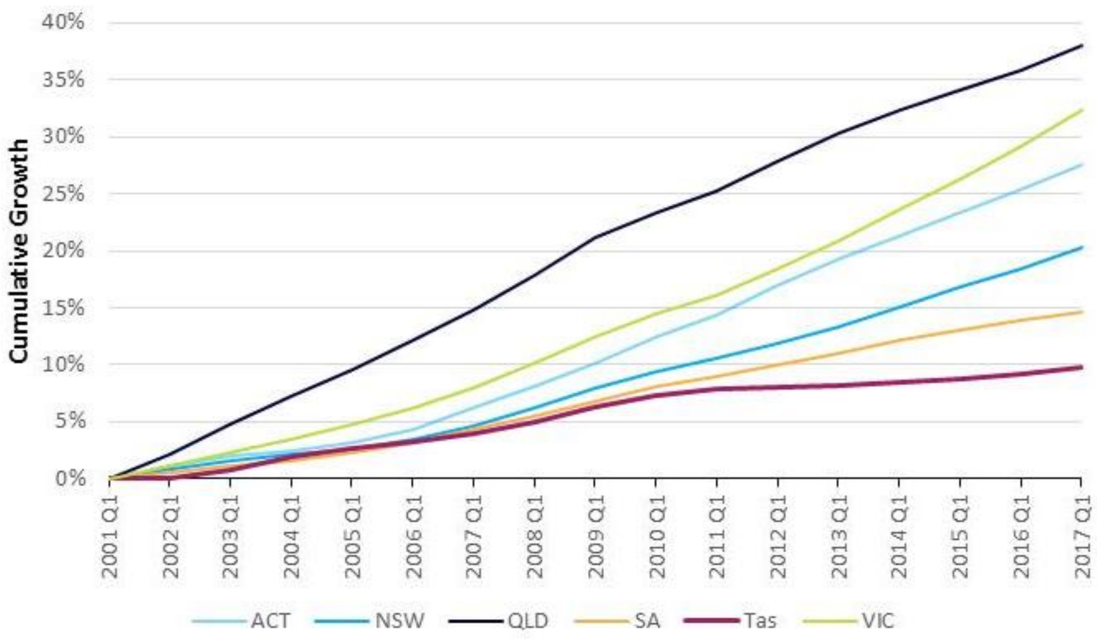
3.1 Drivers of growth

Productivity growth, as a measure of the change in outputs relative to the change in inputs, can be achieved in two ways. A network can realise efficiency gains through increasing outputs relative to inputs or can reduce inputs relative to outputs. Given that output growth is driven by exogenous factors[6], TasNetworks has had to rely on reducing operating expenditure over time to realise productivity gains.

Customer numbers is a dominant variable in the output function and indices of the AER's productivity models[7]. Growth in customer numbers (which increases outputs in the AER's modelling, potentially resulting in a lift in productivity) is tightly correlated to population growth and, as such, beyond the control of network businesses. The growth in customer numbers will also drive other outputs used by the AER such as ratcheted peak demand and energy throughput. These three outputs (customer connections, ratcheted peak demand and energy throughput) account for 76 per cent of the outputs for distribution benchmarking and 62 per cent of the outputs for transmission benchmarking.

Error! Reference source not found. below highlights the slow rate of population growth TasNetworks has experienced over a long period compared to other National Electricity Market (NEM) States and Territories. Whilst the rate was initially similar to South Australia, it has fallen away significantly over the AER benchmarking period (2006 – 2016).

Figure 1 Population Growth by NEM State and Territory



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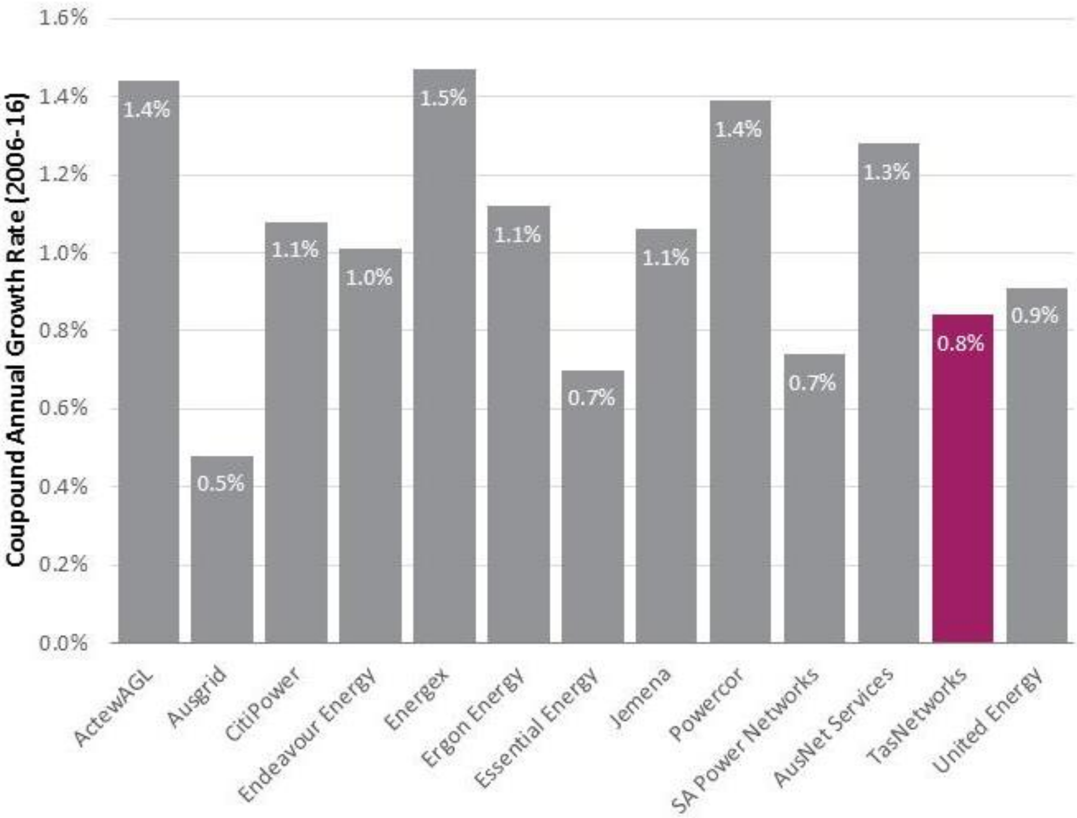
6 Population growth within a network's area, customer consumption patterns, solar panel take-up etc.

7 Customer numbers has a weighting of 46 per cent in the AER's distribution TFP and PFP models and 20 per cent in the transmission TFP and PFP models.

The low population growth rate in Tasmania compared to mainland states has constrained the growth in outputs as defined by the AER productivity benchmarking models. Only Ausgrid, Essential Energy and SA Power Networks had lower output index growth rates (excluding Reliability) than TasNetworks between 2006 and 2016, although those networks have significantly larger output bases.

Figure 2 Change in Output Index Scale Factors Over Time

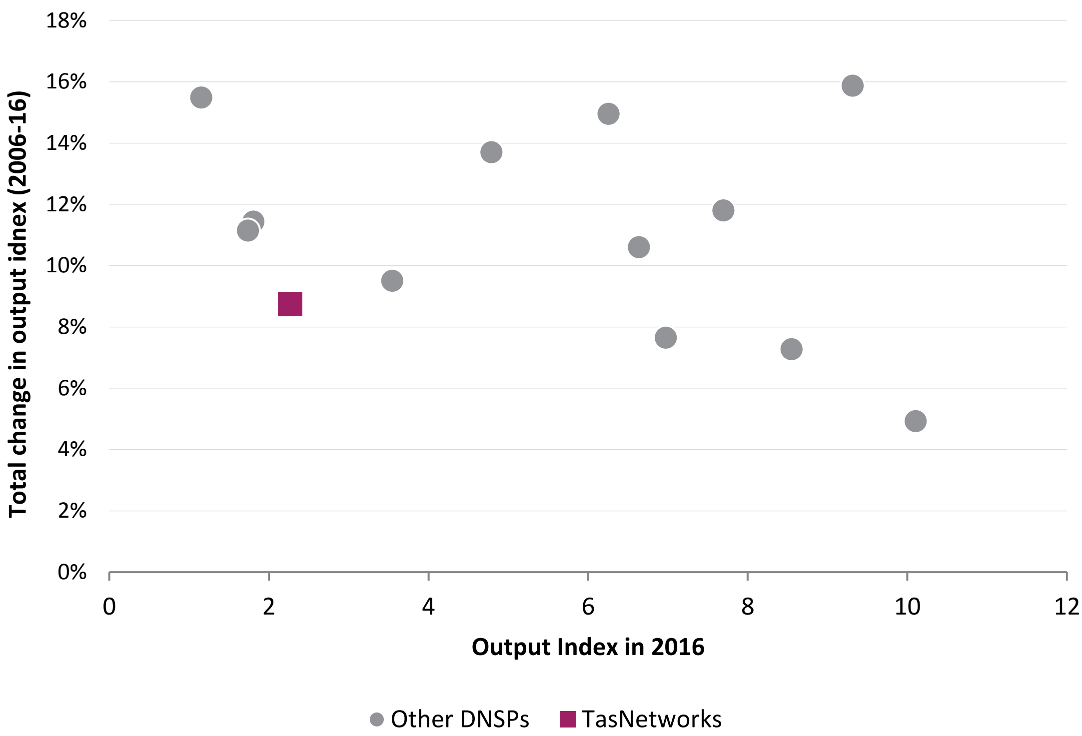


This low rate of growth is different to other smaller[8] networks in the NEM that have been afforded the opportunity to realise economies of scale by spreading their fixed costs over a growing output base. **Error! Reference source not found.** below shows that amongst the distribution networks with outputs most closely resembling TasNetworks (in terms of the aggregated output index[9]) TasNetworks (distribution) has had the smallest growth in its output index since 2006.

[8] We have used the size of the output index to reflect the relative size differences between networks. The output index aggregates customer numbers, circuit length, ratcheted peak demand and energy throughput.

[9] Customer minutes off supply has been excluded so that the index represents scale more adequately.

Figure 3 Current Output Index and Change Over Time – Distribution



It can be argued that a contemporary electricity network business has a different set of outputs to that specified in the AER models and if a different set were specified, the output growth rates would be different. However, any outputs that are associated with customer growth or usage (energy supplied, peak demand, etc.) are beyond the control of the business and therefore cannot be actively increased relative to inputs/costs by the network business.

With little opportunity to increase outputs relative to inputs, TasNetworks must rely on reducing inputs relative to outputs in order to realise productive efficiency gains. There is, however, a limit to how far inputs can be reduced, which is difficult to quantify precisely. TasNetworks may already be at that limit. As a smaller network, the risk to TasNetworks in approaching or even breaching that limit is that the frontier may continue to shift due to incremental improvements by larger networks that may have more room to improve. This has the potential to create a false signal that TasNetworks could continue to improve its productivity. Therefore, we must remain cautious that the safety and reliability of our network is not compromised through erroneous interpretation of our position relative to a theoretical efficiency frontier.

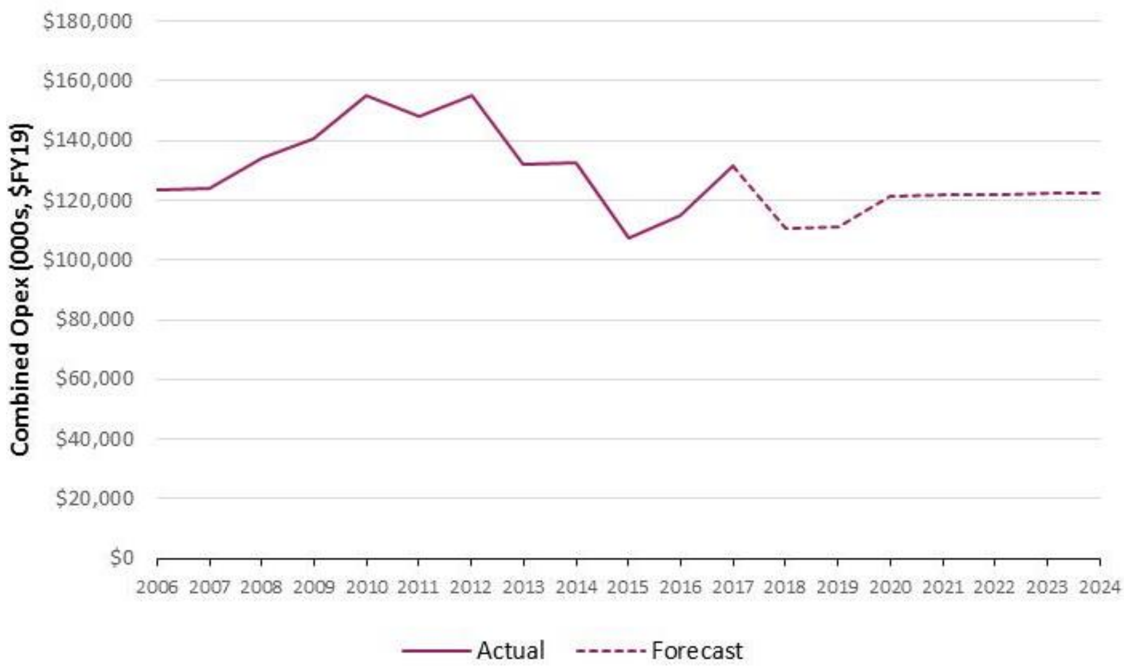
Only ActewAGL has a smaller customer base than TasNetworks, presenting barriers to reducing costs through economies of scale efficiencies – particularly when the transmission and distribution networks were individually operated businesses prior to 1 July 2014 (Transend Networks and Aurora Energy respectively).

3.2 Accessing Economies of Scale through the Merger

Operating in a small island state, the Tasmanian networks have very little scope for economies of scale or other size based advantages. The merger of the transmission and distribution networks was a once-off opportunity to realise some benefit of lowering the fixed costs associated with duplicated network and business support functions. However, the achievement of further scale economies is likely to be underpinned by growth in the Tasmanian customer base, and as has already been noted, the growth in customer numbers in Tasmania is lagging behind other markets within the NEM.

Prior to the merger that formed TasNetworks, the distribution network business of Aurora Energy had already embarked upon a transformation program that resulted in a significant reduction in its workforce. But with a much smaller workforce and a greater reliance on outsourcing, including to Aurora Energy, there were limited opportunities for the other party to the merger, Transend Networks, to rationalise its operations in a similar manner. Nonetheless, the merger has resulted in cost reductions for TasNetworks. The total operating expenditure for the combined networks has reduced from historical levels as shown in Error! Reference source not found.Error! Reference source not found..

Figure 4 TasNetworks Transmission and Distribution Opex over Time



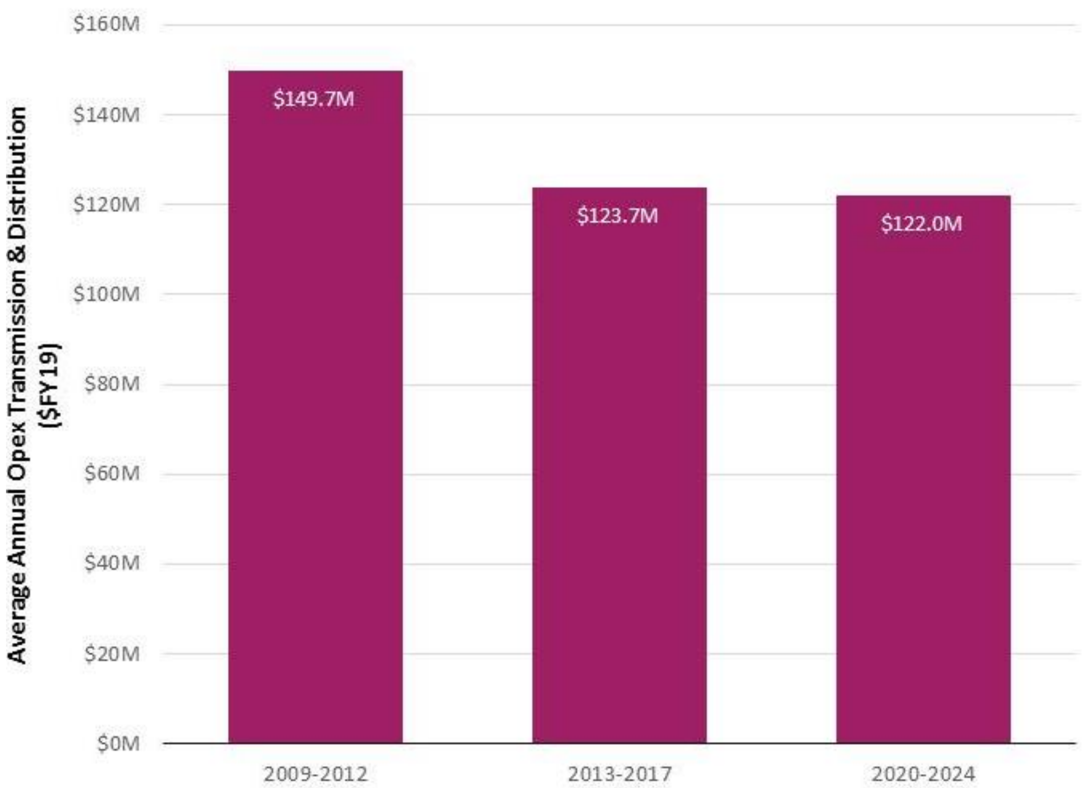
The increase in total opex in the 2017 financial year is a short-term variation that has been borne by our shareholders, rather than passed onto customers. The uplift in opex was largely driven by actions taken to address bushfire and asset-related risks that were identified as improved information became available about the condition of our assets and the extent of vegetation encroachment.

Our customers' have consistently told us that they expect that we will maintain reliability and ensure the safety of our customers, employees, contractors, and the community. Based on the improved information which became available, the business concluded that bushfire and asset-related risks were unacceptably high and we took prudent action to address these risks, which increased our operating expenditure in 2017.

Error! Reference source not found. highlights that, despite the increase over the previous year, TasNetworks' combined transmission and distribution operating expenditure in 2016-17 was still lower than historical levels. Our forecasts also maintain the underlying opex reduction from historical levels achieved since the merger that formed TasNetworks in 2014. This demonstrates that the merger has realised a significant reduction in operating expenditure through consolidation and scale economies, together with the delivery of operational efficiencies. While we continue to pursue efficiency savings, we will not compromise the safety and reliability of our network for today's customers and future customers.

Further, the average total opex for the transmission and distribution networks for the next regulatory control period is forecast to be lower than the 2013 to 2017 average (see Error! Reference source not found.), representing further forecast efficiency gains offsetting growth (escalation, scale and step changes). This represents a 19 per cent reduction in real terms in operating expenditure from the 2009 to 2012 average.

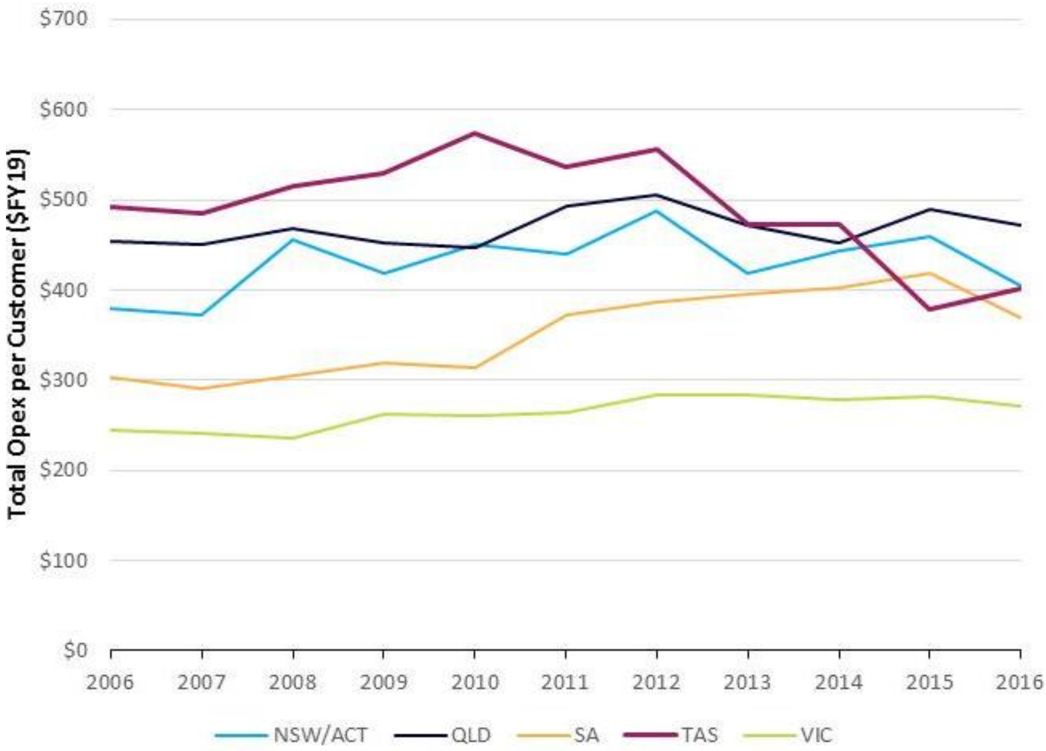
Figure 5 Transmission and Distribution Average Opex



3.3 Reducing Costs for Customers

The merger has been successful in lowering our costs. As the smallest State in the NEM (if the ACT is combined with NSW to allow transmission and distribution opex to be aggregated for comparative purposes), our access to economies of scale are limited and our total opex per customer could reasonably be expected to be higher than larger states. As **Error! Reference source not found.** shows, however, our total opex per customer has reduced from the highest in the NEM to the median.

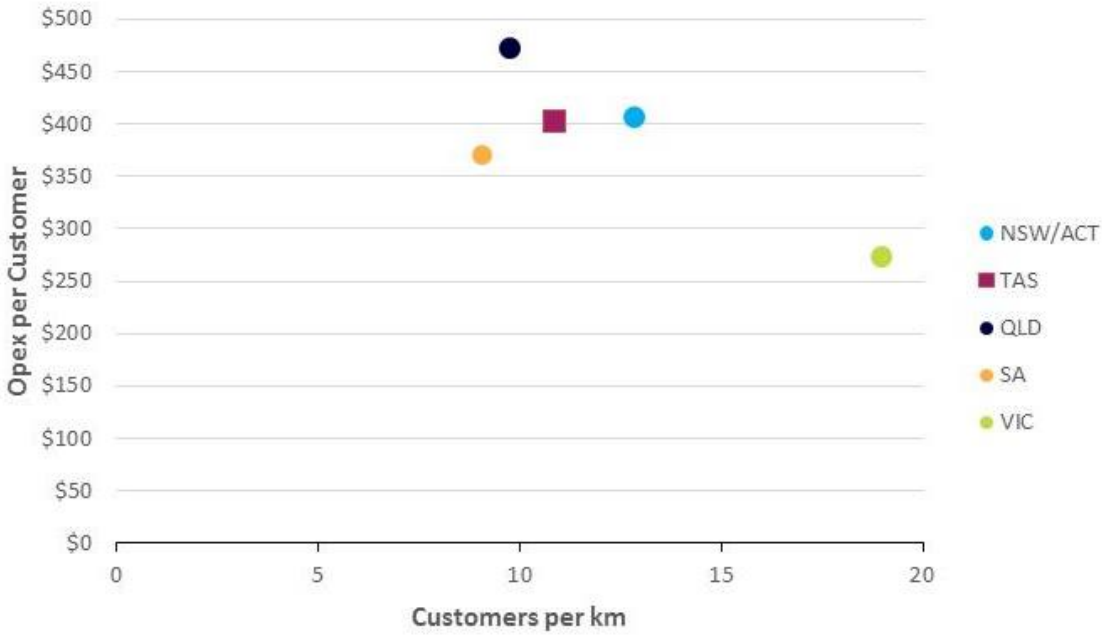
Figure 6 Opex per Customer – Transmission plus Distribution



Note: Opex for other networks for FY17 was not publicly available at the time of this report.

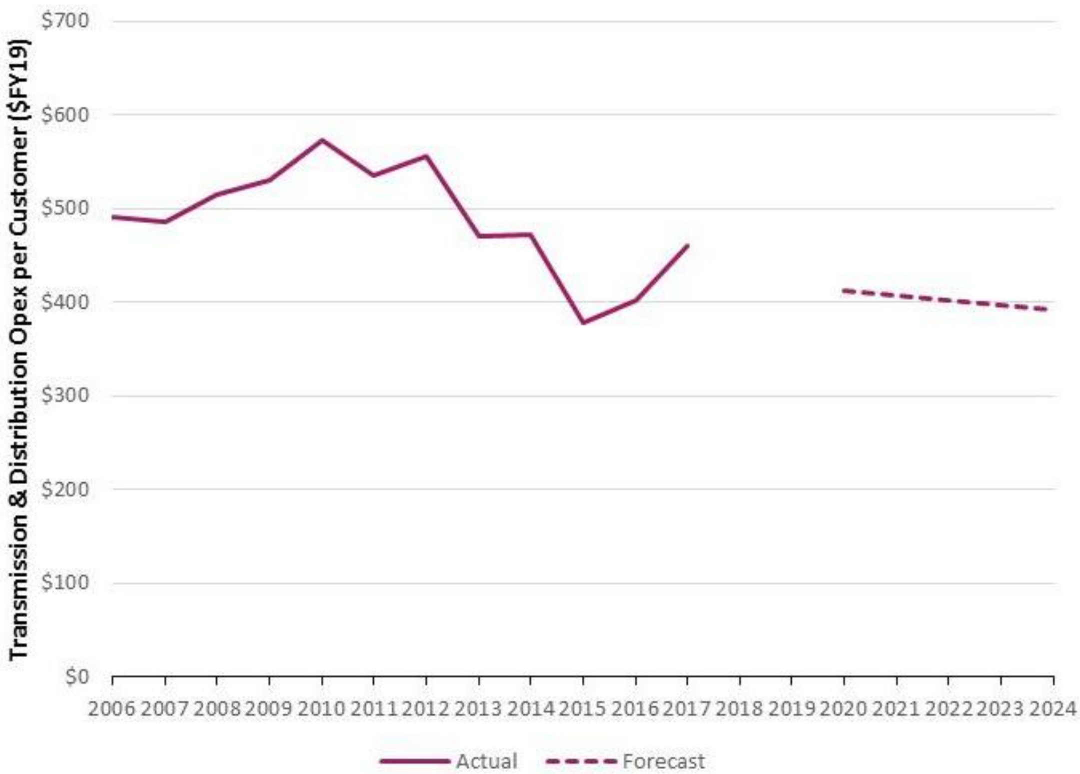
Aggregating transmission and distribution data by State mitigates some of the broad variance in customer densities caused by the specific network boundaries in each jurisdiction and provides a more level playing field for making comparisons. As the following chart shows, with the exception 2016-17 (when our distribution network opex increased as a result of action taken to mitigate bushfire and asset-related risks) our performance on an opex per customer basis at a jurisdictional level is now similar to South Australia. This is despite South Australia benefitting from economy of scale and greater centralisation, with 77 per cent of the South Australia's population living in the state's capital, as opposed to 43 per cent in Tasmania. As the state with the lowest opex per customer, Victoria has economy of scale advantages over Tasmania and economy of density advantages over every other State. **Error! Reference source not found.** shows the 2016 total opex per customer against customer density (expressed as customers per kilometre of network).

Figure 7 FY16 Transmission and Distribution Opex per Customer by State and Density



Our total opex per customer benchmarks very well given our small size and Tasmania's widely dispersed population. Furthermore, our forecasts reflect opex per customer in the longer term which, in real terms, will be lower than in FY16, as shown in Error! Reference source not found..

Figure 8 Actual and Forecast Opex per Customer – TasNetworks Transmission & Distribution



The data in **Error! Reference source not found.** is affected in FY17 by the aforementioned one-off opex increases incurred in that year and absorbed by our shareholders. However, our forecast opex for the distribution network represents levels of opex per customer which are:

(i) Significantly lower than historical values;

(ii) Considerably lower than the current regulatory period's average;

(iii) Equivalent to recent South Australian performance; and

(iv) Higher only than Victoria's current performance, which has both scale and density advantages.

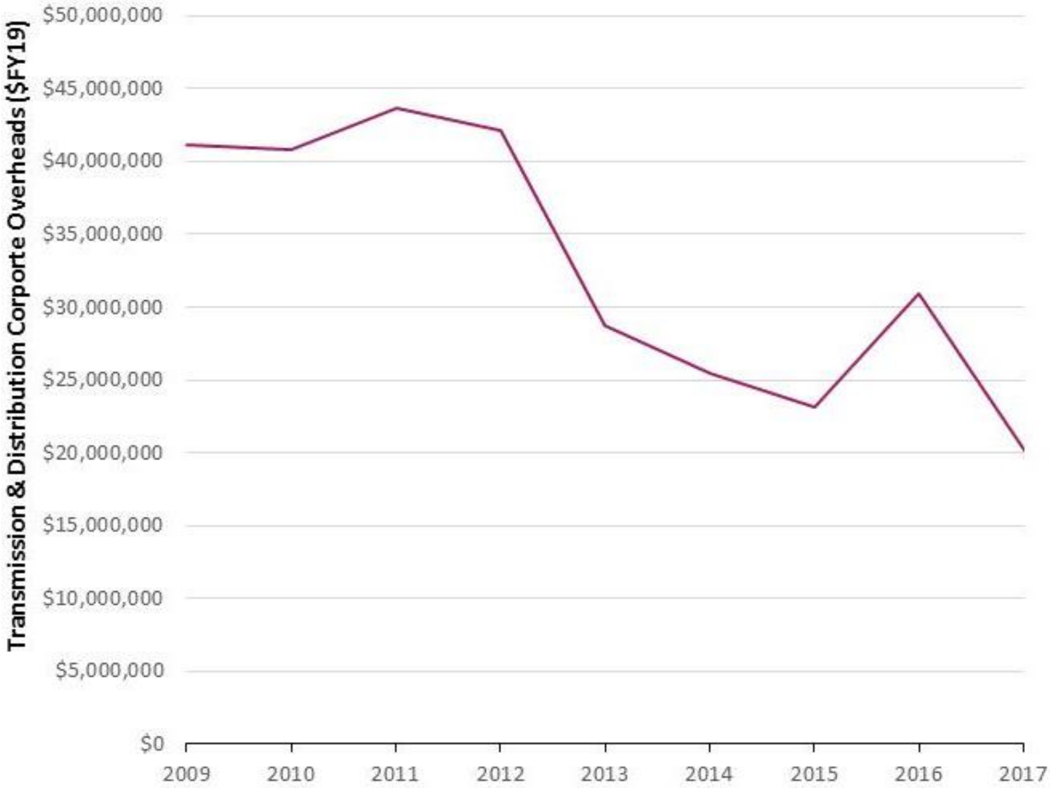
3.4 Maintaining Service Levels whilst Reducing Costs

The National Electricity Rules stipulate that a network should achieve expenditure that represents prudent and efficient levels. Reducing costs through cost-cutting or doing less may appear as efficiency gains, but may not satisfy the criterion of prudence. Our progress towards becoming a sustainably low cost provider has always considered the level of work and investment required to maintain a safe and reliable electricity supply.

The adoption of new technologies and carefully planned efficiency initiatives have ensured that our cost reductions have been responsible and sustainable. In certain areas, we are doing more to reduce risks and ensure safety – such as vegetation management – whereas the focus of our efficiency improvement has been on how we manage and support the primary network functions.

As such, our corporate overheads have reduced to levels that are well below historical costs. **Error! Reference source not found.Error! Reference source not found.** shows the benefits of the merger, highlighted by the compound annual growth rate of corporate overheads for the combined businesses of -6.5 per cent per annum between 2009 and 2017.

Figure 9 Transmission and Distribution Corporate Overheads



4. Our Unique Environment

Key Points:

All networks operate in different conditions and the variations in those conditions must be considered when benchmarking one network against another.

Differences in the efficiency scores of one network relative to another are frequently the result of differences in environmental factors, rather than an indicator of inefficiency or productivity.

Not all attributes of the operating environment can be captured by a benchmarking model, even though many of those attributes may have a significant impact on cost and, therefore, benchmarked performance.

Whilst some operating conditions are favourable, others are unfavourable, and the unique attributes of the Tasmanian operating environment result in a collectively challenging set of operating conditions for electricity network operation and maintenance.

Regional monopolies operating across the diverse environments that exist in Australia will all exhibit their own differences, with no industry standard or "average" operating conditions. Some of these environmental differences will constrain relative efficiency whilst others will enable it. TasNetworks' combination of environmental factors, inherent in the unique attributes of Tasmania, collectively represent challenging operating conditions that differ considerably from those faced by most other networks.

4.1 The Factors that Impact our Costs and Performance

There are many attributes of the Tasmanian environment, our network's design and the business and operating conditions in which TasNetworks operates that impact on our cost and service levels. Each of these attributes exhibits varying levels of management controllability. The AER uses the term Operating Environment Factors **(OEFs)** to describe factors that impact on the benchmark performance of networks which are not accounted for by the AER's benchmarking models. Without consideration of these factors, direct comparison of efficiency scores and productivity indices between networks is less meaningful.

Adding these factors as variables in the model specification would, in theory, make the raw results more comparable. But too many variables in a model can cause statistical instability, particularly where variables are highly correlated[10] (multicollinearity). The AER, therefore, adjusts the results produced by its benchmarking models using estimates of the impact of OEFs. The AER's criteria for an OEF are that:

(i) The OEF is outside of the service provider's control.

(ii) The OEF creates a material difference in the opex of service providers.

[10] For example, the econometric models used by the AER do not include energy throughput because its inclusion introduces instability in the estimated model coefficients as changes in energy throughput is closely related to changes in customer connections and peak demand.

(iii) The OEF should not be accounted for elsewhere.

We find it useful to consider environmental factors in the context of the span of control current management has to change or influence the factor. The UK regulator, Ofgem, has previously used four categories of environmental factors to explain differences between networks[11]. These categories were also adopted in previous TasNetworks benchmarking studies[12]. These categories are:

(i) Inherent factors – factors that are resident in the natural or operating environment which cannot be changed by management;

(ii) Inherited factors – factors that are a legacy of previous activities and decisions, often long ago. These factors are generally difficult to change without significant investment and/or time (e.g. the extant network design);

(iii) Incurred factors – factors that are the direct result of the decisions made by the incumbent management of the service provider; and

(iv) Exceptional factors – factors associated with natural disasters or severe weather events that cannot be changed or controlled but also do not act upon the network at all times, as is the case with inherent factors.

Most networks can be subject to exceptional factors at some time. From a benchmarking perspective it is difficult to account for exceptional factors in models as they are usually unpredictable. These events can often lead to a cost pass through, which makes removal of the estimated value of the event from historical cost data as a pre- or post-modelling adjustment more simple. Consideration of the other three categories of factors relevant to TasNetworks is outlined in the following sections.

4.2 Inherent Factors Influencing TasNetworks

There are many factors that impact on our operations that are unable to be changed or controlled. These inherent factors are frequently unique to Tasmania and have varying impacts on our costs and performance. Some of the more relevant of these factors are detailed below.

4.2.1 Geography and Topography

Our natural environment is characterised by mountainous and heavily forested terrain, with the additional challenge of an island location. Accessibility to our assets is a constant challenge.

[11] See, for example, Ofgem (2002), Comparing Quality of Supply Performance.

[12] See, for example, Transend (2014), Appendix 5: Huegin Benchmarking of Transend Operating Costs.

As a small island, many of our assets are also located in close proximity to the coast (by virtue of having more of our population living near the coast than any other state[13]), which increases the corrosion and degradation rate of assets. For example, between 2012 and 2017 the frequency of interruptions in coastal areas due to issues associated with power poles was approximately double that for poles located in inland areas, which was reflected in the relative contribution each ‘category’ of pole made to our system-wide SAIFI (frequency of interruption).

4.2.2 Climate

Tasmania’s climate also presents challenges to the management of our networks. A significant proportion of our assets are located above the snow line, exposed to high winds, or in areas of high rainfall and high bushfire risk. These factors all contribute to higher likelihood of asset failure or damage, as well as to accessibility challenges.

4.2.3 Demography

The location and energy use of our customers have influenced the design of our network and contributed to some unique attributes. TasNetworks must contend with a very low load density – which increases costs – due to the spread of the population outside of the State’s major population centre, Hobart. This population dispersion means that a greater quantity of assets are required to reach many load centres, but that those individual loads are not particularly high, which results in low load density.

We share this attribute with Queensland, which also has a significant spread of population in regional and remote areas. Whilst our customer density is similar to South Australia’s, the demographics are considerably different in that state. The majority of the SA population live in Adelaide, and the minor communities outside of the capital generally extend due north or down the west and east coasts, allowing a simpler transmission network design.

In contrast, our transmission network is predominately located in the mountains and forests in the lightly populated west of the state and the central highlands, while our distribution network must traverse long distances in the east relative to the load located along and at the end of those feeders.

As an indicator of the distribution network’s low load and customer density, TasNetworks has, like other predominantly rural networks, a significant number of transformers located on rural feeders which are underutilised in terms of their capacity. On average, transformers on our long rural feeders serve only 3.5 customers each, compared to 41 customers for transformers on urban feeders. We also have around 3,500 transformers on long rural feeders which serve a single customer each. Many transformers in rural settings also have to be over sized in order to accommodate the start-up currents associated with motors in dairies and sawmills, as well as irrigation pumps, meaning that most of the time much of their capacity remains unused.

[13] Australian Bureau of Statistics (2001), Population Growth and Distribution, 2035.0, page 3

4.2.4 Generation Market

Tasmania's generation market is characterised by many small, renewable generation sources. Tasmania's primary generation source is gravity based hydroelectric and the many power stations that comprise the Tasmanian generation system must provide base load as well as peaking capacity. This is in contrast to the mainland NEM states which rely on a smaller number of large, generally thermal power stations to provide base load and deliver the required demand for electricity. The differences between Tasmania and the mainland NEM states is highlighted by the variation in average generator size (see Figure A11) and dispatch variability[14].

This large quantity of smaller generators combines with the requirements of the Basslink interconnector between Victoria and Tasmania to present a complex and challenging set of constraints on our transmission system. Similar challenges are emerging in South Australia, but these challenges have been a constant in Tasmania throughout the benchmarking period. This complexity flows through to impact on our business in three ways:

(i) We have to provide transmission infrastructure to connect a large number of low capacity generators;

(ii) Our Transmission Operations are challenging and require particular skills and experience to manage a complex system of constraints and protection schemes; and

(iii) We require a greater number of more complex protection systems which require regular testing and maintenance.

Not only does our transmission network have to connect a large number of generators, but the intermittent nature of the generators being connected means that those connection assets and their associated transmission lines appear under-utilised when compared with the assets serving thermal base-load generators interstate.

4.2.5 Economic Conditions

Tasmania has the lowest average wages in Australia. Whilst this may on face value seem like a beneficial environmental factor, it is actually more reflective of the broader economic climate we operate in. The specific skills required to manage and operate electricity networks are in short supply in Tasmania which presents challenges when balancing our workforce demands with the supply of suitable labour.

Bass Strait shipping fees also impact on our costs for materials. Much of the equipment required for an electricity network can only be shipped in to Tasmania and the shipping rates vary from approximately $600 per container to as much as $1,200 per container[15].

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[14] Defined as the proportion of energy dispatch from non-thermal generators.

[15] Department of State Growth, Tasmania

4.3 Inherited Factors Influencing TasNetworks

4.3.1 Network Design

Our network design is the legacy of decades of investment decisions based primarily on the unique inherent attributes of our environment and customer base. Our transmission network must move power from the primary generation sources located amongst the lakes and mountains in the West of the State and the Central Highlands to the more heavily populated regions to the East, and heavy industry to the north and south. The boundary of our transmission and distribution network is skewed toward the end customer when compared to other Australian networks.

Tasmania's decentralised population, large agricultural sector and low levels of load density require a more asset intensive distribution network and causes lower overall utilisation of transformer assets.

TasNetworks also inherited a distribution network almost totally comprised of lines operating at a voltage of less than 33 kV (mainly 11 kV and 22 kV) and little in the way of subtransmission. Based on the voltages of many of our transmission lines, much of TasNetworks' transmission network, were it located interstate, would be classified as being distribution assets. These differences in network boundaries are one reason that we consider transmission and distribution benchmarks should also be supplemented with state-based benchmarks[16].

4.3.2 Asset Age

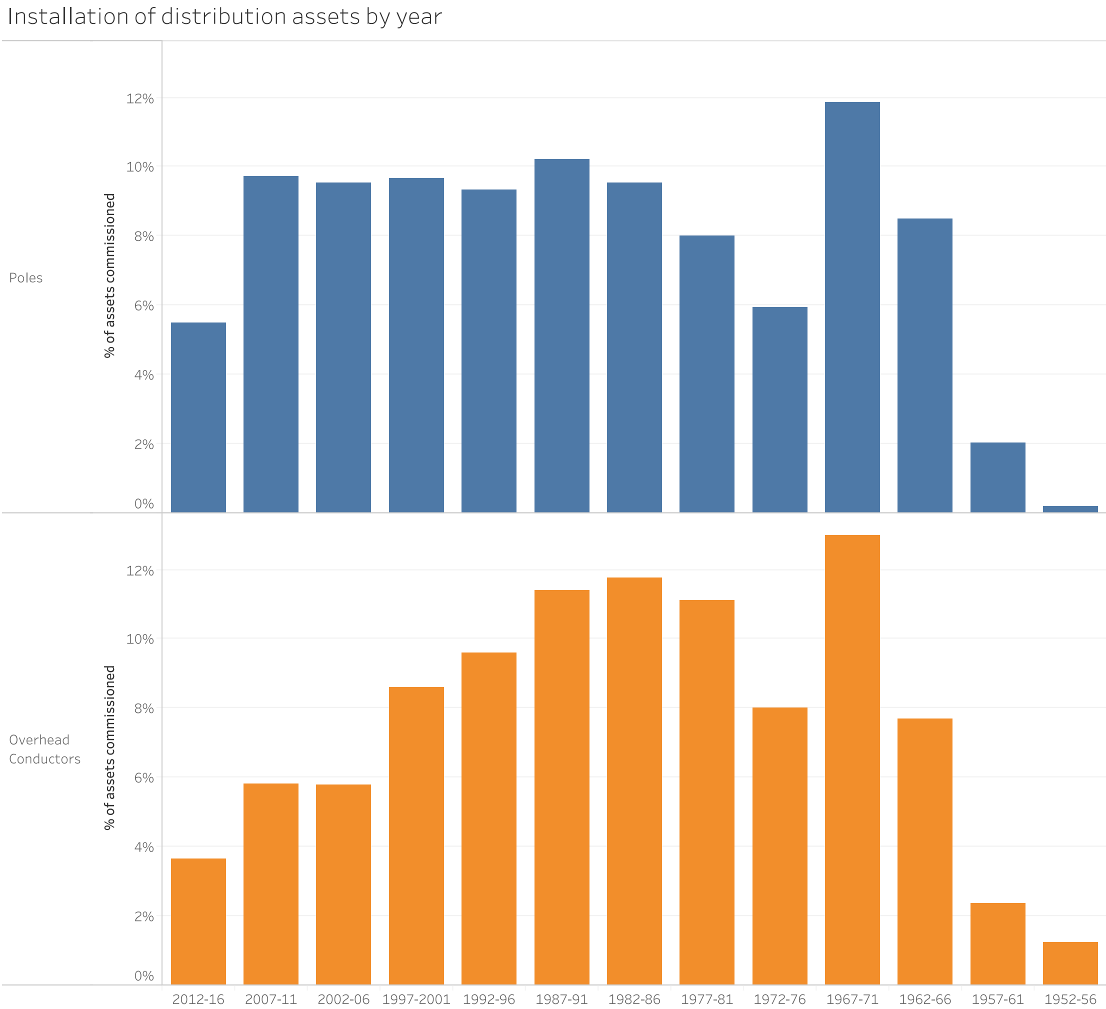
Ageing assets are a concern for all electricity networks. The historical cycles of investment are typically characterised by relatively short periods of rapid expansion of the networks many decades ago. Recent uncertainty in the industry with regards to future demand and technological disruption has constrained investment at a time where large proportions of the network are reaching the end of their economic life.

For TasNetworks, significant bushfires in 1967 resulted in a large number of pole and conductor assets requiring replacement at that time. Those assets are now becoming due for replacement over a short timeframe. This places pressure on replacement expenditure programs, but also puts upward pressure on maintenance costs as long as those assets remain in service.

[16] Whilst we do not support the supplanting of weighted connections with customer connections we note that it does mean the distribution and transmission outputs are now aligned and can be combined to from a single State based view combining both transmission and distribution networks.

The graphs below show the installation of poles and overhead conductors over time for TasNetworks distribution network[17]. Noticeable are the relatively high proportion of assets installed between 1967-71 (45-50 years old in 2017) and the low proportion of assets installed between 2012-16[18].

Figure 10 Pole and Conductor Installations



[17] Data is available in the asset age profile tab of the Category RIN available on the AER's website.

[18] As a rough guide, with an even distribution of asset ages for assets with a life expectancy of 50 years, we would expect an average of 10 per cent of assets to be replaced within a five-year period.

4.4 Incurred Factors Influencing TasNetworks

4.4.1 Organisational Design

The way a business is structured and managed can have an impact on costs. Some of those decisions are within the control of the business, whilst others either are not, or are limited in terms of managerial influence. Our scale is an example of an organisational design factor that has been positively influenced through the merger of the two network businesses, but has limits on further economies now that the only two network businesses in the state have become one.

4.4.2 Work Practices

How we work and the activities we choose to do directly impact our costs. Maintenance strategies, planning methods and working conditions all influence the eventual costs of providing network services. Our vegetation management program is an example of a decision made recently[19] to change our work practices. The change has incurred an initial increase in opex, but will eventually result in better outcomes and an optimised program.

4.4.3 Outsourcing Levels

Outsourcing has an impact on costs, with the determinant of whether the influence is positive or negative reliant upon what work is outsourced and how the outcomes of that work are managed. Often outsourcing can lead to the shifting of costs. For example, outsourcing direct activities such as maintenance will impact overhead and shared cost allocation between indirect and direct, as many of the contractors' overhead costs will contribute to the direct cost of the business.

4.4.4 Assessing Environmental Factors on Benchmark Performance

Consideration of environmental factors is important when attempting to separate legitimate cost differences from inefficiency in any benchmarking model residual (that is, the difference between the operating expenditure a model predicts and the actual operating expenditure incurred). In terms of the categories discussed above, it is the inherent and inherited factors that fit the AER criteria for an OEF. It is these factors, therefore, that should be considered before any interpretation of the efficiency and productivity scores between networks in the AER benchmarking approach can be made.

Some key indicators of inherent and inherited environmental factors that are material to TasNetworks are included in Appendix A – TasNetworks Environmental Factors.

[19] More information on the change to the vegetation management practice is included later in this report.

5. Our Benchmark Performance

Key Points:

Benchmarking results depend on the models and metrics used to compare networks, so care must be taken in interpreting results. Allowances for environmental factors and consideration of change over time are essential.

TasNetworks benchmarks favourably against the AER's opex benchmarks, with our recent efficiency gains reflected in our improvement over time against the AER metrics.

The benchmark models which incorporate physical asset inputs – the MTFP and Capital PFP models – provide little in the way of meaningful insights regarding our relative productivity due to our unique network design and boundary between transmission and distribution, a characteristic noted by the AER in the latest Annual Benchmarking Report for distribution.

The benchmarking of electricity network performance remains an inexact endeavour, more useful for highlighting indicative results than providing definitive measures of efficiency. Our benchmarking performance using the AER models and methods is presented in this section, along with observations and commentary on the interpretation of those results and also some alternative views of our performance.

5.1 Regulatory Benchmarking for the Distribution Network

Our distribution network benchmarks well on some of the AER indicators and less so on others, due mainly to our network design, which is discussed further in section 5.1.2.

5.1.1 The AER's Econometric Models

The AER has recently published the results of its three econometric models for operating expenditure for distribution networks in its 2017 Annual Benchmarking Report for distribution networks. Our performance against these models places us close to the frontier, with the LSE Translog model producing our worst result due to the Translog function disadvantaging small networks.[20]

TasNetworks ranks 5th in two of the models (LSE Cobb Douglas and Opex PFP) and 6th in two of the models (LSE Translog and SFA) based on 2006 to 2016 data (the latest available), prior to any correction for environmental factors. The raw efficiency score, relative to the best performer, are presented in **Error! Reference source not found.** below with rankings in brackets.

[20] The Translog model includes products and cross-products of each of the outputs. This means the larger networks will have a greater influence on the estimated frontier from which networks are measured.

Table 1 AER Econometric Model Raw Efficiency Scores

DNSP	SFA Cobb-Douglas Results[21]	LSE Cobb-Douglas Results	LSE Translog Results	Opex PFP
Powercor	1.00 (1)	1.00 (1)	1.00 (1)	0.89 (2)
CitiPower	0.94 (2)	0.87 (2)	0.82 (3)	1.00 (1)
United	0.88 (3)	0.80 (4)	0.72 (4)	0.75 (4)
SA Power	0.83 (4)	0.81 (3)	0.84 (2)	0.86 (3)
AusNet	0.78 (5)	0.75 (6)	0.72 (5)	0.65 (7)
TasNetworks	*0.78 (6)*	*0.77 (5)*	*0.70 (6)*	*0.71 (5)*
Jemena	0.73 (7)	0.65 (7)	0.56 (10)	0.65 (8)
Energex	0.65 (8)	0.61 (9)	0.66 (8)	0.66 (6)
Essential	0.60 (9)	0.63 (8)	0.67 (7)	0.51 (11)
Endeavour	0.60 (10)	0.56 (10)	0.59 (9)	0.63 (9)
Ergon	0.53 (11)	0.53 (11)	0.53 (11)	0.47 (12)
ActewAGL	0.47 (12)	0.44 (12)	0.40 (13)	0.54 (10)
Ausgrid	0.47 (13)	0.42 (13)	0.48 (12)	0.46 (13)

The nature of these models is that they provide an average performance over the entire period, and the period used by the AER is now eleven years long, dating back to 2006. The sensitivity of the model's results to the period selected is highlighted by the change in the results for TasNetworks using a more recent timeframe, as shown below in **Error! Reference source not found.**.

[21] Adjusted so the best performer (Powercor) has a value of 1

This more recent, five-year period captures the improvement in TasNetworks' efficiency (driven by reductions in TasNetworks opex and changes in the efficiency scores of the frontier networks[22]) and demonstrates that TasNetworks' recent efficiency gains are understated by the AER's models, by virtue of the longer timeframe over which they measure efficiency.

Table 2 AER Model Efficiency Scores, 2012 - 2016

DNSP	SFA Cobb-Douglas Results	LSE Cobb-Douglas Results	LSE Translog Results	Opex PFP
Powercor	1.00 (1)	1.00 (1)	1.00 (1)	0.95 (2)
TasNetworks	*0.86 (2)*	*0.79 (2)*	*0.77 (4)*	*0.84 (4)*
CitiPower	0.84 (3)	0.78 (4)	0.80 (3)	1.00 (1)
SA Power	0.83 (4)	0.76 (5)	0.82 (2)	0.84 (3)
United	0.83 (5)	0.78 (3)	0.69 (6)	0.80 (5)
AusNet	0.73 (6)	0.69 (6)	0.63 (8)	0.67 (9)
Jemena	0.68 (7)	0.62 (7)	0.54 (11)	0.70 (8)
Energex	0.65 (8)	0.60 (9)	0.64 (7)	0.72 (6)
Endeavour	0.65 (9)	0.57 (10)	0.63 (9)	0.71 (7)
Essential	0.64 (10)	0.61 (8)	0.69 (5)	0.57 (10)
Ergon	0.61 (11)	0.55 (11)	0.62 (10)	0.56 (12)
Ausgrid	0.47 (12)	0.42 (13)	0.47 (12)	0.51 (13)
ActewAGL	0.47 (13)	0.43 (12)	0.41 13)	0.57 (11)

Using the average efficiency score constructed from the last five years of data highlights TasNetworks' improved performance over the recent period, relative to the other networks in the NEM[23]. Another way to observe TasNetworks' improved performance over time is to compare TasNetworks' actual opex over the benchmarking period with that forecast using the AER's SFA model, as shown in **Error! Reference source not found.**.

[22] For example, TasNetworks opex PFP score improves significantly depending on the timeframe used. This is due to improvements in TasNetworks own productivity score and reductions in the productivity score of the frontier network CitiPower.

[23] The timeframe used will have a limited impact on the estimate of efficient opex derived from each of the models. The longer time period will apply a lower efficiency score to a higher average opex whilst the shorter time period applied a higher efficiency score to a lower average opex.

Figure 11 AER Model Estimate of TasNetworks Opex and Actual Opex

The difference between TasNetworks' estimated and actual opex between 2006 and 2016 illustrates the efficiency journey that the network has embarked upon, with a decline in opex below the estimated opex since 2013 and actual opex significantly below that estimated by the SFA model in 2016.

5.1.2 The AER's DNSP Index Models

The AER's MTFP[24] and MPFP[25] models are index methods that compare a composite of output variables to a composite of input variables.

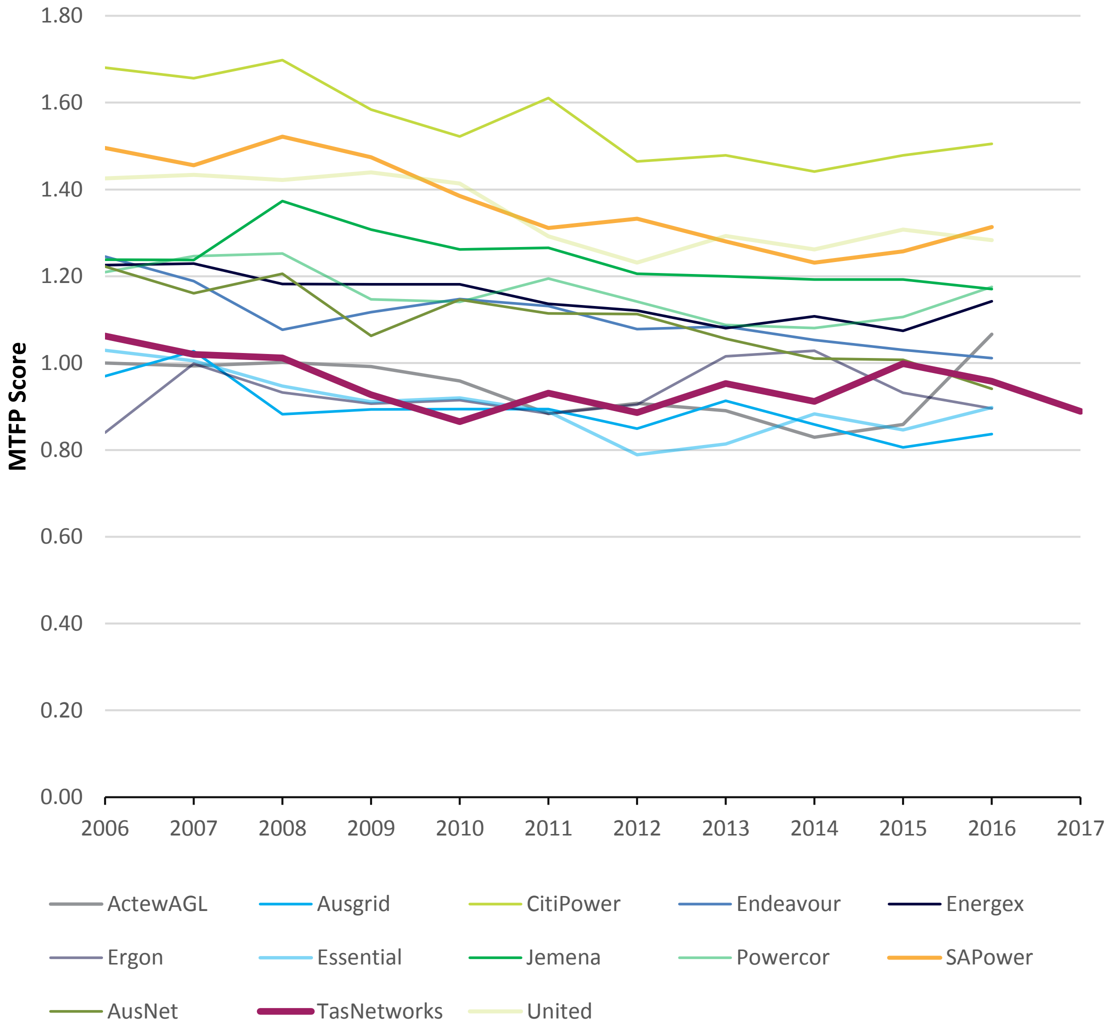
5.1.2.1 Our MTFP Results

The AER's MTFP model results are published annually in the AER's Annual Benchmarking Report for distribution networks. After a period of improvement from 2010 to 2015 which ran counter to the industry trend, our 2016 result was slightly down on 2015 due to relatively flat output growth against moderate opex and underground cable capacity increases. Projecting forward to include our 2017 results shows a similar decline in MTFP (see **Error! Reference source not found.Error! Reference source not found.**) due to the extra vegetation management and emergency response opex incurred in that year.

[24] Multilateral total factor productivity

[25] Multilateral partial factor productivity

Figure 12 AER MTFP Results for Distribution



As discussed previously, direct comparisons of index method scores is not possible without making corrections for environmental factors that are not included in the model specification. The ranking of results is also highly sensitive to the model specification.

The Australian distribution networks which are considered most similar to TasNetworks in terms of their customer density are SA Power Networks, Powercor and AusNet Services. However, while these predominantly regional networks may be useful comparators for simple measures such as opex per customer, the MTFP results in **Error! Reference source not found.** should not be used to infer relative efficiency. This is because the MTFP model's specification uses measures of physical assets as inputs.

Whilst TasNetworks has, on average, a similar customer to line length ratio as the other regional networks, the asset design of the network between those customers is vastly different. The MTFP model specification amplifies these differences through the manner in which the variables are calculated (specifically, the calculation of the line asset inputs as their length times their average rating).

We cannot use SA Power Networks, for example, as a benchmark of MTFP for TasNetworks due to the very different network configurations. For TasNetworks to achieve the MTFP score of SA Power Networks (1.31 in 2016) our opex – the only variable in the model's specification that we can readily change – would need to have been less than $12 million in the same year.

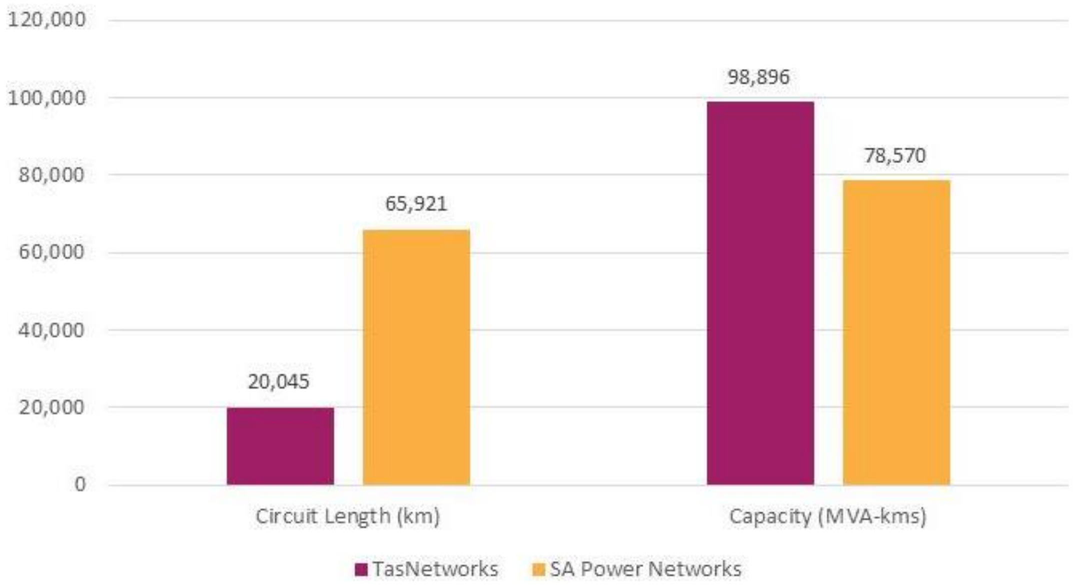
Appendix A – TasNetworks Environmental Factors presents many of the inherent and inherited attributes that make TasNetworks different from what could otherwise be considered our closest regional peers. However it is the method of measurement in the MTFP model, rather than genuine environmental factors, that distort the results. The AER MTFP model splits the network conductor and cable assets into subtransmission and distribution at the 33kV point (with 33kV included in subtransmission). The length of network in each of these categories is multiplied by the average MVA rating of each voltage class to provide a proxy for the capacity of these assets as a capital input in the model. MVA ratings increase exponentially with increases in voltage and when combined with the multiplicative nature of the units of measurement (MVA-kms), networks with long lengths of higher voltage assets in either category (subtransmission or distribution)[26] will be penalised as having excessive inputs in the AER model specification.

Using SA Power Networks as an example again, the large difference in MTFP scores is due to the considerable proportion of 22kV conductor in TasNetworks' distribution network and the considerable proportion of SWER in that of SA Power Networks. To illustrate the issue with using MVA-kms to infer productivity differences between networks we have compared the distribution overhead km input to the circuit length of these assets[27] for SA Power and TasNetworks in **Error! Reference source not found.** below.

[26] For example, more 22kV than SWER or LV in the distribution category or 132 kV versus 33 kV in the subtransmission category.

[27] These are all assets below 33kV and contribute around 17 per cent of the total factor input index and 28 per cent of the capital PFP input index

Figure 13 Circuit Length and MVA-kms for overhead distribution



Error! Reference source not found. shows that SA Power's circuit length of distribution assets, measured as an output, is over 3 times greater than TasNetworks whilst the distribution MVA-kms (an input) for these assets is greater for TasNetworks. The reason for these significant differences between circuit length and MVA-kms is because of the different voltages each network operates at. Whilst SA Power has almost 75 per cent of its overhead distribution assets as low voltage or SWER TasNetworks has less than a third at these voltage levels.

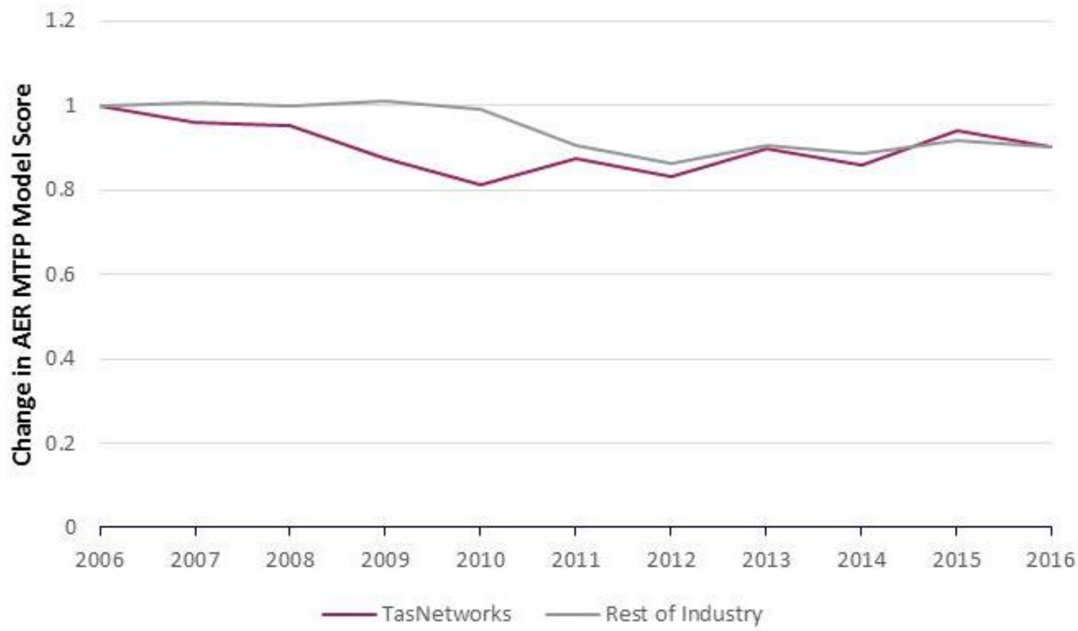
From a technical standpoint:

- The varying amounts of different voltage classes of conductor and cable is a legacy of the original network design and the investment decisions made over many decades. The composition of the network cannot be changed without significant investment and time, and there will often be no technical benefit to do so in any case; and
- The decision to install a particular voltage class of asset over another is based on engineering business cases that address technical requirements (distance, voltage drop, reliability, etc.), lifecycle costs and benefits and procurement options. It is not valid to assume, for example, that a kilometre of SWER is seven times more efficient or productive than a kilometre of 11kV conductor just because the 11kV conductor has approximately seven times the MVA rating of SWER.

The impact of TasNetworks' distribution network design is discussed further in section 5.1.2.3.

As the physical differences between networks render the MTFP comparisons less informative as a benchmarking standard, we examined our change over time compared to the industry average change over time. **Error! Reference source not found.** shows that our opex reductions have closed the gap in MTFP change over time against the rest of the industry.

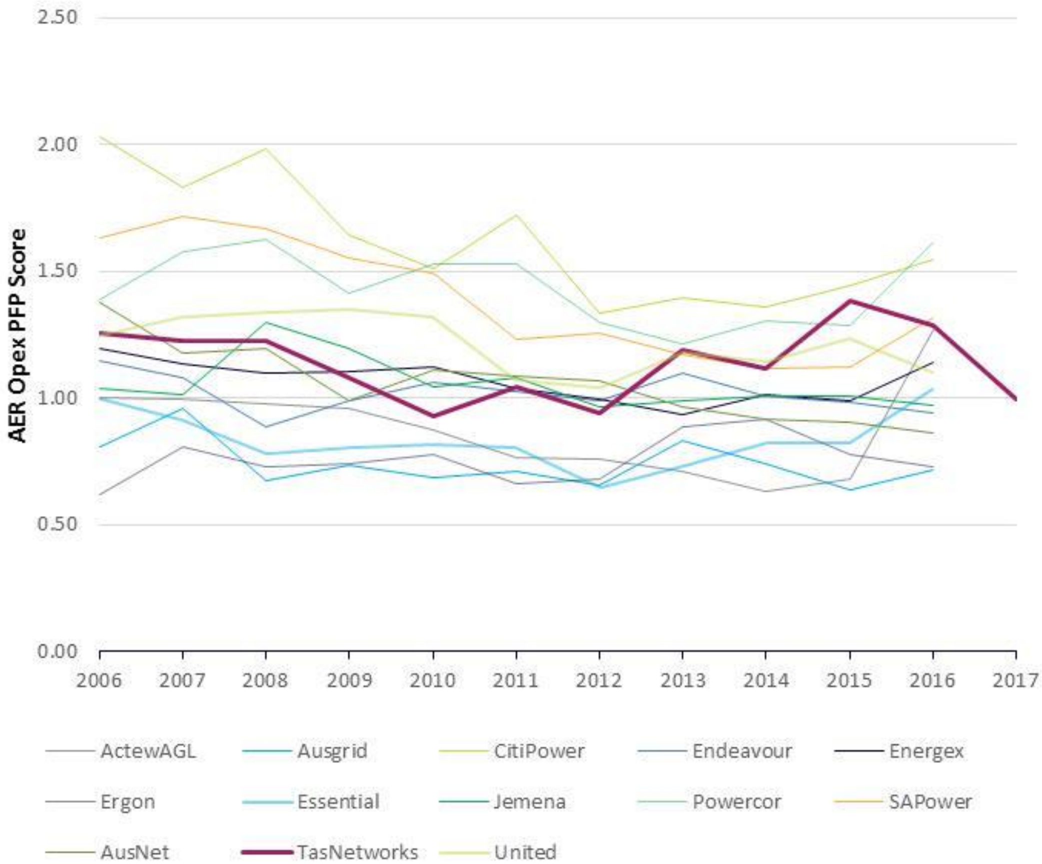
Figure 14 MTFP Change Over Time



5.1.2.2 Our Opex PFP Results

The AER's Opex PFP model does not invoke all of the same issues as the MTFP model as the asset related variables are excluded from the input index. However, the issues of scale and demand density still impact on TasNetworks' results using the Opex PFP model. These results are shown below.

Figure 15 AER Opex PFP Results



TasNetworks benchmarks well in the Opex PFP metric, despite our environmental factor challenges. As a smaller network our Opex PFP results are particularly sensitive to year on year variations in our opex. This is shown through the steady increase in Opex PFP during our transformation years and the recent decline in Opex PFP, particularly in FY17 where the extra emergency response and vegetation management costs were incurred. It is important to note:

- The decision to increase vegetation management spending in 2016-17 was based on prudence in maintaining a safe and reliable network and was predicated by an increase in vegetation related outages, including significant events from vegetation that was outside clearance zones.
- Emergency response opex is generally reactive to exogenous events. FY16 and FY17 were particularly challenging years with respect to natural events and weather and we have not forecast that the resultant recent increase in emergency response costs will continue into the future.
- Increased need for emergency response opex does not stimulate any increase in the AER's specified Opex PFP output variables and changes in these costs therefore appear as declining productivity in their model.

- Our forecast opex is at a level that will return our Opex PFP results to values similar to our performance in FY16[28].

5.1.2.3 Our Capital PFP Results

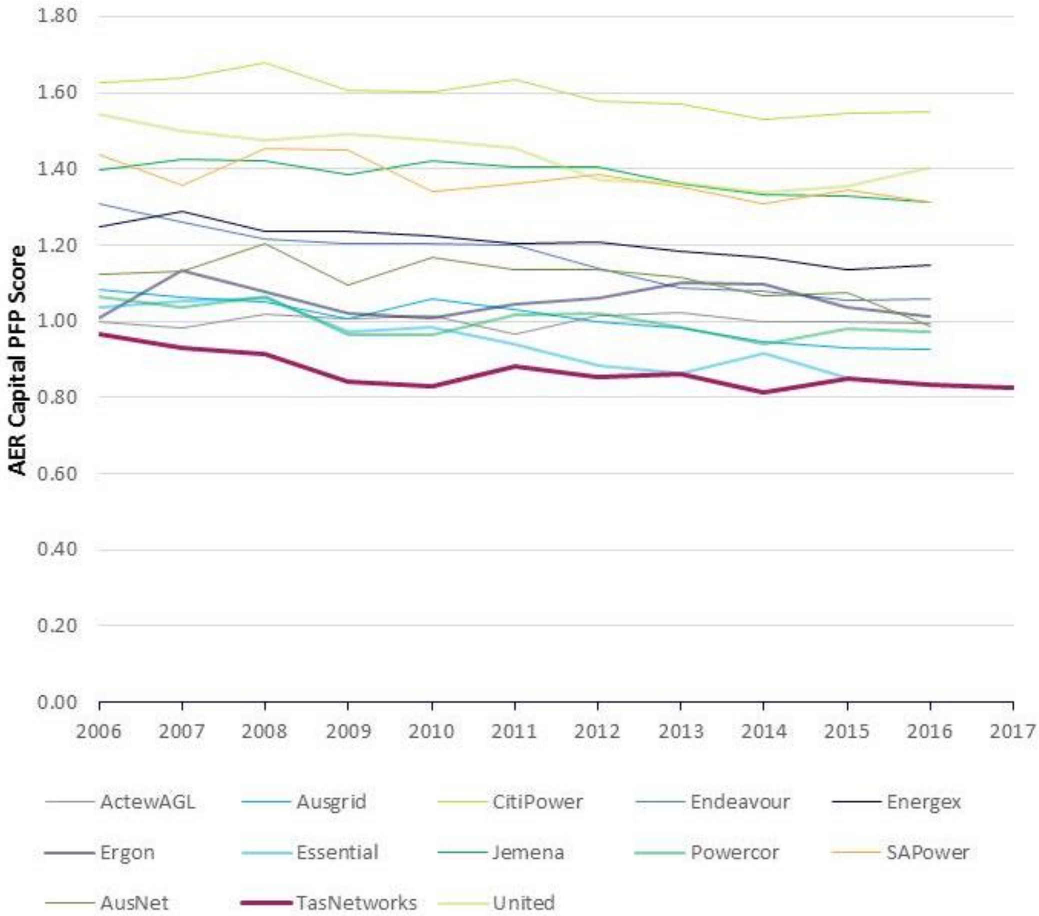
The Capital PFP model amplifies the issue with the model specification and TasNetworks' high proportion of 22kV conductor, as the capital assets are the only inputs in this model. The impact on Powercor is also evident in these results, with its Capital PFP result being much less favourable than its Opex PFP result[29]. TasNetworks and Powercor both benchmark poorly against this metric due to high proportion of 22kV conductors making up their networks.

Powercor has an advantage over TasNetworks, however, in that while it also has a high proportion of 22kV lines (50 per cent of its overhead network, compared to 58 per cent for TasNetworks) it has a significant SWER network (31 per cent of its overhead network, compared to 2 per cent for TasNetworks), which is treated more favourably by the Capital PFP model. SA Power Networks benchmarks well on this measure due to its significant proportion of low MVA rated SWER.

[28] Estimated assuming the output growth rates in our forecasts and also assuming negligible relative change in other networks. See section 0 for more detail.

[29] It is important to note that this isn't a capex / opex trade-off as the capital PFP measure physical inputs and not capex. For example, if a network decided to refurbish an asset (capex) there would be no change in the capital inputs (capital PFP would stay the same) whilst we would expect maintenance opex for that asset to decline (and opex PFP to improve).

Figure 16 AER Capital PFP Results for Distribution

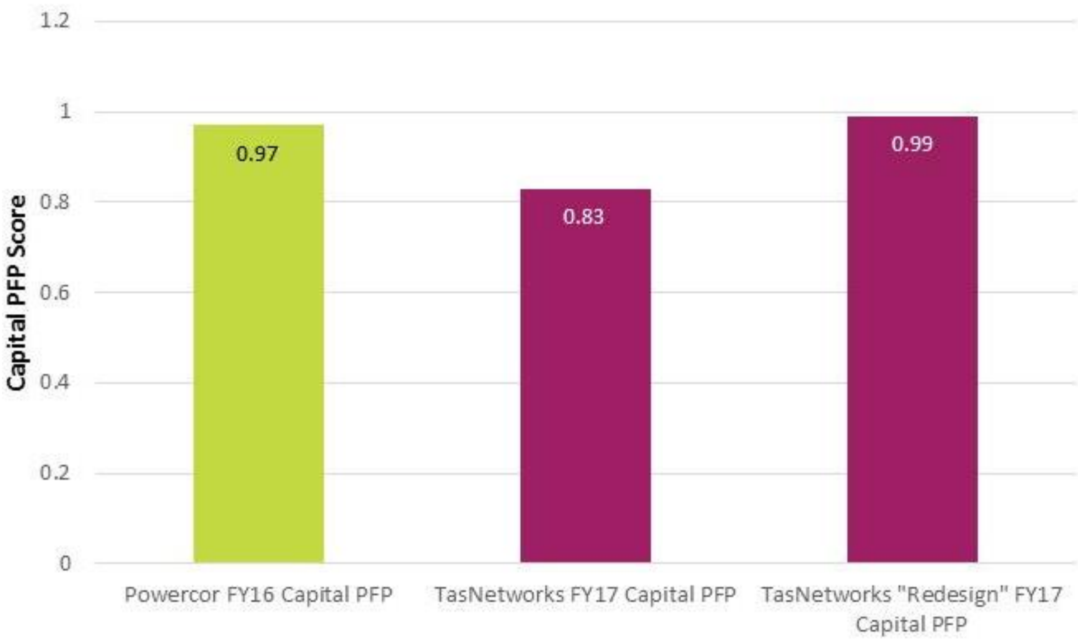


To illustrate the sensitivity of the model's results to the individual compositions of the network conductor and cable, we substituted Powercor's network composition into the 2017 data for TasNetworks, scaled by total circuit length. That is, we applied the same ratios of each voltage class as Powercor to TasNetworks' total network length. In effect, this shifts a lot of TasNetworks' existing LV and 11kV assets in our network (currently 40 per cent compared to Powercor's 14 per cent) into the SWER category.

This hypothetical network "redesign" has a significant impact on the Capital PFP results as shown in **Error! Reference source not found.** below. It shows that with the equivalent network configuration of line assets as Powercor, our Capital PFP would be almost exactly the same.

The Capital PFP result is not, therefore, an indicator of our capital efficiency. Rather, it is a reflection of network design decisions taken many decades ago and the specific variables and measurement method selected by the AER for its model.

Figure 17 TasNetworks Change in Capital PFP with Powercor's Conductor Attributes



As with MTFP, the Capital PFP model is not a good indicator of relative efficiency, mainly due to the measurement basis of the network inputs. Specifically, the use of MVA-kms as a measurement unit is not standard for measuring the "amount" of assets employed, and results in broad variation in figures due to its multiplicative nature. Further, the average MVA ratings reported by the networks are not measured on a consistent basis. Even if the MVA-kms were an appropriate representation of the capital inputs in a productivity model, the composition of the network is not a decision made by the incumbent management team.

Whilst TasNetworks exhibits some customer density similarities with networks such as SA Power Networks and Powercor, those networks have significantly more SWER and hence higher Capital PFP scores. High proportions of SWER would not have been an economically beneficial (nor technically feasible) option for TasNetworks' original network design. The Capital PFP score should not, therefore, be considered indicative of our capital productivity – nor does it have any bearing on our capital expenditure efficiency.

5.2 Regulatory Benchmarking for the Transmission Network

The AER is faced with greater challenges in benchmarking transmission networks, due to the even smaller sample size (when compared to the number of Australian distribution networks). The small number of transmission networks which make up the NEM effectively prohibits the use of econometric and other statistical methods. Nonetheless, MTFP, Opex PFP and Capital PFP results are published in the AER's Annual Benchmarking Report for transmission networks and the latest results are detailed in the following sections.

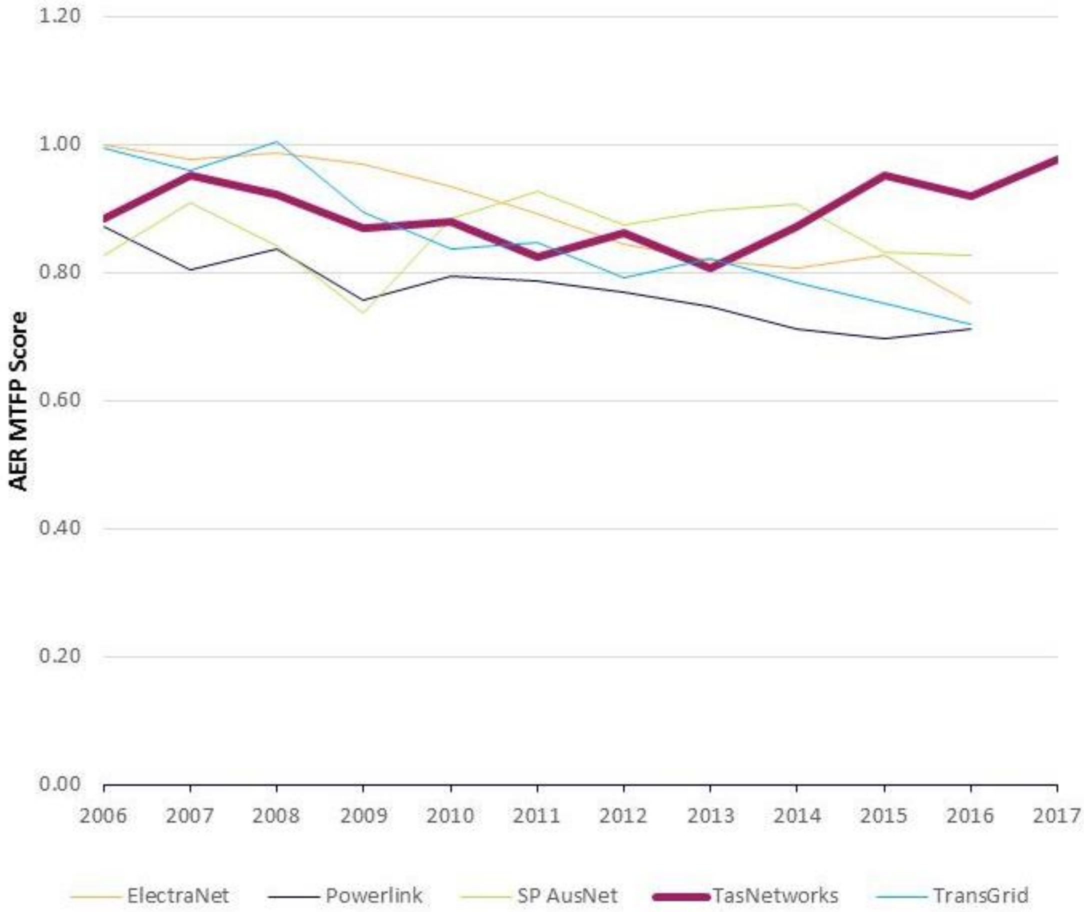
5.2.1 The AER's TNSP Index Models

As with the models that the AER uses to benchmark distribution networks, the AER's transmission benchmarking models include index based models of total, opex and capital productivity.

5.2.1.1 Our MTFP Results

The most recent results for our transmission network using the AER's MTFP model are shown in Error! Reference source not found.Error! Reference source not found. below.

Figure 18 AER MTFP Results for Transmission

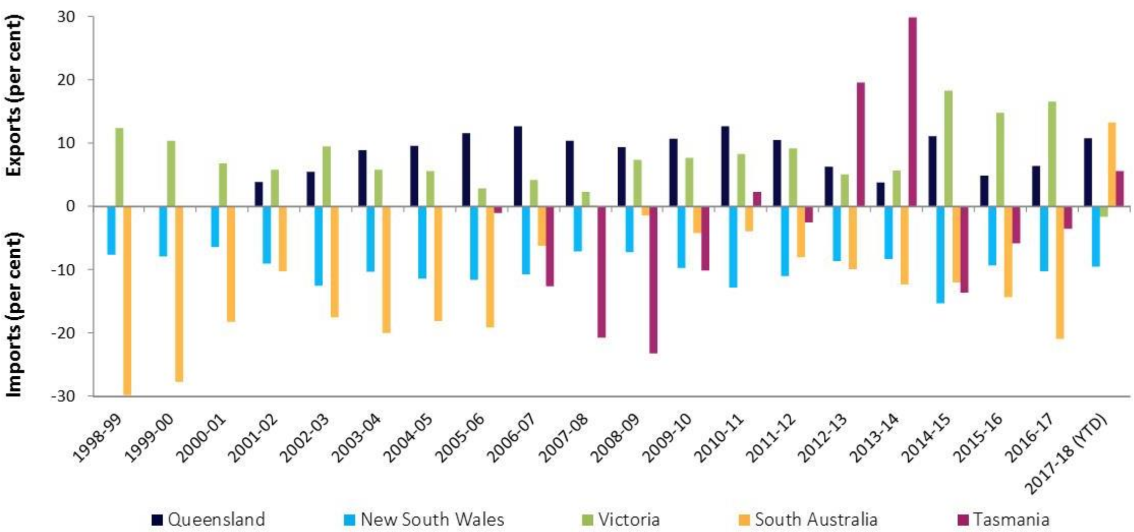


The uplift in our MTFP score in recent years is largely attributable to a significant decrease in our transmission network opex since the merger that created the TasNetworks business in 2014, along with a considerable decrease in Energy Not Supplied in FY15 and FY16 compared to historical levels.

The energy throughput for the transmission network, one of the five outputs used in the AER's MTFP model, also varies in response to the level of energy transferred across Basslink, which has an impact on our MTFP score. In 2015-16 Basslink experienced an outage that lasted for six months, which impacted significantly on the throughput of our transmission network, which would have contributed to the reduction in TasNetworks' MTFP score for 2016. This illustrates the point that changes in the energy throughput of our transmission network between years are not necessarily a function of TasNetworks' performance, and that exogenous events can impact on the AER's measures of our business' productivity.

The following chart (0) illustrates how TasNetworks transmission network is required to support years of significant energy imports into Tasmania and others with significant net exports. No other jurisdiction within the NEM exhibits this variability in energy flows. Victoria and Queensland have both been consistent 'exporters' of electricity, while South Australia and New South Wales have been consistent importers. Relative to Tasmania's on island demand, the amount of energy imported or exported into Tasmania also typically represents a far greater proportion of demand than the interregional trade of electricity represents in other parts of the NEM.

Figure 19 Interregional trade as a percentage of regional electricity demand



Note: This chart presents the net trading positions of the regions since the NEM commenced. The first commercial transfer of electricity across the Basslink interconnector occurred in April 2006. It should be noted that NSW and Victoria gained additional hydroelectric peaking capacity following the abolition of the Snowy region on 1 July 2008.

Source: Australian Energy Regulator, Australian Energy Market Operator

There are also some inherent factors in our operating environment that influence the transmission network's benchmarking results. The fact that TasNetworks has a different voltage boundary between our transmission and distribution networks than many other Australian states (with connecting substations and transformers classed as transmission rather than distribution assets) tends to favour the transmission network's performance against the AER's benchmarks at the expense of our distribution network.

Whilst our complex market (many, small and variable generators and the Basslink interconnector) increases our actual costs, the higher demand and energy flows across our transmission network relative to the distribution network provide an advantage in the AER's TNSP MTFP model specification[30].

The recent change in the model specification – moving from an output variable of weighted average connection voltages to distribution customer numbers – is, however, a disadvantage to our MTFP results. The fact that ElectraNet, for example, can service three times as many distribution customers with one and a half times the circuit length is more a function of South Australia's population and where those people live relative to the sources of generation, rather than any indication of relative efficiency.

The use of distribution customer numbers as an output measure also fails to take into account the fact that large industrial customers in Tasmania account for around 60 per cent of the State's electricity consumption, with four major industrial users using around half of the energy supplied by our transmission network. While this could potentially be interpreted by some as a favourable OEF, on the basis that industrial customers typically have high load factors – which should translate into lower costs compared to our peers – the fact that we have to move generation from variable sources located a long way away from that load is a bigger cost driver that outweighs any advantage that might be associated with the level of industrial demand in Tasmania.

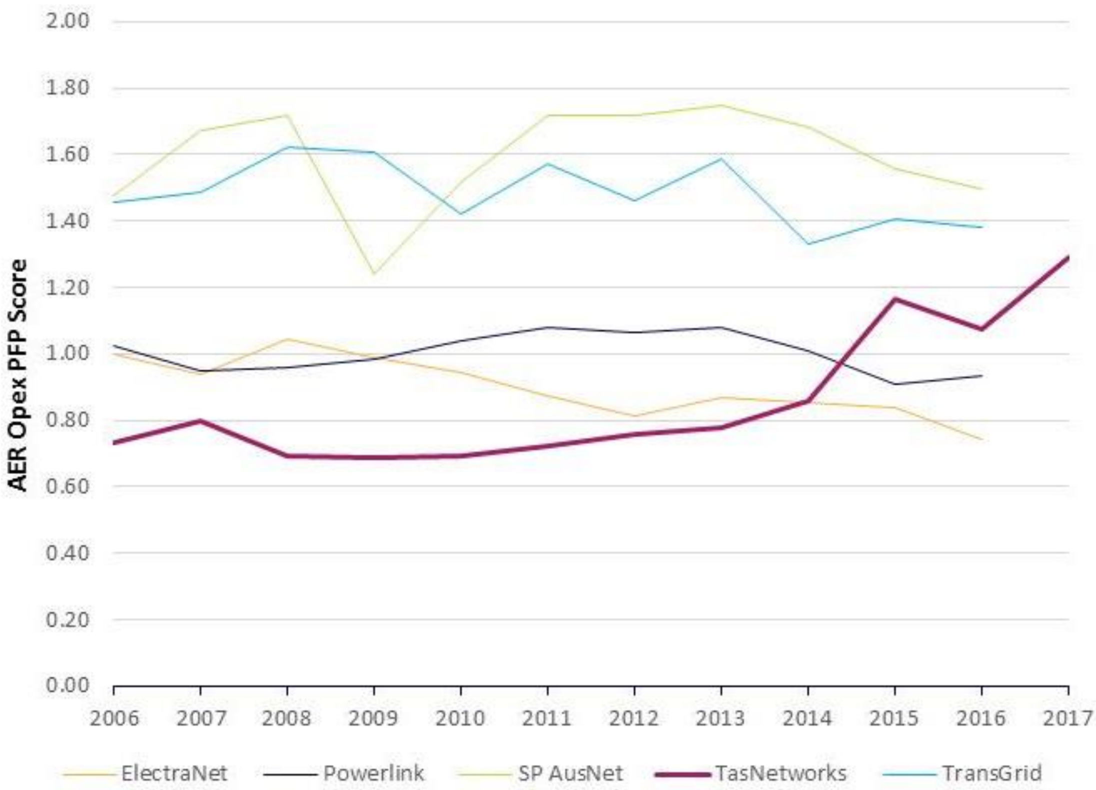
The use of downstream customer numbers also doesn't capture the scale and complexity associated with the requirement to connect a relatively large number of small hydro and wind generation sources scattered around remote areas of the State, which is a material driver of cost for our business. Nor do downstream customer numbers recognise the role of transmission in facilitating cross-NEM trade, in Tasmania's case, via Basslink.

5.2.1.2 Our Opex PFP Results

Our Opex PFP results compare reasonably well with other Australian transmission networks. As with our performance against the MTFP metric, this result can in part be attributed to low opex levels relative to circuit length, demand and energy delivered. Given the limitations associated with direct comparison against other networks, it is potentially more instructive to consider the improvement in our Opex PFP over time, which is being driven by our decrease in opex and improvement in Energy Not Supplied over time (measures that directly impact on customers). The results are replicated below.

[30] Note that this increases the volatility of TasNetworks transmission benchmarking as energy throughput can vary significantly year on year depending on whether Basslink is a net importer or exporter to the mainland.

Figure 20 AER Opex PFP Results for Transmission



The 2017 Annual Benchmarking Report incorporates two opex benchmarking models to measure changes in opex productivity for transmission networks since 2006. The first model includes customer connections as an output (the results of which are replicated in **Error! Reference source not found.**20 above) following the recommendations of Economic Insights in a recent Position Paper, whilst the second model includes voltage weighted connections.

As outlined previously in this report, TasNetworks significant number of transmission connections (due to the large number of generation sources in the State) means that its transmission network benchmarks much more favourably using the original model specification. The exclusion of generation connections in the output specification of the revised model means that direct comparisons between transmission networks are unlikely to provide useful indicators of relative productivity until post model adjustments are made. This was highlighted in the Positions Paper used to justify the replacement of voltage weighted connections with customer connections:

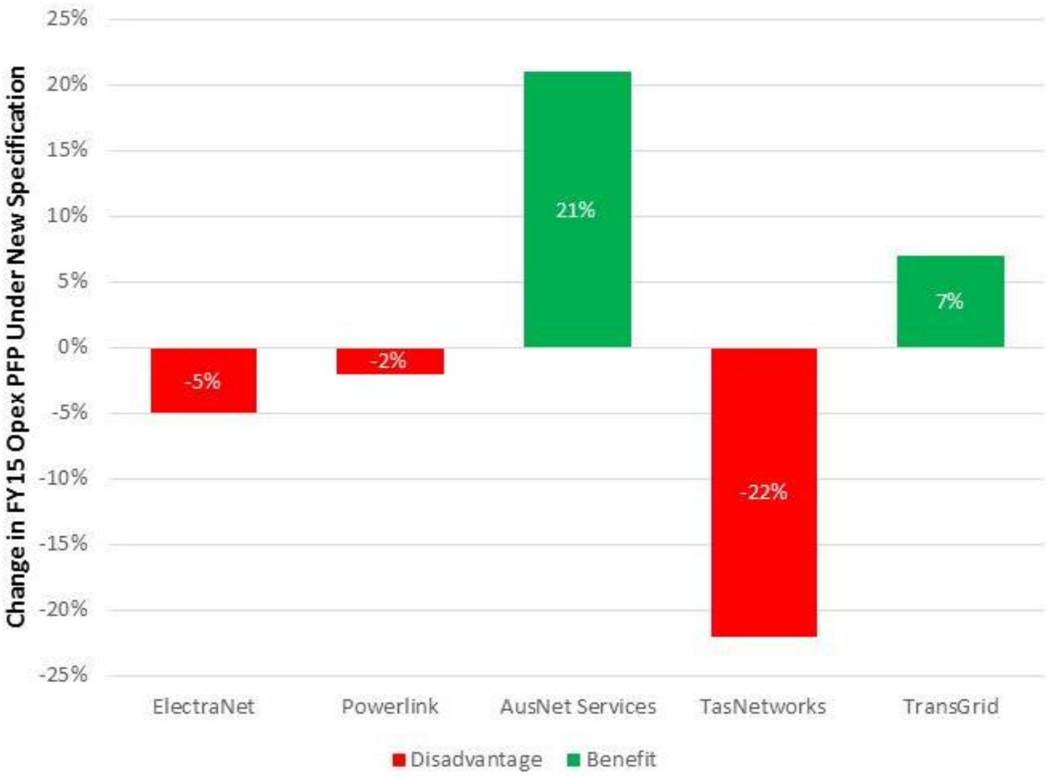
"It needs to be recognised that the output specification cannot take account of all operating environment factors (OEFs) and unusual circumstances facing a TNSP such as the need to connect a large number of smaller renewable energy generators than other TNSPs. This may be best dealt with through the application of separate OEF analysis"

Page iii, Position paper for the Review of TNSP Economic Benchmarking, Economic insights, 9 August 2017

Such a significant change in the results is a reminder that caution must be exercised when interpreting TFP and PFP model results. Using FY15 as a common year that has been reported on using both model specifications, the changes in networks' FY15 Opex PFP scores due to the introduction of the new model specification are shown in **Error! Reference source not found.**1**Error! Reference source not found.** below.

The chart shows a substantial downgrading of TasNetworks' performance against the Opex PFP metric in 2014-15, along with a similarly large improvement in the performance of AusNet Services and a material uplift in the performance of Transgrid – both of which argued in favour of the change in the model's specification. AusNet Services contended that the change from the use of voltage-weighted connections to downstream customer numbers as an output in the AER's models would remove performance outliers (including TasNetworks, which was consistently rated as the best performing transmission network) that indicated specification issues with the previous model.

Figure 21 Change in FY15 Opex PFP with Model Specification Change



At one point in time the previous specification was relied upon by the AER as the most suitable means of undertaking whole of business benchmarking for transmission networks. While the AER has now revised its models, it is unlikely that these will be the last revisions made to the benchmarking models.

The fact that such a large change in the results has occurred between versions of a model that have both, at one time or another, been considered to be the most suitable metric for comparing network performance, highlights the need to avoid comparing network productivity scores on a prima facie basis, or using productivity and efficiency metrics in a deterministic fashion when setting revenue allowances.

Our improvement over time as assessed under either iteration of the model is the best indicator that our customers are benefiting from our efficiency programs. Using the change in productivity over time means that problems associated with model specification and different operating environment factors are largely mitigated as these factors are likely to persist throughout the benchmarking period. Error! Reference source not found.2 and Error! Reference source not found.3 below show the change in productivity score over time for both model specifications and are taken directly from the AER's 2017 Annual Benchmarking Report.

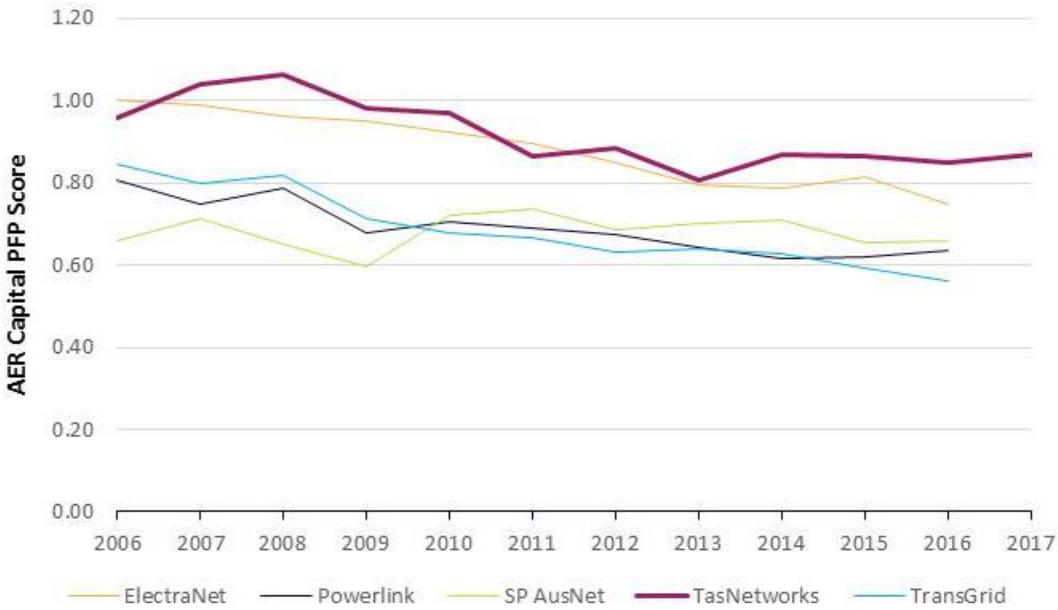
Figure 22 Change in Opex PFP - Customer Numbers Specification

Figure 23 Change in Opex PFP – Voltage Weighted Connections Specification

5.2.1.3 Our Capital PFP Results

The Capital PFP model produces favourable results for our transmission network despite the specification change. The change in specification has reduced the range of Capital PFP scores, the results are replicated below in Error! Reference source not found.4Error! Reference source not found..

Figure 24 AER Capital PFP Results for Transmission



Our network design, which creates a negative bias for our distribution network in the AER models, creates a positive one in transmission. Given the limitations of the productivity models to provide meaningful insights about efficiency, particularly without adjustment for all environmental factors, we could consider the change over time.

As shown in Error! Reference source not found., Capital PFP over time is either flat or decreasing for all networks. AusNet Services has a zero per cent (the highest) compound annual growth rate of Capital PFP over the timeframe, due mainly to its significant increase in reported maximum demand. TasNetworks has the second highest growth rate (negative 1.1 percent), whilst the other three networks have declined more substantially.

As with the distribution Capital PFP model, these results provide negligible productivity information and no information on the efficiency of the businesses capital expenditure programs. Most of the outputs in the model will likely remain relatively flat, but that does not mean that inputs will. For example, the connection of more generation sources such as wind farms and other small renewables, will require an increase in high-rated assets (inputs) with little change to the outputs.

5.3 A State Based View

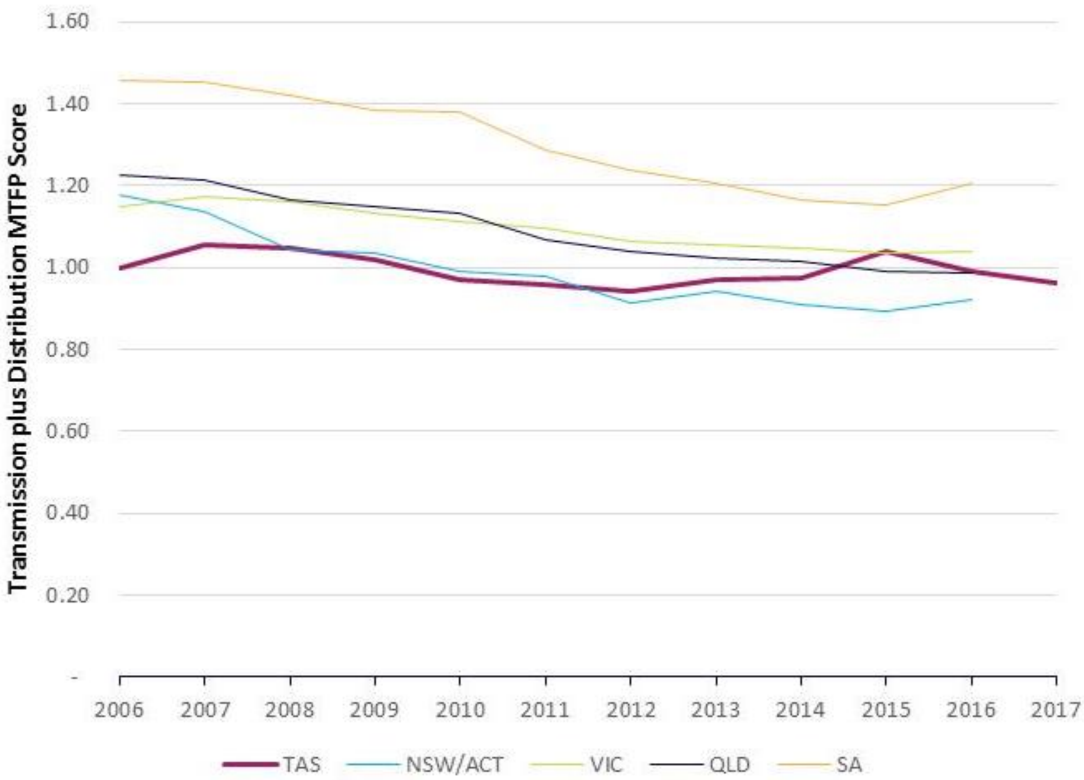
As detailed previously, there are limitations in the benchmarking models and techniques applied to the electricity industry. These are compounded by the broad spectrum of operating conditions and factors in each jurisdiction. While TasNetworks was not supportive of the change in the specification of the transmission productivity models used by the AER, the change does present an opportunity to combine the transmission and distribution network data in each State and present a view of State based total network (transmission plus distribution) productivity.

Combining the transmission and distribution networks at the State level mitigates some of the environmental differences between networks, particularly those related to the differing boundaries between networks and location of distribution networks (CBD, urban or rural). Other environmental factors will obviously remain, however boundary (geographical and network) issues are ameliorated somewhat. This is shown by the tightening of the range of results in the following sections.

5.3.1 State MTFP Results

At the State level, all States have experienced an overall general decrease in MTFP over the measurement period, as shown by **Error! Reference source not found.**5. This is largely due to flat growth in the outputs which inform the AER's model. Tasmania is the only State that has recorded an MTFP score in this current period which is higher than the 2006 starting point (in 2015). Tasmania and Victoria are the only States to experience a positive ranking change since the starting point.

Figure 25 State View of MTFP for Transmission Plus Distribution



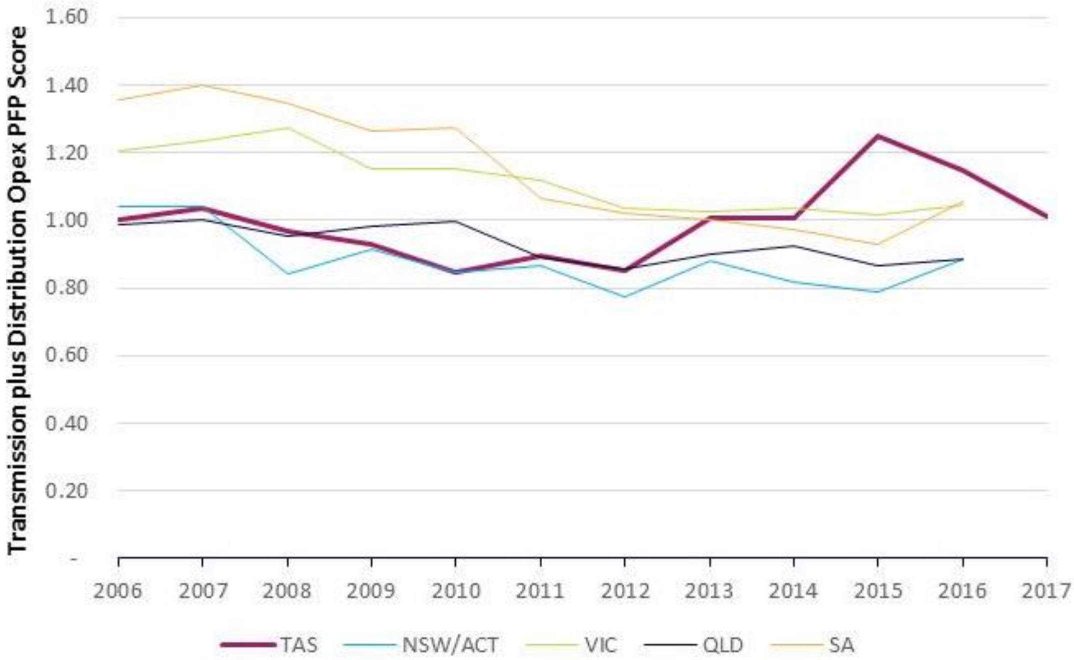
Caution must still be exercised in comparing results amongst the group, even though the aggregation at State level and transmission and distribution networks provides for less variation in environmental factors. However in terms of change over time, Tasmania's compound annual growth rate of this aggregated MTFP model is the highest, as shown in Error! Reference source not found.6.

Figure 26 State Total MTFP Compound Annual Growth Rate

5.3.2 State Opex PFP Results

At a State level, Tasmania is the only set of networks to have current Opex PFP performance above the 2006 starting point, as shown in Error! Reference source not found.7. Whilst all other States have had an increase in Opex PFP between 2015 and 2016 following restructures and opex reductions, Tasmania has experienced strong improvement overall since 2010.

Figure 27 State View of Opex PFP for Transmission Plus Distribution



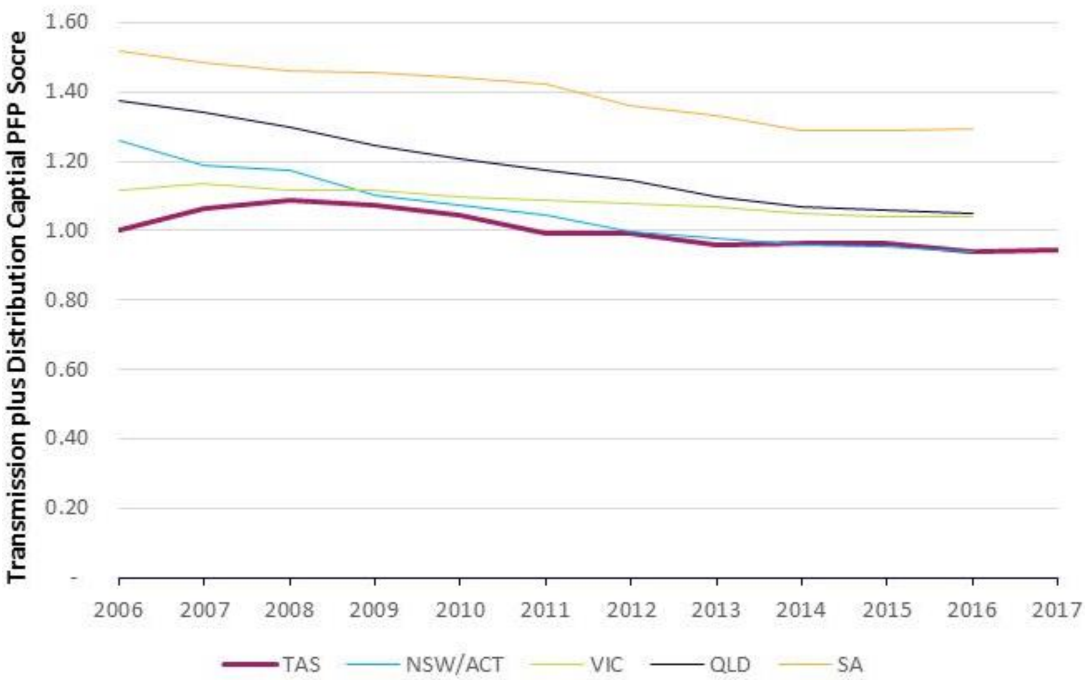
The change over time in Opex PFP for Tasmania is, as with the case for our MTFP, the highest amongst the group, as shown in 0.

Figure 28 State Total Opex PFP Compound Annual Growth Rate

5.3.3 State Capital PFP Results

Like the MTFP State-level results, Capital PFP has generally declined in all regions, given the flat outputs and use of physical assets as the inputs to the model. **Error! Reference source not found.**9 shows similar patterns to the distribution network Capital PFP results, with TasNetworks lower level of performance relative to other jurisdictions being driven by its small customer base (an output measure in the model) relative to its higher rated[31] assets (an input).

Figure 29 State View of Capital PFP for Transmission Plus Distribution



Similar to the MTFP and Opex PFP models, Tasmania has had the highest rate of change over the timeframe. The change over time in Capital PFP is shown in **Error! Reference source not found.**30.

[31] For example, in Tasmania small, regional clusters of customers are connected to the transmission network points via long stretches of predominately 22 kV feeders, whereas similar sized regional populations in other states are connected via feeders with relatively higher proportions of the much lower MVA rated SWER and/or LV conductor types.

Figure 30 State Total Capital PFP Compound Annual Growth Rate

5.4 Our Category Benchmark Position

We generally benchmark favourably using the AER benchmarking models. As a "bottom-up" cross-reference of our modelled performance, we have analysed expenditure at the category level for both networks. This information is included in **Error! Reference source not found.**.

6. Our Forecast Performance

Key Points:

Both our transmission and distribution forecasts of opex represent ongoing cost reductions through further efficiency gains beyond those already achieved.

Our distribution opex base year and forecast are both considerably lower than the efficient level predicted by the AER's three econometric models.

Our forecast of further reductions in our transmission opex demonstrate a commitment to further efficiency gains, on top of the largest historical improvement in the AER's Opex PFP model results as illustrated in the previous section.

Benchmarking of TasNetworks using the AER's models and approaches indicates that our current expenditure is efficient and has improved significantly over time. Recent improvements in opex productivity are industry leading using the AER's productivity models. We have committed to maintaining efficiency improvement in the next period by reducing opex in real terms for both transmission and distribution.

6.1 Distribution Forecast

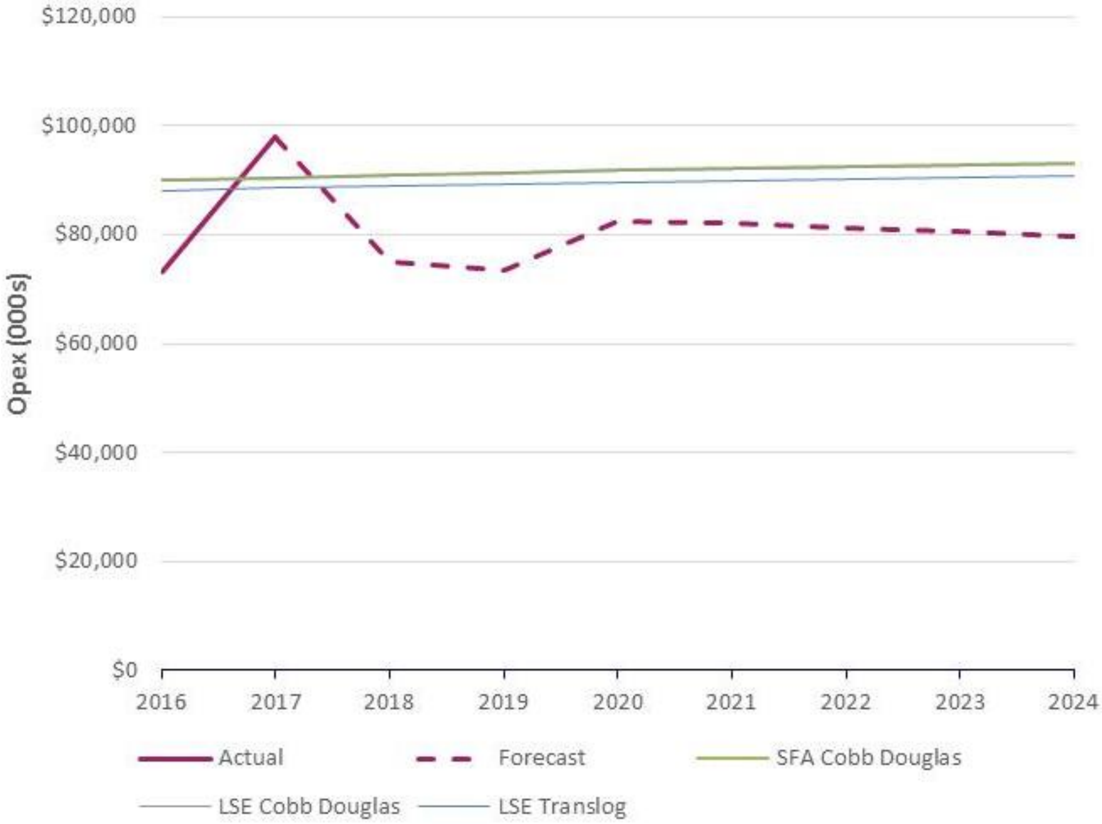
Our distribution network base year (FY18) and our forecast opex represent both:

(i) Ongoing efficiency gains over time; and

(ii) Values that are comfortably within the limits of the amount predicted by the AER models.

Error! Reference source not found.1 below shows our actual and forecast opex, indicating that both the base year and the forecast opex are below the level of opex predicted by the three AER econometric models (note that the two Cobb Douglas models, SFA and LSE, appear as one line as they give similar results).

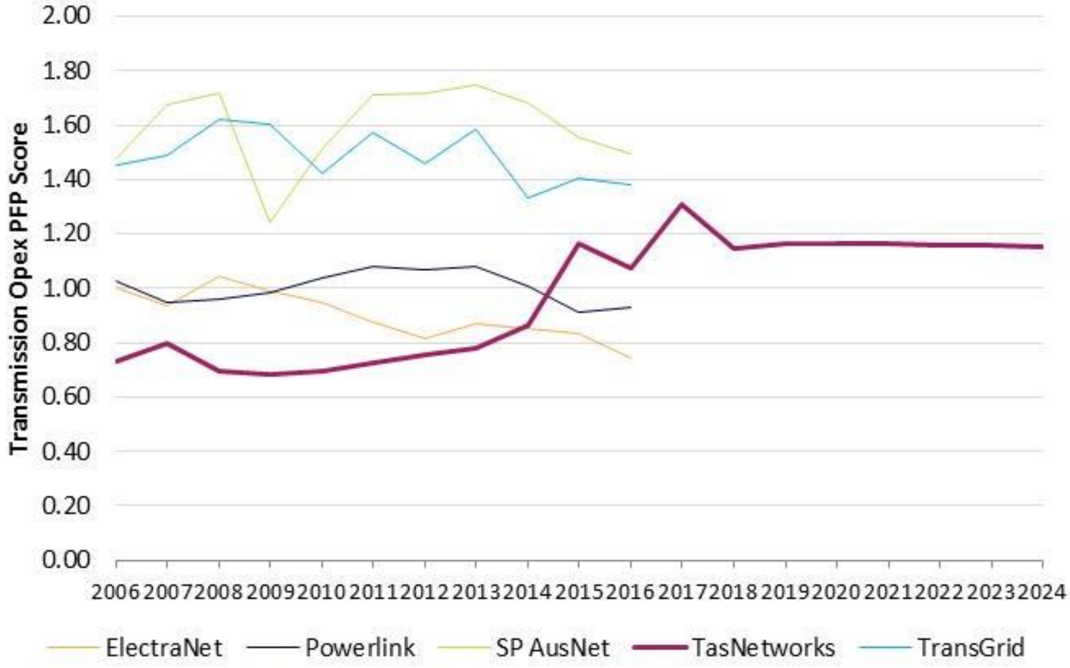
Figure 31 TasNetworks Distribution Opex Forecast and AER Predicted Opex



6.2 Transmission network opex forecasts

The AER's benchmarking approach does not include forecasting models for transmission opex. We have, therefore, judged our transmission opex benchmarked performance based on maintaining the recent improvement in Opex PFP driven by the merger efficiencies. 32 shows the impact of our transmission opex forecast on our forecast Opex PFP. Note that whilst we have forecasts for most output variables, we do not forecast Energy Not Supplied. We have, therefore, assumed a constant value for this variable in the future to allow projection of the Opex PFP result.

Figure 32 Transmission Opex Forecast and Opex PFP



Appendix A – TasNetworks Environmental Factors

Geography and Topography

OFGEM's[32] work on creating network asset health indices for the UK electricity networks offers an insight into the impact of locational factors on electricity assets. As part of OFGEM's calculation of asset health indices the normal expected life (and probability of failure rates) of assets are altered to take into account locational factors such as proximity to the coast, altitude and current levels of corrosion. The adjustment for these locational factors is recognition that they accelerate the ageing of network assets resulting in a corresponding increase in the probability of failure, relative to other assets which are not subjected to the same locational factors.

> "The Expected Life of an asset is affected by the environment in which the asset is installed. For example, assets exposed to higher levels of moisture or pollution may be expected to degrade quicker than assets of the same type exposed to lower levels of moisture or pollution. The levels of exposure will depend upon the location of the asset and also whether, or not, it is installed within an enclosure that affords protection from the weather. This effect is recognised by the use of an asset specific Location Factor in the determination of the Expected Life for individual assets. For all Asset Categories, except LV UGB and Cable, this Factor is influenced by:-
>
> i) distance from coast;
>
> ii) altitude;
>
> iii) corrosion category; and
>
> iv) environment (indoor / outdoor)"
>
> Page 42, DNO Common Network Asset Indices Methodology, OFGEM

The formula for adjusting an asset's expected life is shown below.

Expected life = Normal expected life / (duty x location factors)

For TasNetworks, both proximity to the coast and altitude are locational factors that are likely to cause cost premiums for the network. These costs may be in the form of increased emergency response expenditure when assets fail prematurely, additional refurbishment costs, costs associated with applying protective coatings to assets to shield them from corrosion, or costs associated with the early replacement of assets. Two specific locational factors that have an impact on TasNetworks are the proximity to the coast of network assets and the altitude at which they operate. These factors are discussed below.

[32] The Office of Gas and Electricity Markets – the UK gas and electricity regulator

Coastal Proximity

As of 2001, Tasmania had the largest proportion of its population living within 50kms of the coastline of all Australian States (99.5%)[33]. TasNetworks Asset Management Plans (AMP) detail the impact coastal proximity has on its network assets.

Pole mounted transformer asset management plan, Page 19 – "Due to Tasmania being an island state the majority of transformers installations are exposed to salt pollution, in order to ensure longevity in this corrosion prone environment the preferred protective coating to the exterior and interior surface is galvanised and unpainted."

Ground mounted substation asset management plan, page 21 – "Current maintenance programs have identified higher levels of corrosion on assets located in harsher environments such as those located in close proximity to coastal and also industrial areas. As at August 2017, there are approximately nine substations located within twenty metres of coastal areas or major estuaries. Modern kiosk substations installed in these areas are installed with specially manufactured corrosion resistant enclosures."

Transmission line conductor assemblies asset management plan, page 20 – "Analysis of these fault events also shows that fatigue and corrosion have caused conductor assembly failures in the past. The risk of this reoccurring is high on transmission lines:

located in highly corrosive regions (e.g. coastal, industrial and/or moist environments);

constructed utilising galvanised steel strands, particularly SC/GZ earth wires and ACSR/GZ conductors) and approaching end of technical life".

The relationship between coastal proximity and average network asset ages used by OFGEM in their Network Asset Health Methodology are outlined below.

Figure A1 Impact of Coastal Proximity on Asset Lives (OFGEM)

TABLE 20: DISTANCE FROM COAST FACTOR LOOKUP TABLE

Distance from Coast Banding	Switchgear	Transformers	Poles (Wood)	Poles (Steel)	Poles (Concrete)	Towers (Structure)	Towers (Fittings)	Towers (Conductor)
≤ 1km	1.35	1.35	1	1.5	1.25	1.8	2	2
> 1km and ≤ 5km	1.1	1.1	1	1.2	1.1	1.45	1.5	1.5
> 5km and ≤ 10km	1.05	1.05	1	1.1	1.05	1.2	1.2	1.2
> 10km and ≤ 20km	1	1	1	1	1	1	1	1
>20km	0.9	0.9	1	1	1	0.85	1	1
Default	1	1	1	1	1	1	1	1

The distance from coast factors provide an estimate of the impact coastal conditions have on expected asset lives. For example, if a transformer operating under normal conditions had an expected life of 50 years then the same transformer operating within 1km of the coast would be expected to have a life of 37 years (50 years / 1.35).

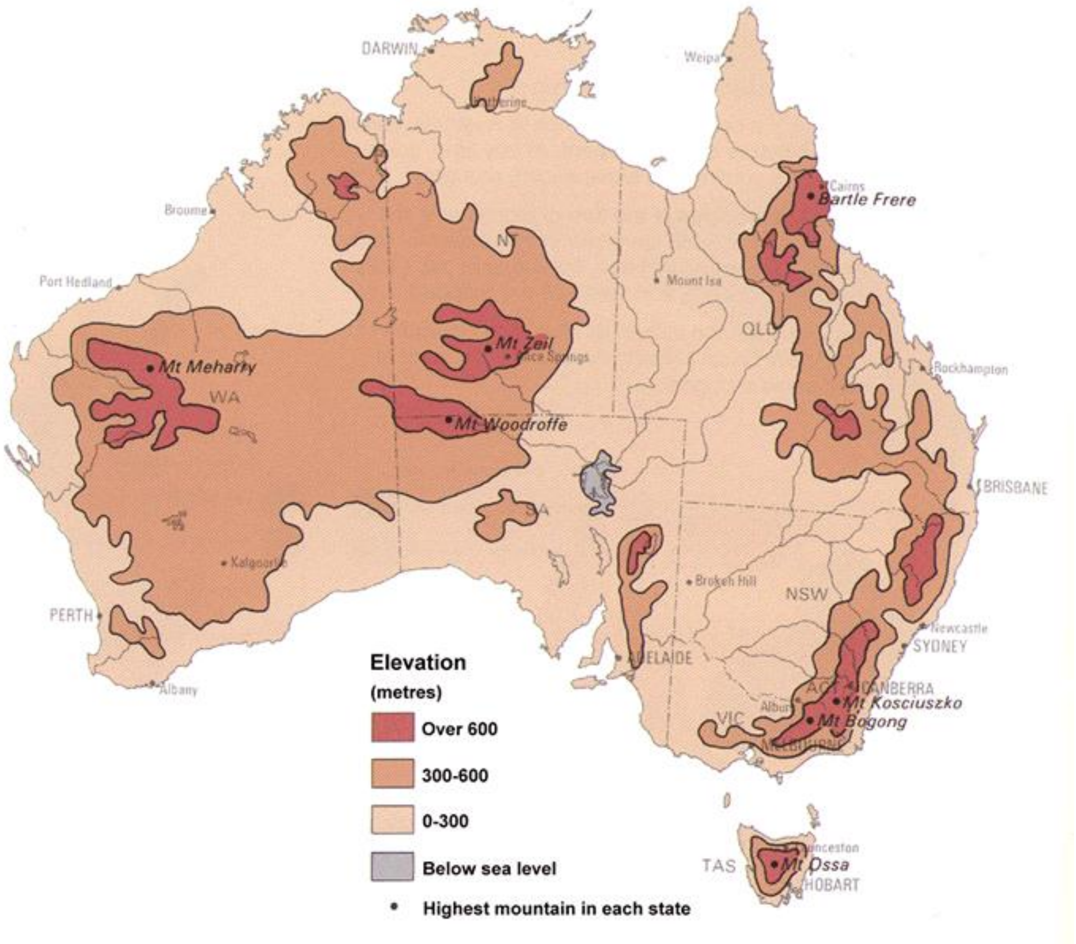
[33] 1301 – Year Book Australia, 2004, Australian Bureau of Statistics

Evidence of the impact of coastal proximity to asset failure is provided in TasNetworks reliability data with the frequency of interruptions in coastal areas due to issues associated with power poles approximately double that for poles located in inland areas, reflected in the relative contribution each 'category' of pole made to our system-wide SAIFI.

Altitude

Tasmania has the highest proportion of its land above an elevation of 600m of all NEM States (see Figure A2). Many of TasNetworks assets are at high altitude, particularly the transmission assets in the West.

Figure A2 Australian Elevation Map

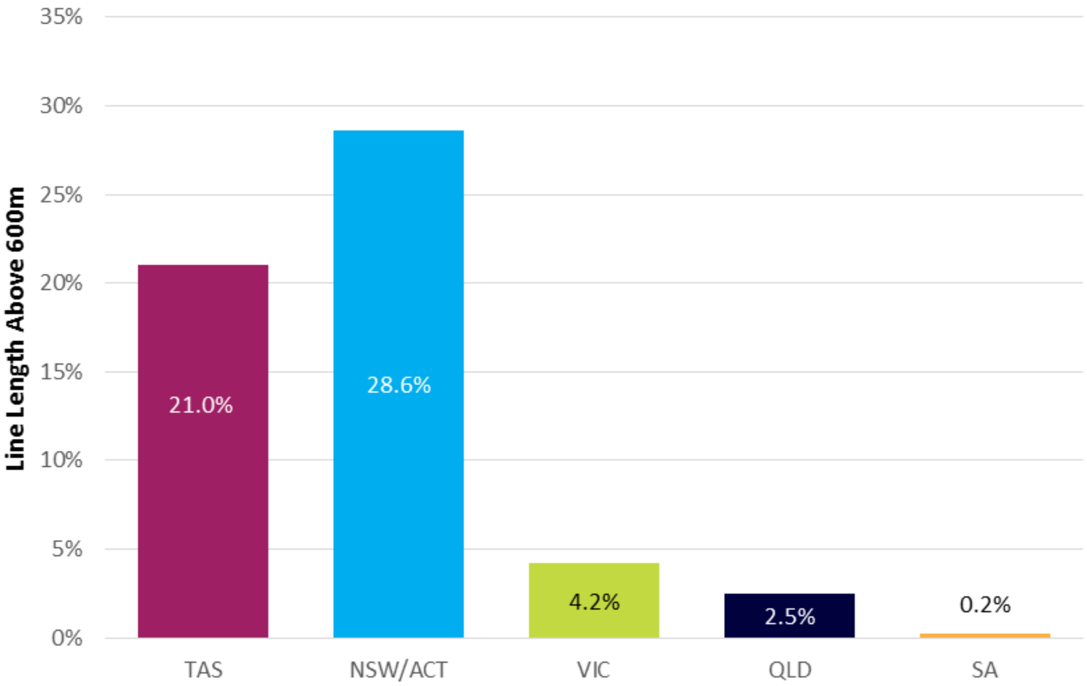


Map Source: http://www.ga.gov.au/scientific-topics/national-location-information/landforms/elevations

The AER's Economic Benchmarking RINs provide information on the line length of transmission assets operating above 600m from sea level[34]. The proportion of the network at high altitude for each of the transmission networks in the NEM are shown in Figure A3.

[34] Table 3.7.1 of the Transmission Economic Benchmarking RIN

Figure A3 EB RIN Line Length Above 600m



Insulation capability degrades with increasing altitude and design considerations must therefore be taken into account. Accessibility can also be problematic with high altitude assets. In the UK, the regulator (Ofgem) applies a degradation factor of up to 1.3 for high altitude assets in its approach to measuring network health[35].

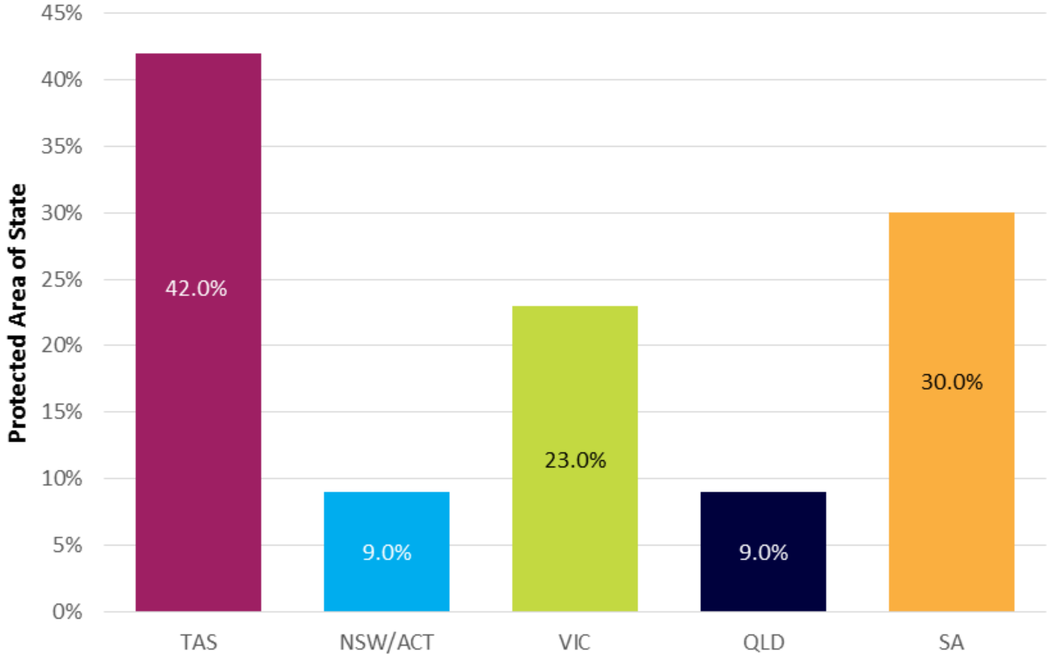
Accessibility

Tasmania has the highest proportion of protected reserve land of all NEM States and Territories. Protected areas include: conservation parks, heritage rivers, indigenous protected areas, national parks, natural catchment areas, natural features reserves, nature conservation reserves, private nature reserves, state parks, wilderness parks and wilderness zones. Figure A4 shows the proportion of total land that is designated as protected area for each NEM State[36].

[35] DNO Common Network Asset Indices Methodology, OFGEM

[36] Data sourced from: http://www.environment.gov.au/land/nrs/science/capad/2016

Figure A4 State Protected Areas as Proportion of Total Land Size



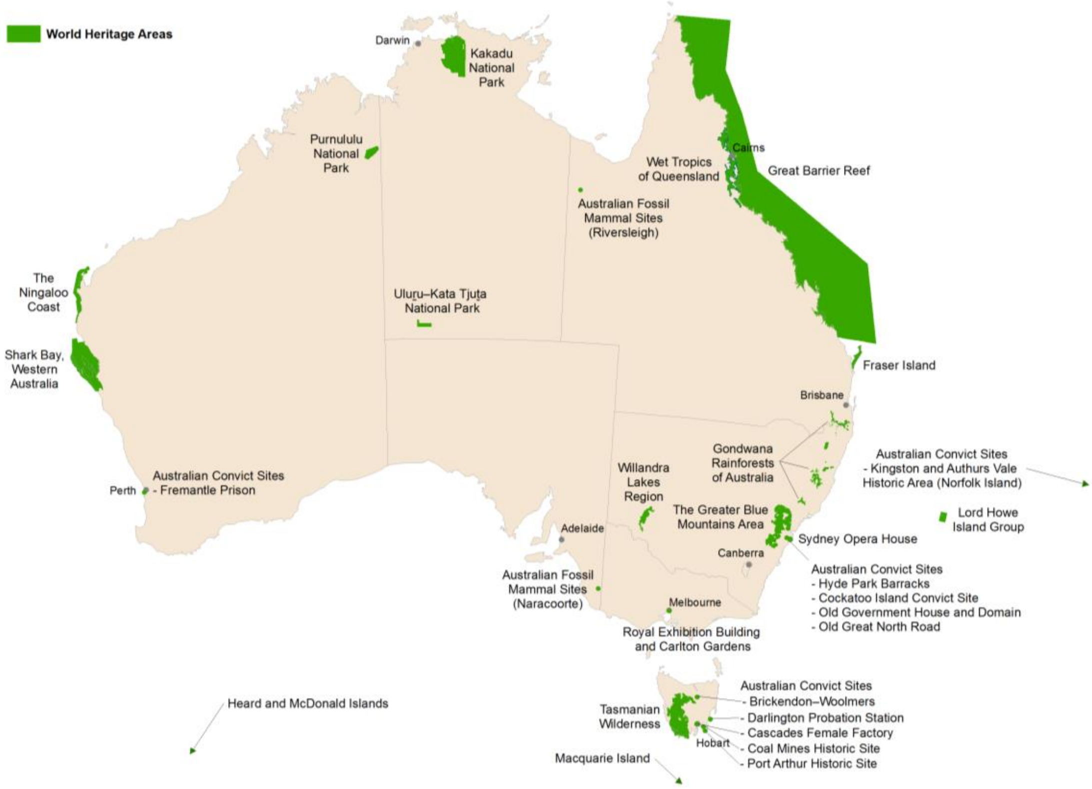
Much of the protected area in Tasmania has World Heritage status. The Tasmanian wilderness is the largest land-based world heritage area of all the NEM States (Queensland's Great Barrier Reef obviously does not significantly affect network operations), as shown in Figure A5.

A unique challenge in Tasmania is presented by the fact that the transmission network runs partially through the World Heritage Area. The AER has acknowledged the costs associated with these areas previously:

"World heritage status in some areas contributes to increased transmission costs."

Australian Energy Regulator TNSP Electricity Performance Report 2009-10

Figure A5 World Heritage Area Map – Australia



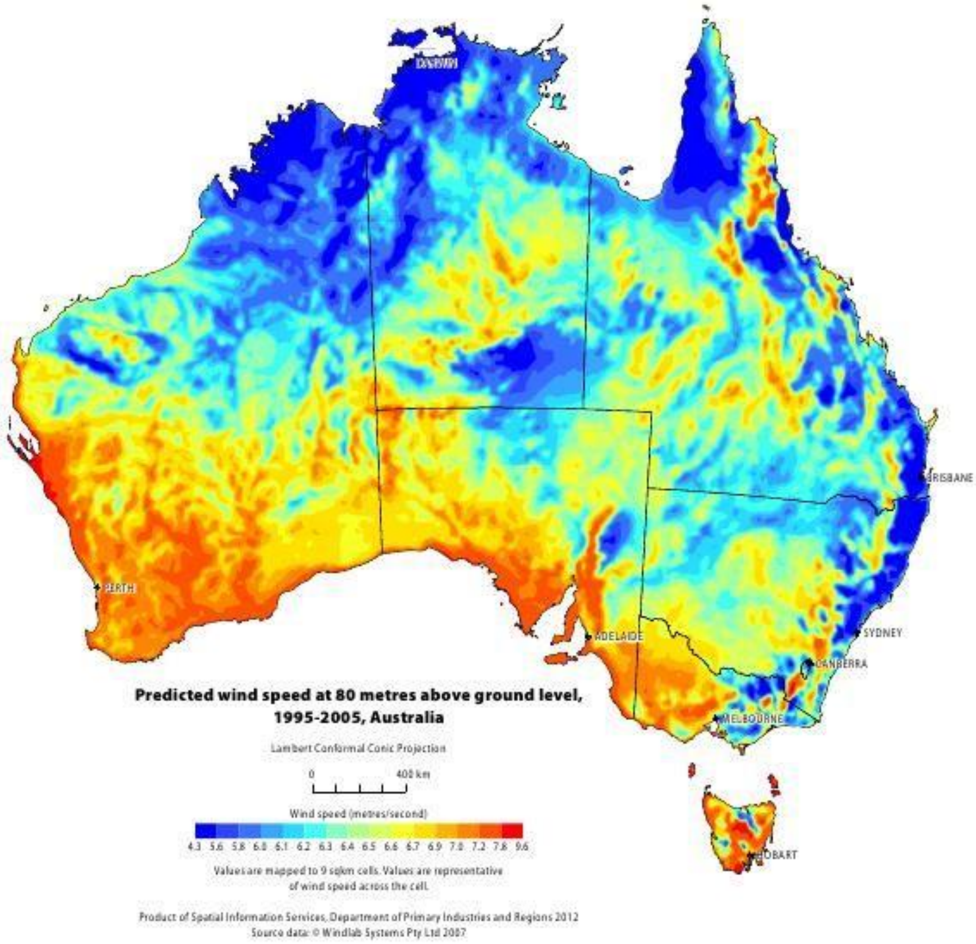
Map Source: http://www.ga.gov.au/scientific-topics/national-location-information/landforms/elevations

Climate

Tasmania has a highly variable climate, both over time and by region. High wind and rainfaill areas in the West contrast with drought and bushfire prone areas in the East. Climatic variability can increase the degradation rate of assets. Some features of our climate can also increase the risk of asset failure, such as frost and windspeed.

High winds can cause conductor clashing and increase the likelihood of conductor and pole failure. Tasmania experiences wind speeds greater than most NEM States, with the Eyre Peninsula in South Australia perhaps the closest area in terms of high winds (see Figure A6).

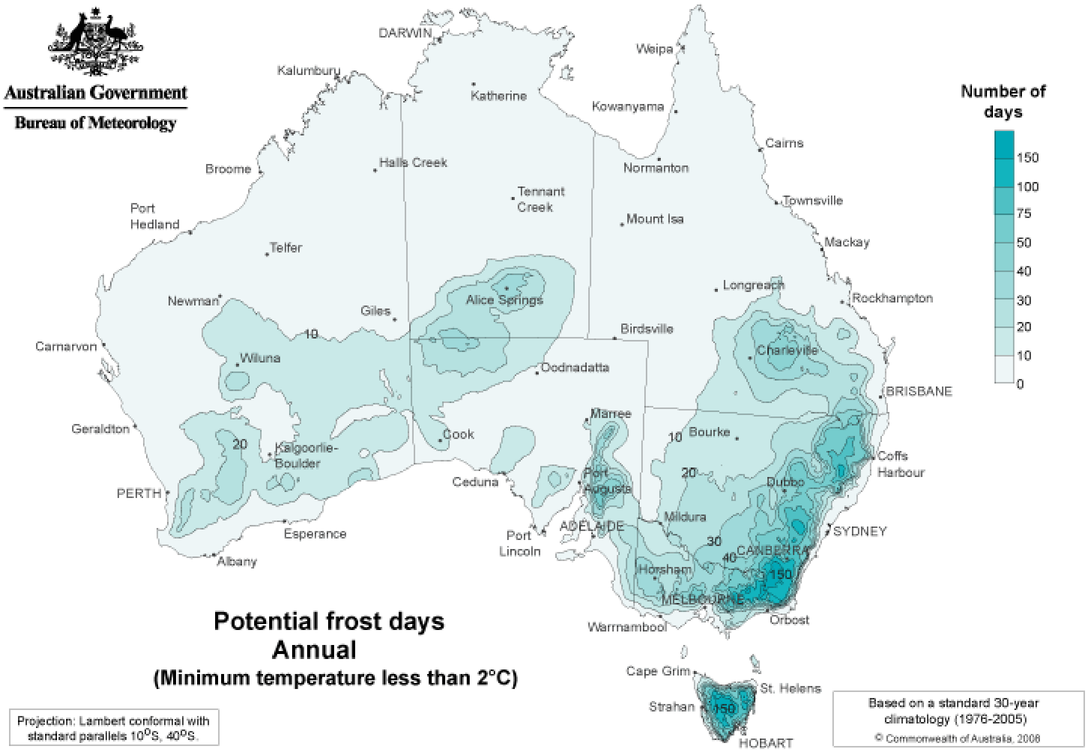
Figure A6 Australian Wind Speed Map



Map Source: Renewables SA

The entire State of Tasmania experiences an equivalent number of annual frost days to the snow fields of Victoria and NSW (see Figure A7). Those areas in NSW and Victoria, however, are lightly populated resort towns compared to Tasmania's permanent resident areas.

Figure A7 Frost days in Australia

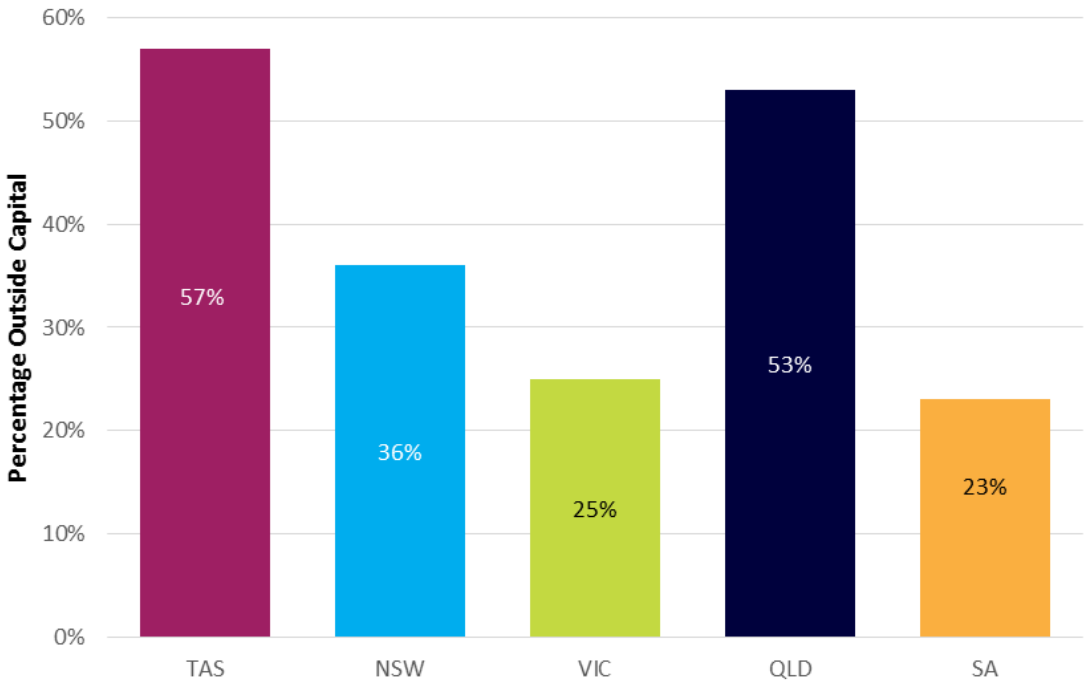


Map Source: Bureau of Meteorology

Demography

Tasmania's population is spread over more towns and cities relative to any other NEM state. Tasmania has the greatest proportion of its population living outside the largest population centre in each State (see Figure A8). South Australia, despite its overall low population density and network customer density has the highest proportion of its total population living in the capital.

Figure A8 Percentage of Population Living Outside of Capital City



Data Source: Australian Bureau of Statistics

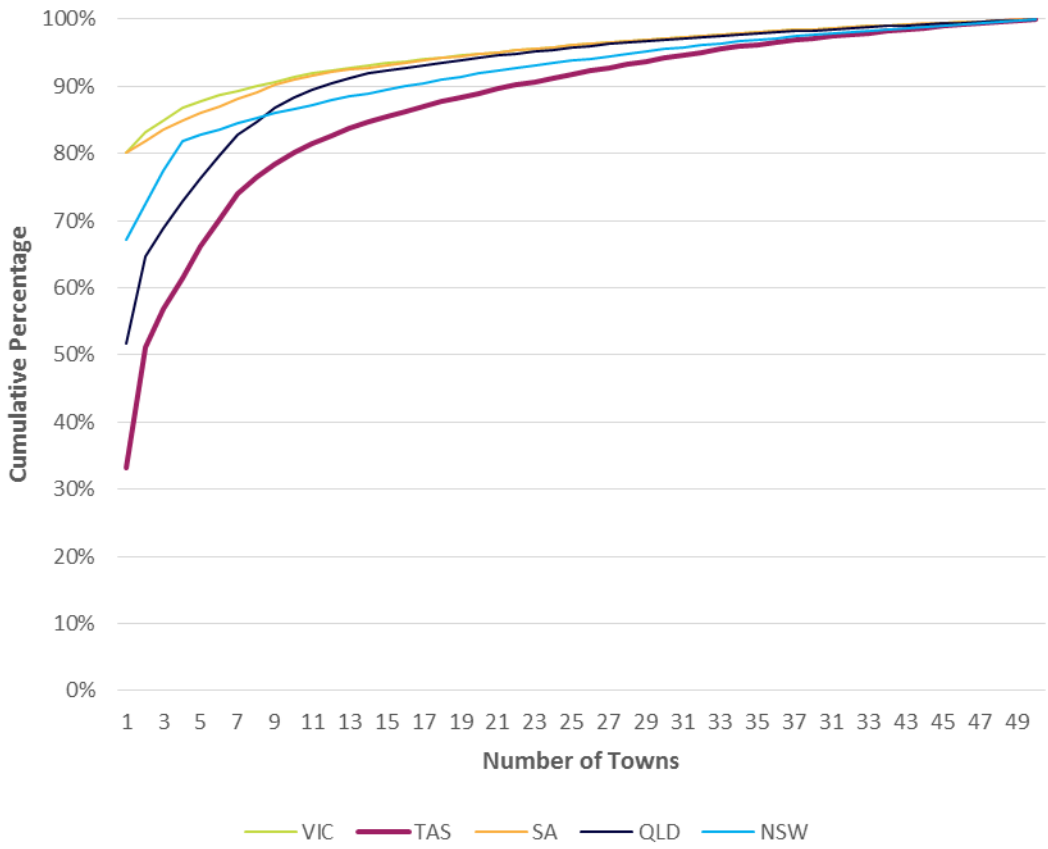
The other unique attribute of the Tasmanian population is the spread across the State. The table below shows the distance between the population centre of each State and its capital city. Only Queensland has a greater separation, and that is over a State that is 25 times the land area of Tasmania.

State Population Centres

State	Population Centre Location	Distance to CBD of Capital City (km)
Tasmania	Woods Lake	120
Queensland	Coalstoun Lakes	300
New South Wales	Lower Portland	80
South Australia	Gepps Cross	11
Victoria	Coburg North	10

Figure A9 below shows the cumulative percentage of the population of the largest 50 cities and towns in each State. All other states reach 90% by the top 15 towns, a mark that takes 22 towns in Tasmania.

Figure A9 Cumulative Town Population Percentage by State



Data Source: Australian Bureau of Statistics

This highly dispersed population has consequences for our asset design, requiring more assets spread over greater relative distances, often resulting in unavoidably low local utilisation rates.

Generation Market

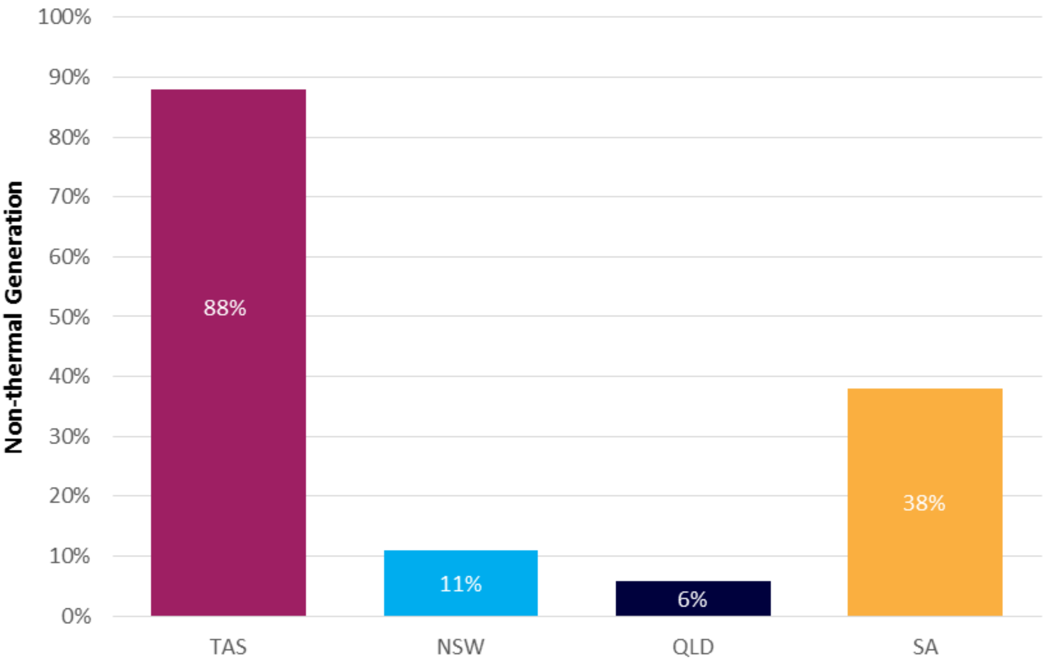
Our complex system of multiple, small hydro-generation suppliers causes variability of supply and complexity for constraint management. Tasmania has the highest variability of dispatch in the NEM - measured as the percentage of non-thermal generation (see Figure A10)[37]. This, along with the challenge it brings, has been acknowledged by the AER in the past:

"Due to the majority of Tasmania's generation being hydro-electricity and variations involved in generation output, Transend may encounter additional costs in providing transmission services relative to other TNSPs."

Australian Energy Regulator TNSP Electricity Performance Report 2009-10

[37] Data Source: 2016 TNSP Economic Benchmarking RINs, Table 3.7.2 **AusNet Services redact this information*

Figure A10 Variability of Dispatch

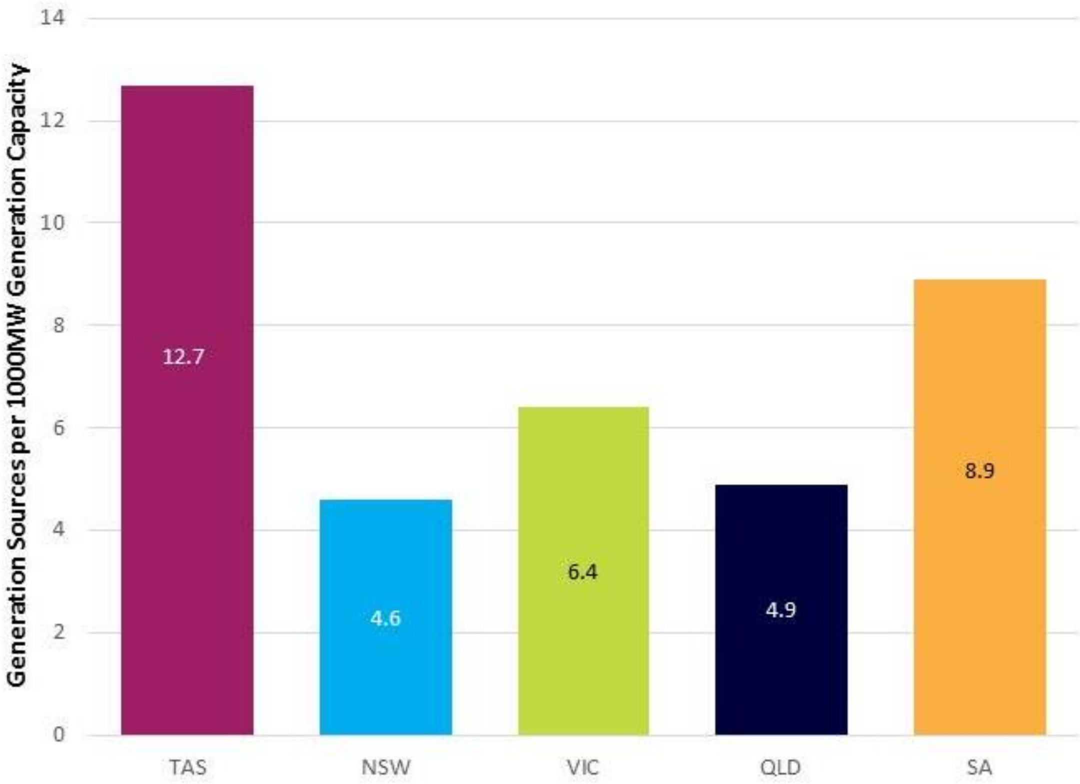


As well as variable output from hydro-generation, the number of generators required to service the demand is very high. With uncertain output and many small generation sources, managing and balancing the network is a challenge. Economic Insights have acknowledged this recently:

> "It needs to be recognised that the output specification cannot take account of all operating environment factors (OEFs) and unusual circumstances facing a TNSP such as the need to connect a large number of smaller renewable energy generators than other TNSPs. This may be best dealt with through the application of seperate OEF analysis"
>
> Page iii, Position paper for the Review of TNSP Economic Benchmarking, Economic insights, 9 August 2017

Figure A11 shows the number of generation sources required for every 1,000 MW of generation capacity per NEM State. As shown, the number of generation sources required in Tasmania is significantly higher than other States which, when combined with the high penetration of renewables, increases the complexity of constraint management and network operations.

Figure A11 Generation Sources per 1,000 MW Generation Capacity



Data Source: Geoscience Australia Database of Power Stations

A Unique Design

The aforementioned environmental factors combine to produce a unique set of challenges for Tasmanian electricity transport and hence a unique design. Our many, small generators at high altitude and dispersed, decentralised population lead to:

(i) transmission assets at high altitude in difficult access terrain;

(ii) the requirement to use higher voltage distribution lines to connect population centres to the grid backbone;

(iii) constraints on our ability to switch loads and maximise asset utilisation at local and system levels.

These factors have a material impact on our capital program and maintenance and operation of the networks.