2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

APPENDIX 4.01

Huegin
Powerlink Operating Expenditure Benchmarking Review

Delivering better value

Powerlink Operating Expenditure Benchmarking Review

Report

huegin

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Introduction

This benchmarking report for Powerlink considers the AER benchmarking techniques, their use in determining efficient costs and Huegin's view on Powerlink's opex efficiency.

Benchmarking of National Electricity Market (NEM) Transmission Network Service Provider (TNSP) operating expenditure is challenging due to the limitations in data, benchmarking techniques and the very small sample size of five networks.

Conditions across Australia vary considerably and the service areas and population densities each network services presents different challenges to each business. With only five networks to compare, deep analysis of cost drivers and differences across networks is difficult to attain.

Whilst regulation requires the assessment of the efficiency of a business, with the limitations inherent in benchmarking Australian TNSPs, the exercise often becomes one of deduction or testing for the absence of indicators of material inefficiency.

Using the AER techniques and category analysis of Powerlink's opex, there is nothing to suggest that it is materially inefficient compared to its peers in other states.

“

Huegin advocates and applies benchmarking as an informative process for identifying and communicating differences in the cost outcomes between businesses. We see the results of benchmarking as the means for initiating investigations into productivity and efficiency improvement opportunities, not the ends. In our experience, those investigations invariably uncover another level of detail about cost drivers. It takes considerable time and effort to determine the root cause of benchmarked cost differences and similar effort again to determine the ability of the business to influence those causes. Our experience is that benchmarking is not reliable in predicting an industry cost function and should not be used as a substitute for forecasts.

- page 8, Huegin Submission on Expenditure Forecast Assessment Guideline, September 2013

A Review of Techniques

This section includes an overview of the AER techniques including a summary of the advantages and disadvantages of each.

1

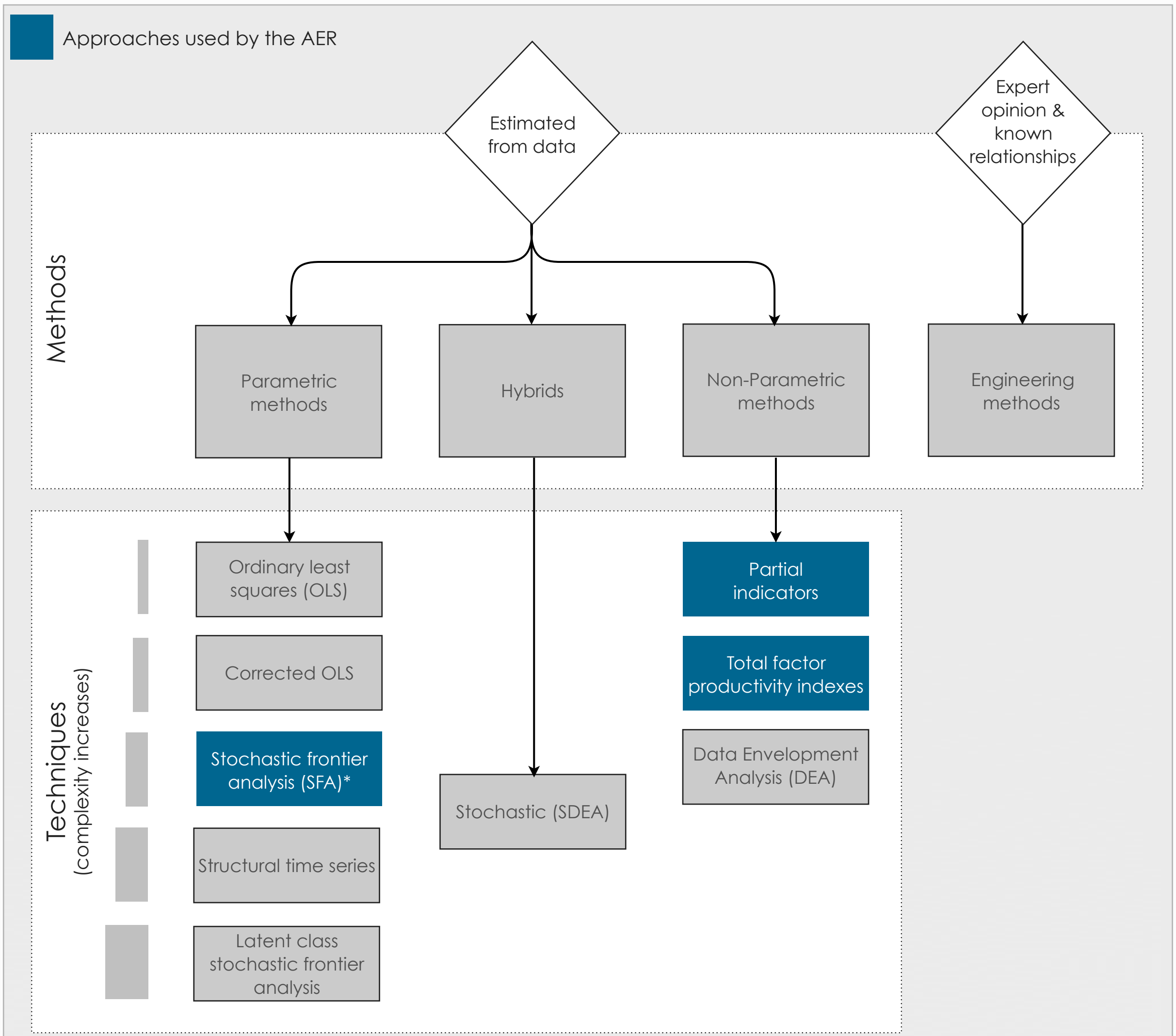
The AER benchmarking techniques

The 2015 Annual Benchmarking Report produced by the AER is analogous to the previous Report (2014) in that the same benchmarking techniques and model specifications have been used. The three techniques used in the report are:

1. Partial Productivity Indicators (PPIs);
2. Multilateral Total Factor Productivity (MTFP);
3. Multilateral Partial Factor Productivity (MPFP) for both Capital (Capital PFP) and Opex (Operating PFP).

These methods are known as non-parametric methods. The AER also uses an econometric method (Stochastic Frontier Analysis, SFA) for estimating base year opex efficiency and substituting forecast opex for distribution networks only. SFA requires significantly more data than is available for transmission in Australia and therefore has not been used. The approaches used by the AER, and the framework of common techniques are shown below.

Benchmarking methods and techniques. *Benchmarking methods are categorised mainly as parametric or non-parametric. These are then broken down further into techniques which describe the basis of combining variables and the reference point of measurement.*



* Distribution only

Partial Productivity Indicators (PPIs)

Partial indicators are the ratio of a single input and output, for example opex/kilometre. Whilst this technique is relatively simple in comparison to other benchmarking techniques it does not account for the different factors beyond the control of businesses that influence the ratios.

Total and Partial Factor Productivity (TFP)

Total factor productivity incorporates multiple outputs and inputs by using different weights derived from revenue and cost shares to aggregate them into a single output and input index. Total factor productivity is generally preferred to partial indicators because it is able to include more outputs and inputs through which to benchmark businesses. A criticism is that it is unable to account for environmental differences that can influence the productivity results. TFP has been utilised in electricity network regulation in New Zealand, Canada and the United States.

Application of methods

For transmission benchmarking, the AER relies more heavily on its MTFP and MPFP models than partial performance indicators, which are largely used to support the results of the multilateral total and partial factor productivity scores. The AER have articulated their view on a preference for economic benchmarking models over PPIs and the utility of PPIs in the 2015 Annual Benchmarking Report:

> **We have focused on an economic benchmarking technique - multilateral total factor productivity (MTFP) - as the primary technique to compare relative efficiency.**
>
> - 2015 Annual Benchmarking Report, AER, page 4

and

> **The PPIs support the MTFP results because they provide a general indication of comparative performance and are useful for assessing the relative efficiency of the TNSPs.**
>
> - 2015 Annual Benchmarking Report, AER, page 17

Some caution should be noted with respect to these extracts from the Annual Benchmarking Report, as the particular disadvantages of the MTFP technique (listed in the next section) render it limited in its ability to inform ***relative*** efficiency.

General advantages and disadvantages

The general advantages and disadvantages associated with each approach are summarised on the following pages.

Partial Productivity Indicators

Partial Productivity Indicators is the least complex of the techniques adopted by the AER and involves finding the ratio of a single input to output. General advantages and disadvantages are shown to the right.

The AER has relied upon data in the Regulatory Information Notices (RINs) supplied by the businesses. The AER also takes a five year average of the data used to generate the category analysis ratios.

Advantages

Measures are simple ratios of readily available network attributes

Results are more easily conveyed through graphical representation of comparisons

The amount of data required is less exhaustive than for other benchmarking techniques

Disadvantages

Businesses will appear efficient and inefficient for the same cost category depending on the denominator chosen

Cost allocation methodology differences skew the results in single cost categories

Dissimilar businesses cannot be reliably compared

Total and Partial Factor Productivity

Total and partial factor productivity incorporates multiple outputs and inputs by using different weights derived from revenue and cost shares to aggregate them into a single output and input index. Total factor productivity is generally preferred to partial indicators because it is able to include more outputs and inputs through which to benchmark businesses.

A common criticism is that total factor productivity is unable to account for environmental differences that can influence the productivity results. This limitation requires post modelling treatment, such as second stage regression, to correct for bias when comparing networks that operate in different environments. This limitation, when considered with the very small sample in Australia, is significant.

TFP can be disaggregated into the component measures of capital and operating partial productivity indices by omitting:

- The capital inputs to calculate opex partial factor productivity (Opex PFP); and
- The operating inputs to calculate capital partial factor productivity (Capital PFP).

The AER has chosen to use Multilateral TFP (MTFP) - a multiple input and output index over time - for benchmarking total expenditure and Opex and Capital PFP for evaluating operating and capital productivity.

Separating TFP measures into Capital and Opex PFP introduces its own issues associated with cost allocation. Because TFP mixes operating expenditure (i.e. dollars) with capital assets (i.e. physical measures), any allocation of expenditure away from opex and toward capex will improve both the Opex PFP of a business and the MTFP result.

Advantages

An industry cost function does not need to be assumed

DNSPs are directly compared to others within the industry and not a regression line (econometric modelling) or a hypothetical frontier business (DEA)

The amount of data required is less exhaustive than for other benchmarking techniques

MTFP benchmarking is transparent and easy to replicate

Disadvantages

MTFP does not take into account environmental variables, making it difficult to distinguish between inefficiency and the result of different operating environments

MTFP does not take into account economies of scale, making it difficult to distinguish between inefficiency and the result of scale differences

MTFP scores can change significantly depending on the choice of inputs and outputs

MTFP does not produce any statistical results which makes it difficult to determine if the results are valid

Operating and Environmental Factors

This section includes information on operating and environmental factors relevant to Powerlink.

2

The significance of operating and environmental factors

As discussed in the previous section, the inability of MTFP techniques to account for environmental factors and differences in operating conditions is one of its primary limitations. The Australian electricity supply system is one of the most heterogenous in the world, therefore any model or technique that does not account for differences in operating conditions will not be robust enough to draw conclusions about relative efficiency between networks. MTFP analysis includes two predominant measurement indices:

1. The Malmqvist Index, for comparing productivity between entities; and
2. The Fisher Index, for observing productivity changes over time.

The lack of homogeneity of operating conditions and the small sample size in Australian transmission networks means that benchmarking using economic models presents only limited information about absolute or relative efficiency.

Sample size presents a further challenge

A common technique for factoring in differences in environments and operating conditions when using MTFP models is a second-stage regression against variables known to influence cost. With only five transmission networks, however, second-stage regression does not produce reliable results as the relationship between the regressed variables will not be statistically significant due to sample size. Understanding the influence of environmental factors on benchmarking results therefore is limited to direct observations.

A framework for assessing environmental factors

There are many environmental factors known to influence the operating and maintenance costs of any networked asset. Geographical differences are a common set of factors that will influence cost to varying degrees. Other factors that influence costs include:

- Climate and weather;
- Accounting differences;
- Network design;
- Customer demographics; and
- Penetration of other technologies or fuel types.

We consider that environmental and operating condition factors that drive cost differences can be considered in two dimensions:

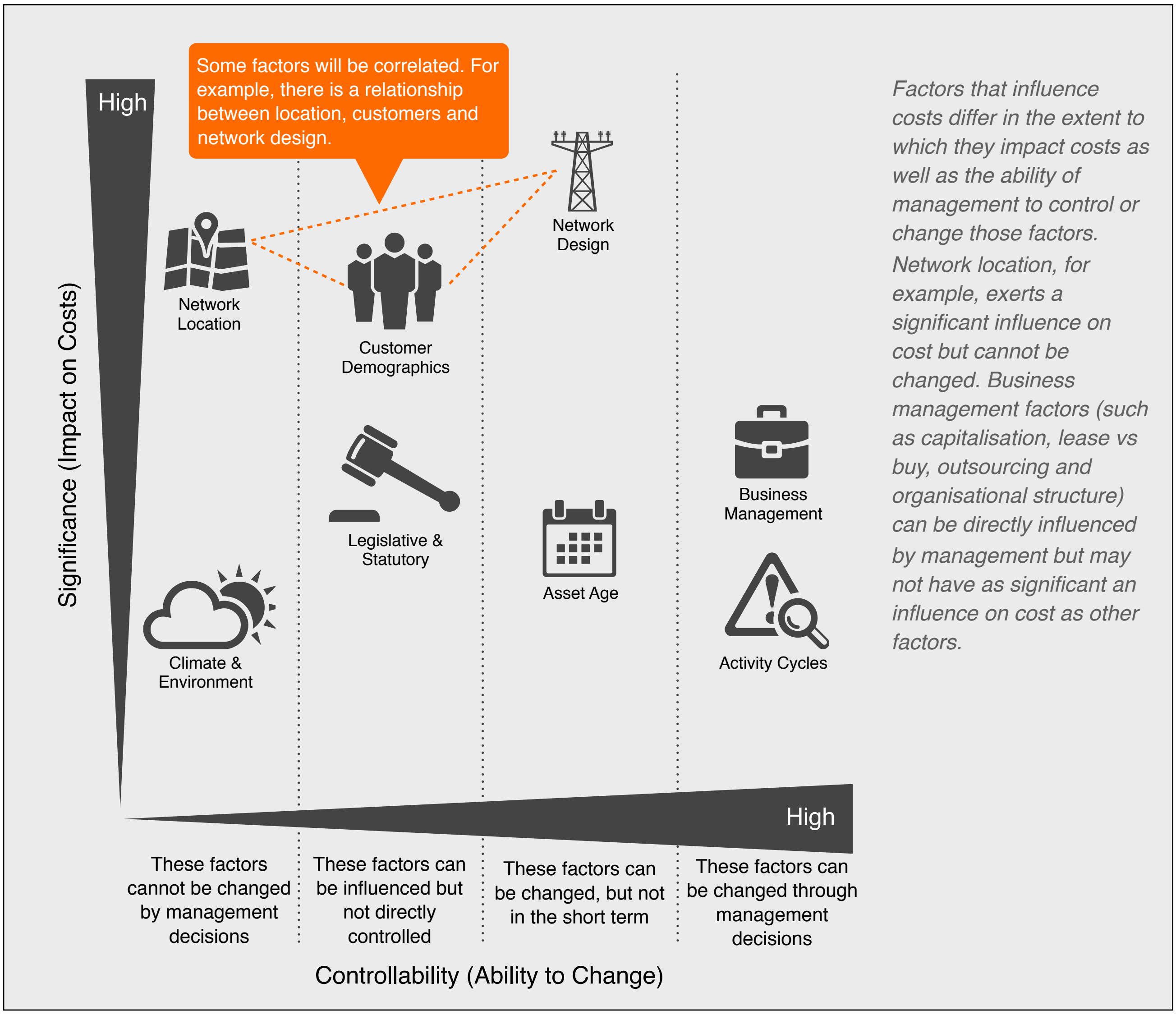
1. The *significance* of the factor, in terms of the extent to which they influence cost; and
2. The *controllability* of the factor, in terms of management's ability to control or mitigate the cost factor.

With respect to the two dimensions above, we consider that factors can be:

1. **Inherent**: These are factors that are present in the environment and cannot be readily changes; that is, these factors are exogenous.
2. **Inherited**: These are factors that are the legacy of previous decisions or ownership regimes.
3. **Incurred**: These are factors that are generally an outcome of management decisions.
4. **Exceptional**: These are costs that are exogenous and unforeseen, such as storms and other disasters.

Across the first three of the four categories above, they are presented in generally increasing order of controllability, but decreasing order of significance. That is, the factors that have greatest significance on cost are generally those that are hardest to change. A framework for categorising eight of the most influential environmental factors is shown below.

Category	Factor	Detail
Inherent	Network Location	Geographic location affects accessibility, labour costs, etc.
	Climate & Environment	Climate and environment affects accessibility and maintainability.
Inherited (externally controlled)	Customer Demographics	Location of customers and the energy they use influence costs.
	Legislative and Statutory Rules	Legislative and statutory requirements (e.g. vegetation management, safety, etc) influence particular cost categories.
Inherited (internally controlled)	Asset Age	Older assets often require more maintenance and monitoring.
	Network Design	The design of the network influences operating and maintenance costs.
Incurred	Activity Cycles	How often assets are inspected and maintained has a direct influence on costs.
	Business Management	Management structures, accounting and procurement decisions have an impact on most costs.



Most significant environmental factors for Powerlink

Huegin tested the significance of a number of environmental and operating factors relevant to Powerlink's operating expenditure performance; each is described below.

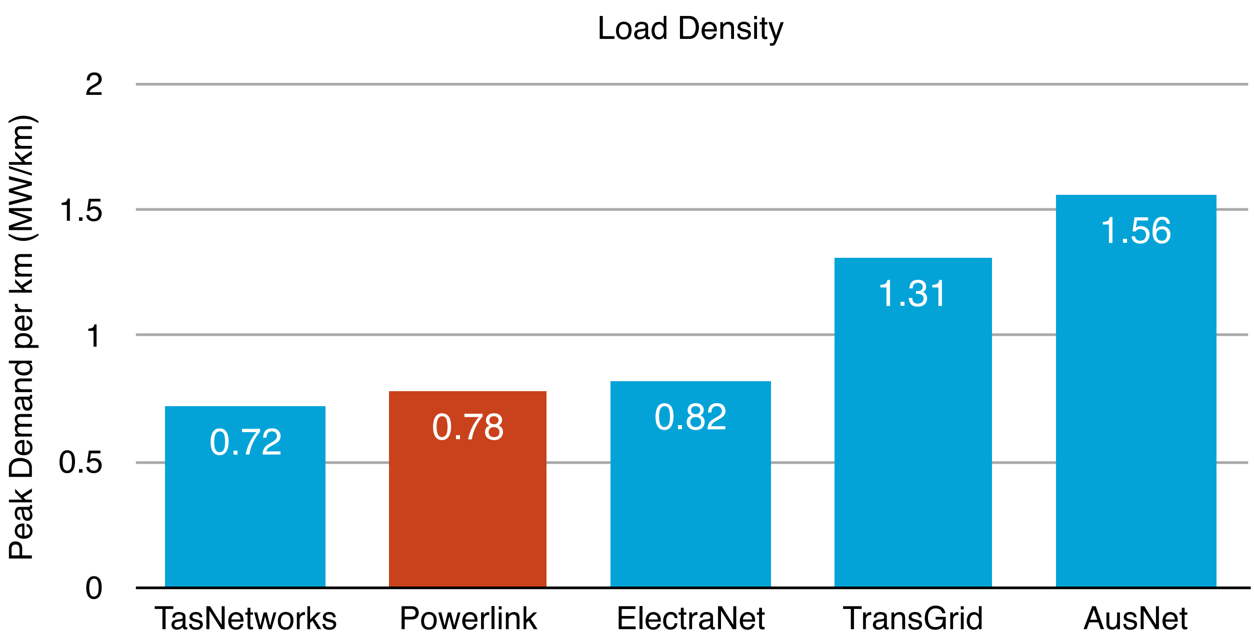
Load density

Load density, the MW of peak demand per kilometre of network, is a known driver of cost. There is a natural cost premium with lower load density. Network kilometres are required to reach customers based on their geographic location, regardless of the extent to which they contribute to the system peak demand. Low load density cost premiums have been recognised by other benchmarking efforts:

> **...it is more expensive to supply customers in areas of low load density than in areas of high load density.**
>
> Energy Policy and Planning Office, Thailand

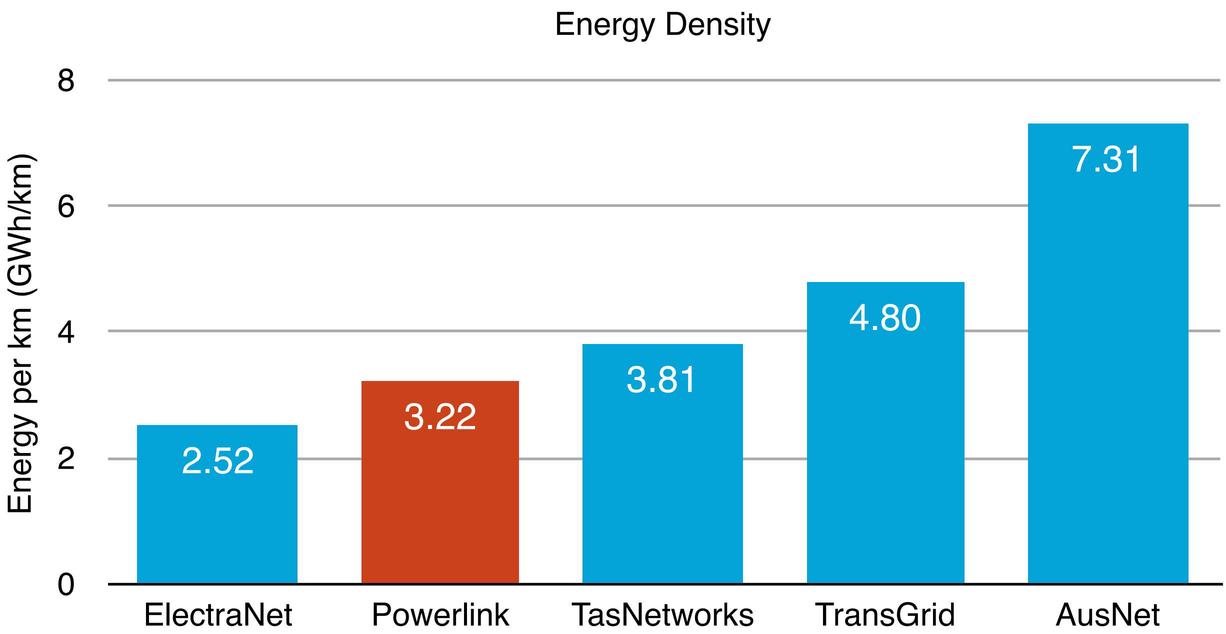
> **As load density increases, the cost per customer and the cost per transmitted electric energy decreases.**
>
> Hyvärinen, M., *Electrical networks and economies of load density.*

Powerlink has the second lowest load density in National Electricity Market (NEM), as shown below.



Energy density

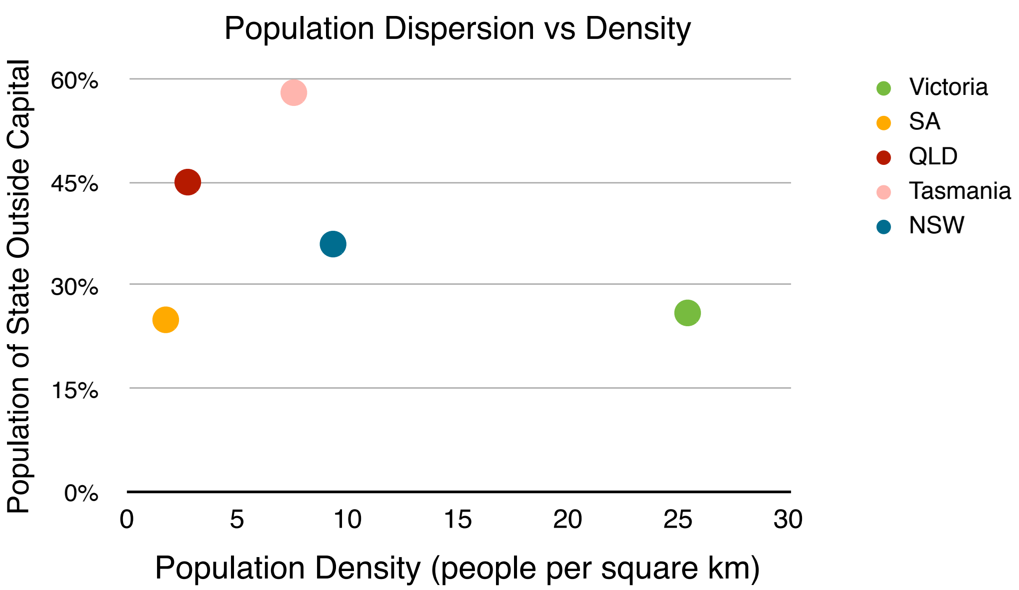
Energy density is correlated to load density, therefore as expected Powerlink also ranks lower on this measure than most networks.



To a large extent load and energy density are products of the demographics in each state, with more highly concentrated populations affording higher network densities.

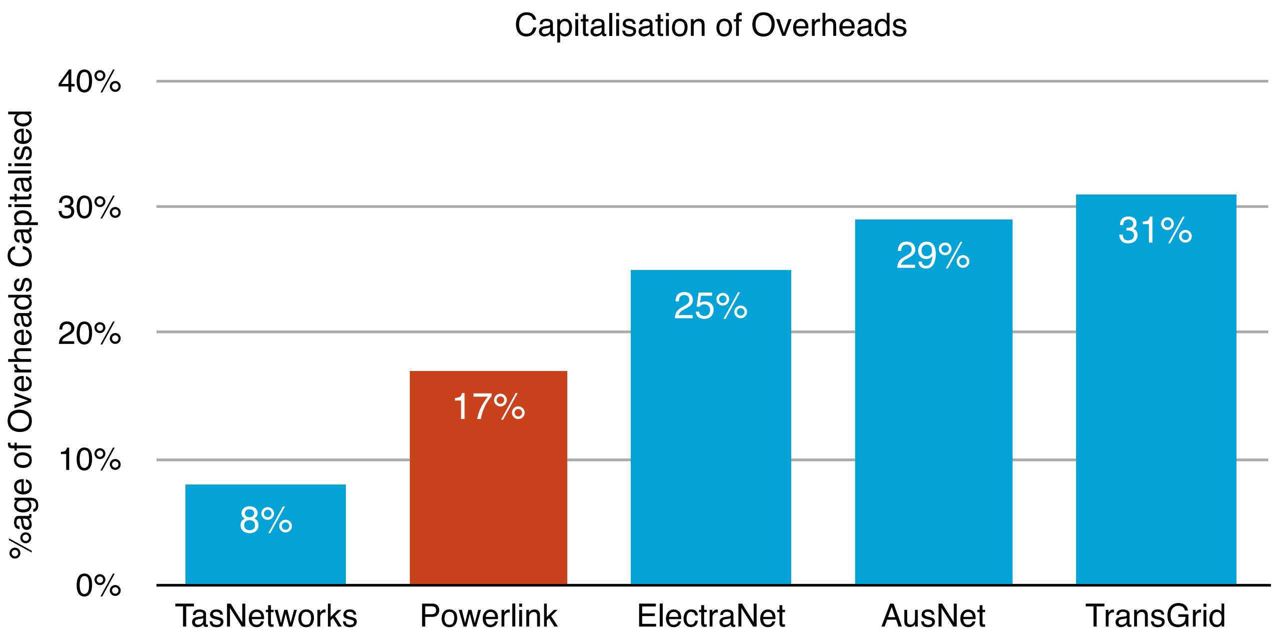
Customer demographics

As mentioned, energy and load densities are largely an outcome of the location and density of the population - where customers are more dispersed over larger areas, usage and load densities will be lower. As shown below, AusNet's high load and energy density is driven by its dense population concentrated in the capital city. Queensland has the second highest proportion of the population outside the capital and the second lowest overall population density.

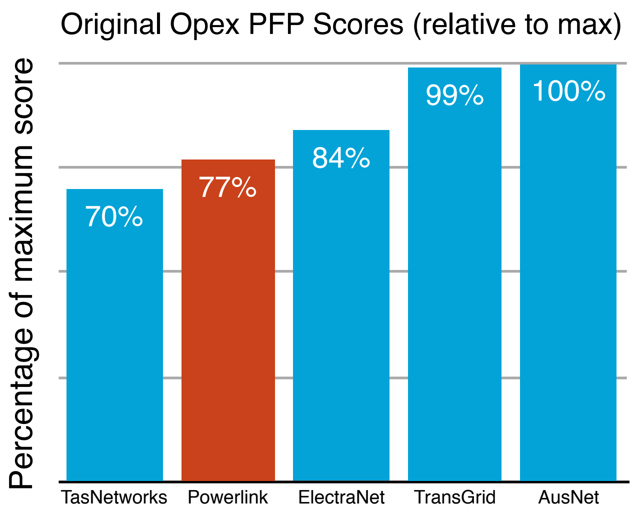


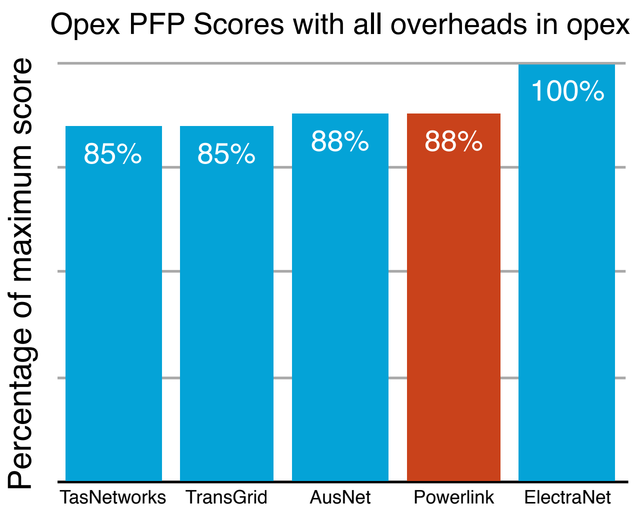
Capitalisation and accounting

Accounting practices are perhaps the most significant of all factors in the context of the AER benchmarking framework, where capital expenditure is not included in the primary benchmarking models. MTFP includes operating expenditure and physical measures of the asset as a proxy for capital expenditure, therefore any operating expenditure dollar capitalised provides an individual business with a direct advantage under the AER approach. Powerlink capitalises less of its overheads than all transmission networks other than TasNetworks.

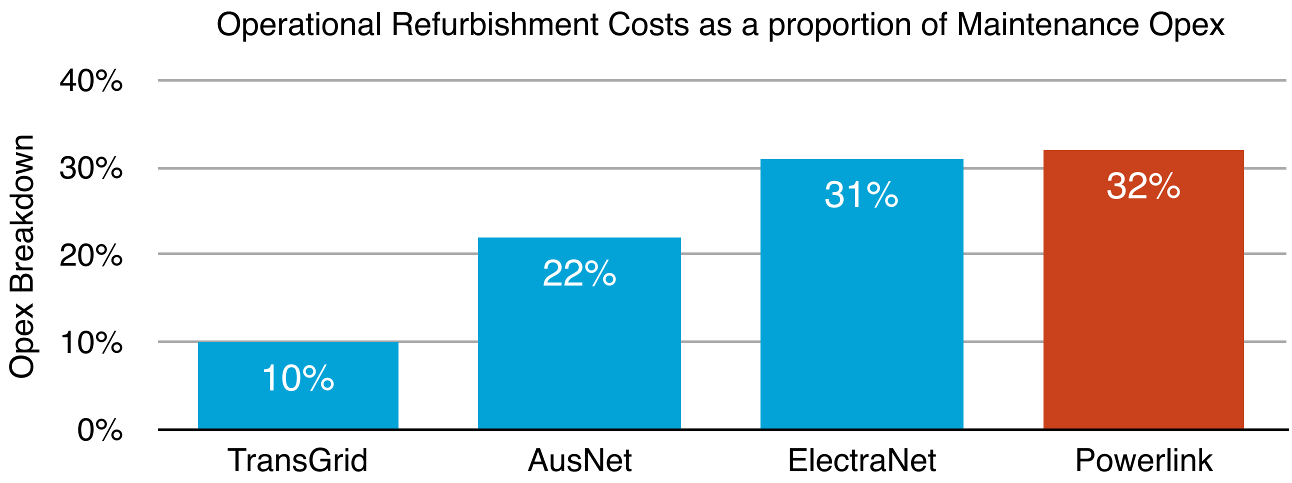


The extent of the disadvantage to Powerlink in opex benchmarking due to variation in capitalisation practices can be explored by comparing the original Opex PFP scores (measured relative to the maximum) with the same scores if all overheads are included in opex. Note that the comparison to the maximum score is used to show the relative change only, as discussed in this report, these scores are not suitable for comparing across businesses.





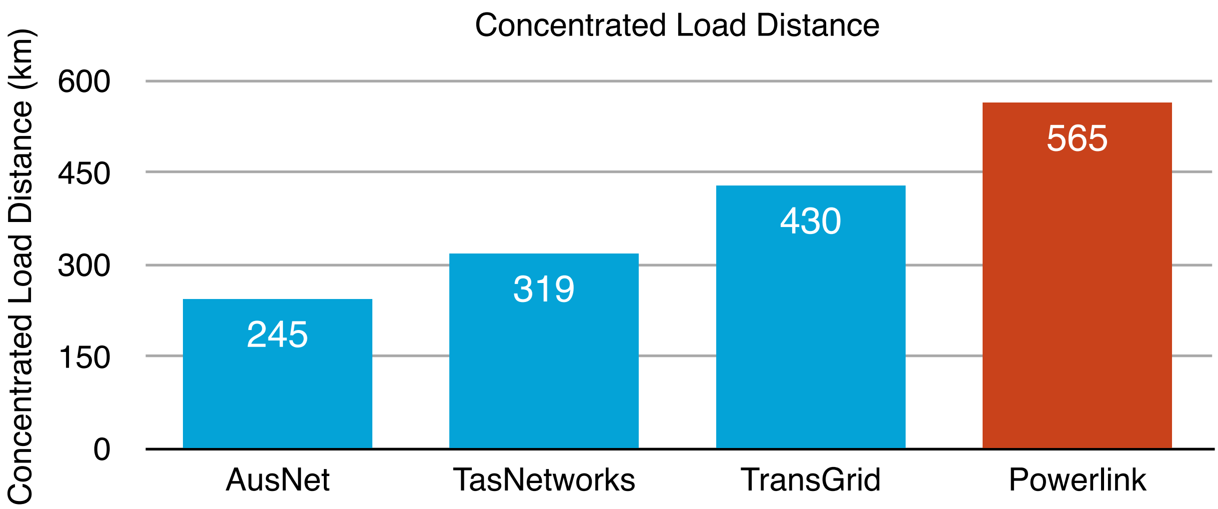
It is not just overheads that capitalisation impacts. The allocation of direct costs to either operating or capital expenditure also influences the AER benchmarking results. For networks that capitalise higher levels of expenditure, there is a material advantage under the AER model for every dollar that is moved from operating to capital expenditure. There are four networks that report Operational Refurbishment costs in their opex - costs that might otherwise be capitalised. For Powerlink, this represents a significant amount of opex - shown below is the percentage of total Maintenance Opex that is reported as refurbishment projects for the four networks for which data is available. As shown, there is a significant variation and the magnitude of this category of opex for Powerlink and ElectraNet in particular will influence any benchmark model of opex only costs.



Network Location

The market structure, terrain, climate and population concentration vary greatly across the NEM states. The distance between supply (generation) and demand (distribution connection points) centres in each state obviously increases with the larger states (NSW and QLD), but also with the fragmentation of the generation sources and spread of the population. Tasmania, for example, is the smallest state, but has many small generators and a large proportion of the population living outside the capital. Victoria is a small state, and also has a high concentration of generation in the La Trobe valley and the highest proportion (along with South Australia) of the population living in the capital.

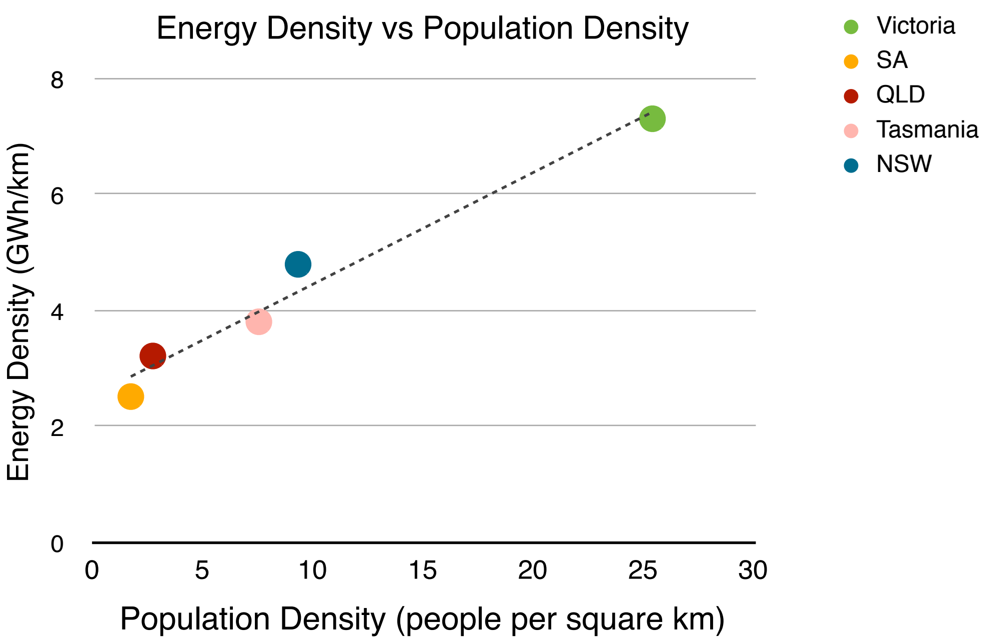
As shown below Powerlink must contend with the highest concentrated load distance (the distance between the major generation and load nodes, or groups of nodes) in the NEM (ElectraNet did not provide information on this variable).



As indicated earlier in this section, many of the environmental factors are correlated. The fact that Powerlink has a high concentrated load distance and a low energy and demand density are all related to the fact that it operates in a large state with a smaller population spread over a larger area.

Combinations of factors inform categorisation of networks

Often operating environment factors are tightly correlated, particularly where a number of factors are proxies for a specific attribute of a network. For example, a low energy density (more assets per GWh of energy transported) is often cited by regulators and other analysts as evidence of "gold-plating" - installing more assets than are needed to service the demand. However energy density can be shown to be tightly coupled with population density (see below).



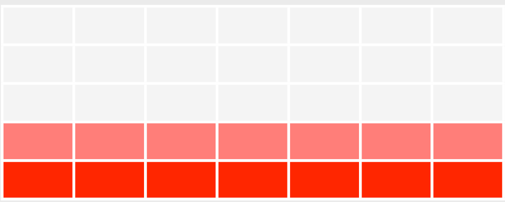
In the example above, what would appear to be a design factor (volume of assets to service given demand), which is somewhat within a network service provider's control (an internal, inherited factor), can in fact be demonstrated to be more closely related to the external, inherited factor of customer demographics, which in turn can be considered to be driven by the inherent factor of geographical location. In this case, management's ability to influence the design of the network is constrained by the broader dispersion of smaller population centres (which demand less energy per kilometre of network required to meet the supply point closest to them).

The analysis above demonstrates the importance of considering all environmental factors in aggregation as well as individually. When multiple environmental factors are considered collectively, the true variation in the operating conditions of the different networks is more readily apparent. The graphic on the following page highlights the difference in operating conditions across the transmission networks of the NEM based on the operating factors presented in this section.

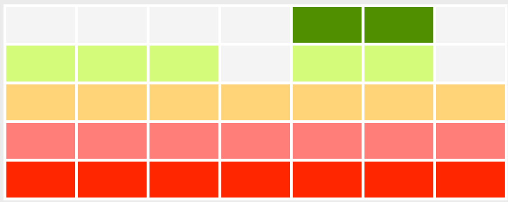
Profiling Transmission Networks: the environmental factors presented in this section can be used to profile differences between networks. Below are the rankings of the networks against each factor, with a higher ranking indicating more favourable conditions. Variation in conditions across networks can be shown by the individual network profiles underneath the table.

Rank	Load Density	Energy Density	Population Density	Population Outside Capital	Overheads Capitalisation	Operational Refurbishment	Concentrated Load Distance
1st	AusNet	AusNet	AusNet	ElectraNet	TransGrid	TransGrid	AusNet
2nd	TransGrid	TransGrid	TransGrid	AusNet	AusNet	AusNet	TasNetworks
3rd	ElectraNet	TasNetworks	TasNetworks	TransGrid	ElectraNet	ElectraNet	TransGrid
4th	Powerlink	Powerlink	Powerlink	Powerlink	Powerlink	Powerlink	Powerlink
5th	TasNetworks	ElectraNet	ElectraNet	TasNetworks	TasNetworks	No data for TasNetworks	No data for ElectraNet

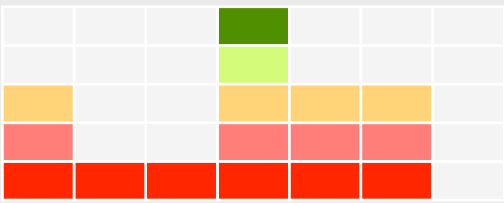
Powerlink



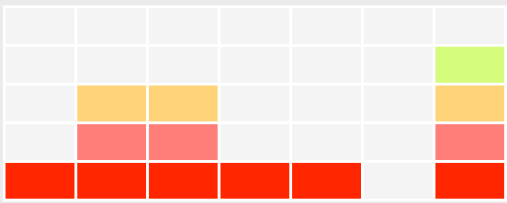
TransGrid



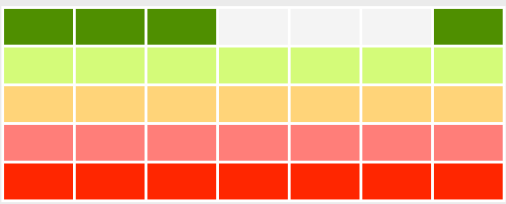
ElectraNet



TasNetworks



AusNet Services



Powerlink's Historic Opex Efficiency

This section analyses Powerlink's historic opex efficiency using AER techniques and other benchmarking information.

3

The AER uses MTFP analysis to inform its decisions

As discussed earlier, the AER uses MTFP (and Opex and Capital PFP) and Partial Productivity Indicators to benchmark transmission networks. The full model specification for MTFP is as follows:

1. **Outputs**: Energy throughput (GWh), Ratcheted maximum demand (MW), Voltage weighted entry and exit points, Circuit length (km) and Reliability
2. **Inputs**: Opex, Overhead lines (MVA-kms), Underground cables (MVA-kms) and Transformers (MVA).

A specific issue with model specifications such as this is that many of the variables are not actually production inputs and outputs, rather they are proxies for cost. Some are poor proxies, but may have seemed more tightly correlated due to historical multicollinearity. That is, many output variables have historically increased incrementally in line with costs, thereby providing signals of correlation that have been confused for causality. Such apparent causality fails when there is a change in the direction and rate of change in the output (for example, maximum demand), and this is then misinterpreted as changes in productivity or efficiency.

One of the difficulties the AER faces in the use of benchmarking TNSPs is the lack of comparators. Put simply, five businesses is an insufficient sample size to make any inferences on efficiency differences between TNSPs as diverse as those in the NEM. This is a limitation that the AER has previously eluded to in TransGrid's most recent Revenue Determination:

> “
>
> **At this stage, we are not confident that the MTFP model specification and results are sufficiently robust to assess the efficiency of the transmission service providers base opex.**
>
> Attachment 7 - Operating expenditure, Final Decision TransGrid transmission determination, AER, page 7-21

We note that similar acknowledgements of the limitations of the benchmarking results were also present in the 2014 version of the AER Annual Benchmarking Report:

> “
>
> **It should be noted that the ability to draw conclusions from the benchmarking of transmission networks within Australia may be limited by the number of networks and their diversity.**
>
> 2014 Annual Benchmarking Report, AER, page 17

and

> “
>
> **Given the relatively low number of observations caution should be exercised when interpreting the finding of this MTFP benchmarking.**
>
> 2014 Annual Benchmarking Report, AER, page 23

It is worth noting that any reference to the limitations of the MTFP analysis based on the small sample size have been removed in the 2015 version of the Annual Benchmarking Report. The 2015 version does, however, include a caution about using the results to compare networks, shown in the quote below. We do observe that the final sentence of the quote goes on to make a comparison, despite the caution.

> **In contrast to electricity distribution networks, where there has been a long history of benchmarking by international regulators, the benchmarking of transmission networks is relatively new. As a result, and because our models do not incorporate OEFs, the comparison of productivity levels between firms should be treated with caution. However the MTFP scores indicate that TasNetworks has relatively high productivity level compared to the other TNSPs.**
>
> 2015 Annual Benchmarking Report, AER, page 13

Whilst the use of benchmarking has been prominent in the recent NSW and ACT distribution determinations, its limitations in the context of benchmarking Transmission networks meant that it was only applied contextually in TransGrid's determination. The sample size available in transmission has obviously not grown and the MTFP model specification has not changed from 2014, yet the 2015 Transmission Annual Benchmarking Report omits many of the 2014 version caveats and acknowledgements of the limitations inherent in the results. Comparison of the 2014 and 2015 Annual Benchmarking Reports appear to suggest growing AER confidence in the MTFP model and results. The following quotes from the 2014 and 2015 reports respectively highlight the shift in thinking. In 2014:

> **We have not drawn conclusions on the relative efficiency of the transmission networks because the relative rankings observed are currently sensitive to the model specification. MTFP analysis is in its early stage of development in application to transmission networks. Further, there are only a few electricity transmission networks within Australia which makes efficiency comparisons at the aggregate expenditure level difficult.**
>
> 2014 Annual Benchmarking Report, AER, page 6

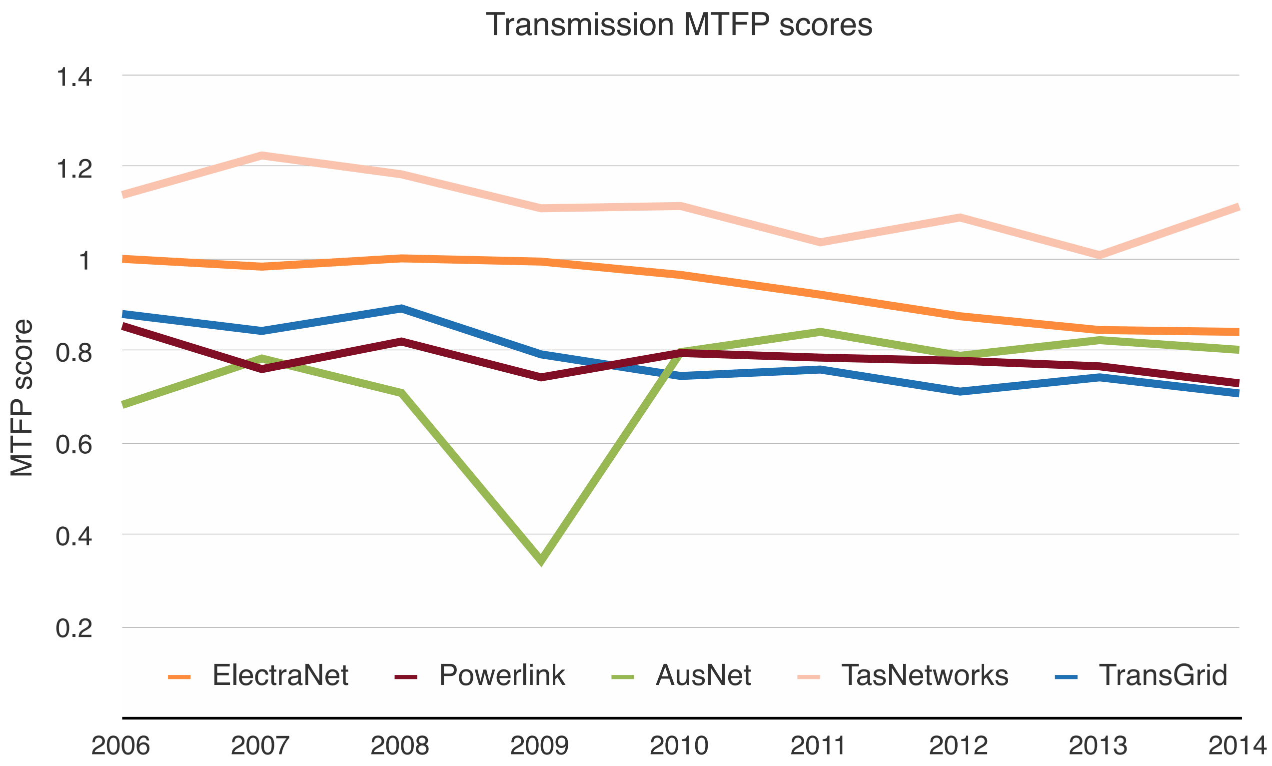
and in 2015:

> **MTFP is a sophisticated 'top down' technique that enables us to measure each TNSP's overall efficiency at providing electricity services...**
>
> **...The 'multilateral' method enables comparison of productivity levels and productivity trends. MTFP is the primary technique we use to compare relative efficiency in this report.**
>
> 2015 Annual Benchmarking Report, AER, page 4 and 6

The risk to a TNSP of this shift in thinking is that the MTFP results will be used to adjust a regulatory proposal forecast without appropriate consideration of the limitations of sample size and network diversity and unproven fitness for purpose of the current model specification to inform such an endeavour.

TNSPs are likely to be benchmarked against themselves over time

The small population of comparator firms, ongoing concerns over the MTFP model specification and need to take into account the differences in operational environment are all reasons why the MTFP results are limited in informing comparisons between networks. This is particularly the case given ElectraNet and TasNetworks - the two smallest networks, benchmark significantly better than PowerLink and TransGrid - the two largest networks. The results of the AER's MTFP benchmarking analysis are included below.



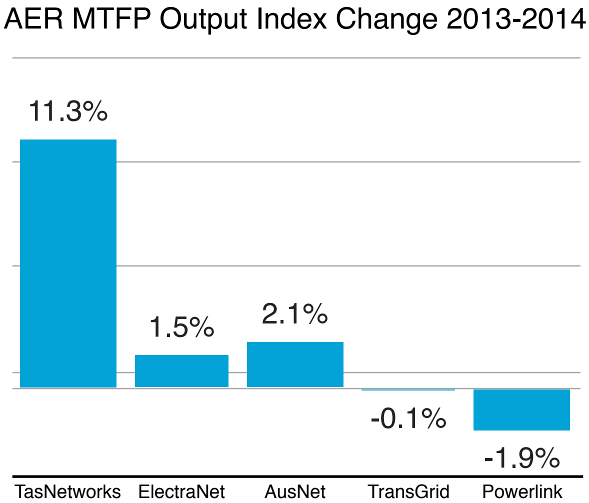
In addition to the observation that network size appears to be a factor in the benchmarking results, the performance of AusNet Services in 2009 indicates the sensitivity of the benchmarking results to changes in the measure of reliability year on year.

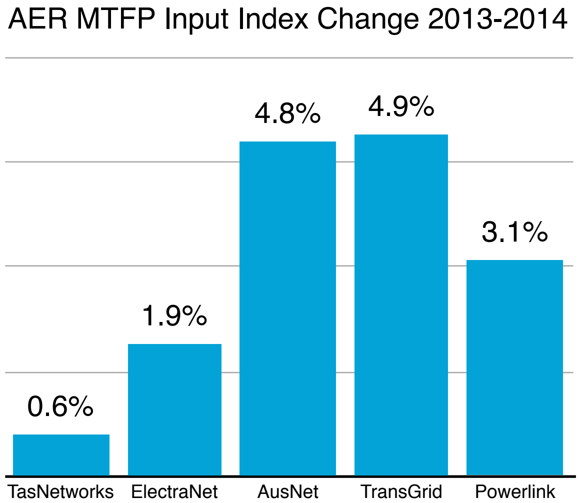
Notwithstanding the limitations of using MTFP to compare networks, the AER suggests that it will use the change in results over time to evaluate TNSP productivity. The AER made comment on the change in MTFP results over the 12 months between the first and second Annual Benchmarking Reports:

> **The last column in Table 1 shows the only TNSP who has improved its productivity between 2013 and 2014 is TasNetworks. All other TNSPs' MTFP performance declined in 2014. Both Powerlink and TransGrid had the largest declines in productivity with falls of 4.9 and 4.8 per cent respectively. AusNet Services had a decline of 2.5 per cent and ElectraNet had a marginal decline of 0.4 per cent.**
>
> 2015 Annual Benchmarking Report, AER, page 15

Significant care must be taken when making observations such as the change in an MTFP score from year to year. The AER's observation that only TasNetworks has "improved its productivity" and that "Powerlink and TransGrid had the largest declines in productivity" must be considered in the context of what the MTFP model is capable of measuring. It is certainly not cost efficiency; and it is only productivity to the extent that one accepts that the model specification represents the appropriate outputs of a transmission network.

Consider the drivers of the changes to the MTFP score across years. Between 2013 and 2014, the change in MTFP scores can be broken down into the changes in the input index and the output index. The graphs below show the changes in these indices for each network.





As shown, TasNetworks performs well in terms of annual improvement of its MTFP result due to the significant increase in its output index relative to a small change in its input index. Powerlink, by comparison, had the most negative change in output index and a relatively moderate increase in input index. The contribution of output index change year on year to the change in MTFP results highlights the caution that must be taken when interpreting MTFP results. The most significant changes in the output index variables for TasNetworks and Powerlink were energy transported and energy unserved. The table below outlines the respective changes to these variables for the two networks.

Network	Variable	2013 Value	2014 Value	Change
TasNetworks	Energy Transported (GWh)	12,866	13,360	3.8%
	Unserved Energy (GWh)	535	102	-80.9%
Powerlink	Energy Transported (GWh)	49,334	47,614	-3.5%
	Unserved Energy (GWh)	34	272	700.0%

One would not expect a short term change in cost from annual fluctuations in the amount of energy transported across a fixed asset or the amount of energy unserved year to year. The significance of the changes in these two variables to the change in MTFP results highlights again the importance of understanding the basis for changes in measures such as MTFP and the limitations on using results from such models for particular purposes.

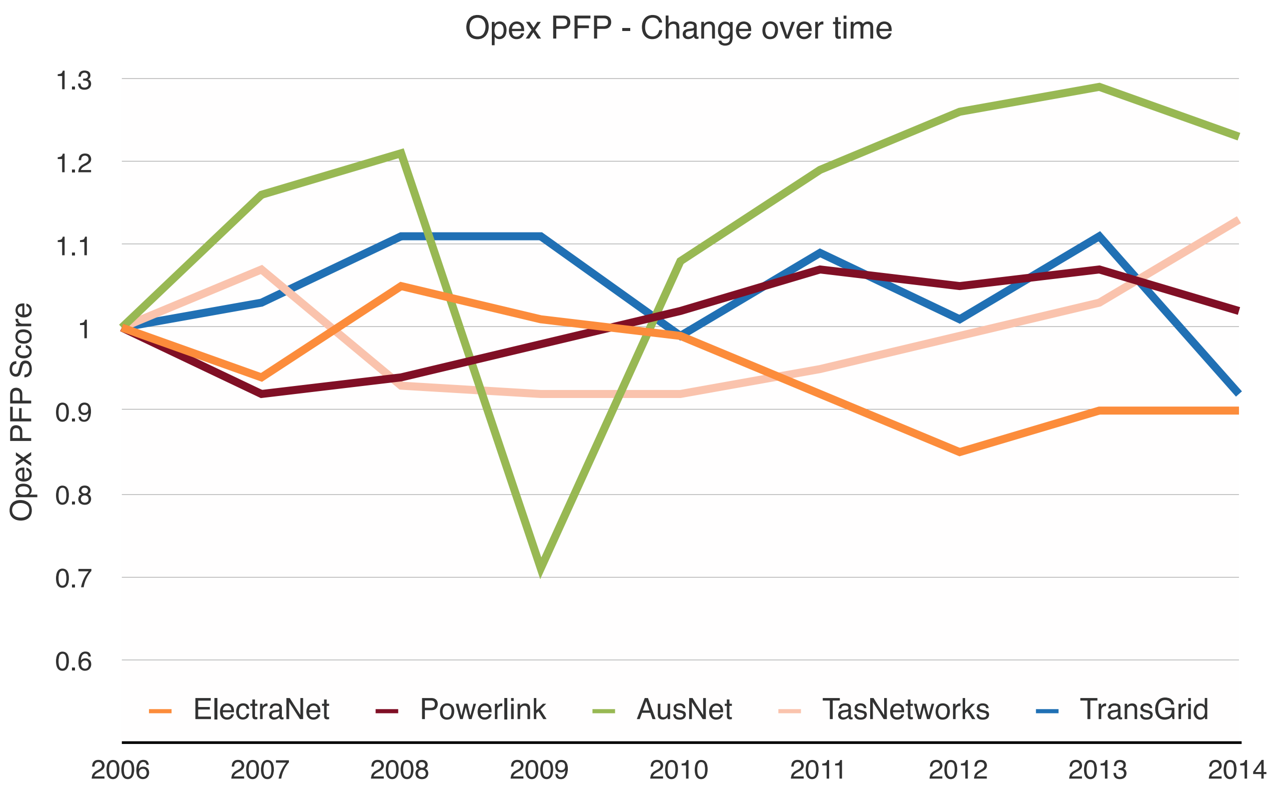
Finding an opex benchmarking framework for Powerlink

Notwithstanding the limitations of benchmarking, some metrics are better than others, and as suggested in the previous section, movement over time is a reasonable indicator of change. To benchmark Powerlink's historic opex we used the following techniques:

1. Analyse the AER's Opex PFP model over time;
2. Analyse Partial Productivity Indicators - relative and over time; and
3. Consider the signals of efficiency against environmental factors and other circumstances.

Opex PFP over time

The AER acknowledges that Opex PFP comparisons across businesses is problematic. As such, we considered the change in Opex PFP over time. The graph below show the change over time normalised to one at the starting point (2006).

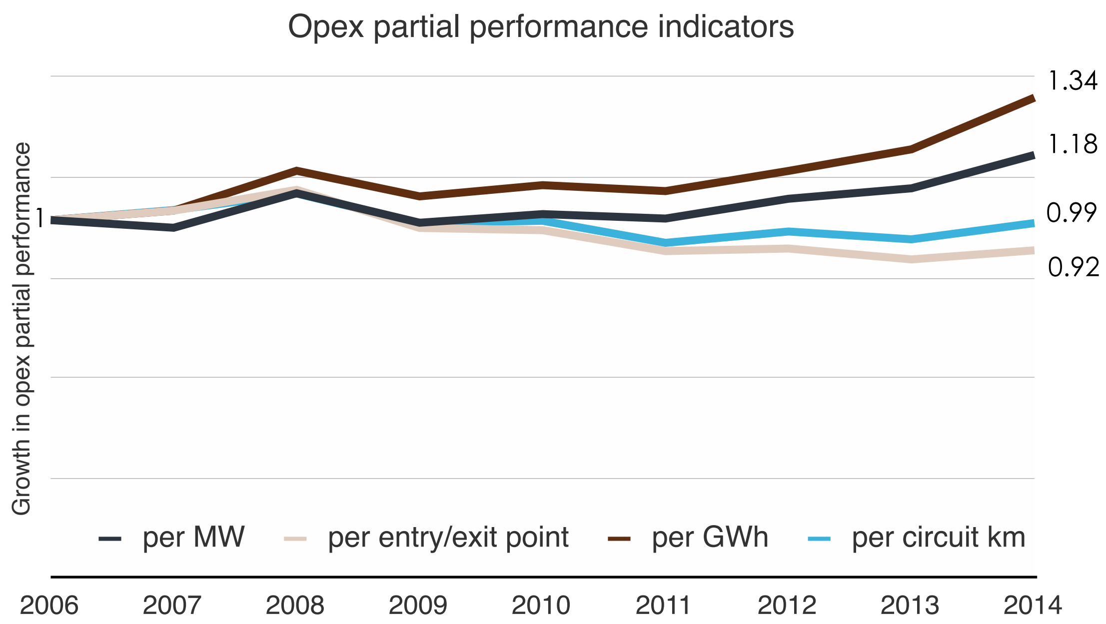


As shown, Powerlink is one of the three businesses to improve Opex PFP in 2014 from 2006. After the early years where Powerlink's Opex PFP declined relative to its starting point and Transgrid, it has improved in recent years to be equivalent or higher than Transgrid.

These results must be treated with caution. As noted earlier, the output variables in the AER model specification are not necessarily good indicators of the requirements for opex. There are limitations in what conclusions can be drawn about cost or efficiency performance where changes in performance are driven by changes in more volatile outputs or those not directly related to the activities that incur costs (such as unserved energy).

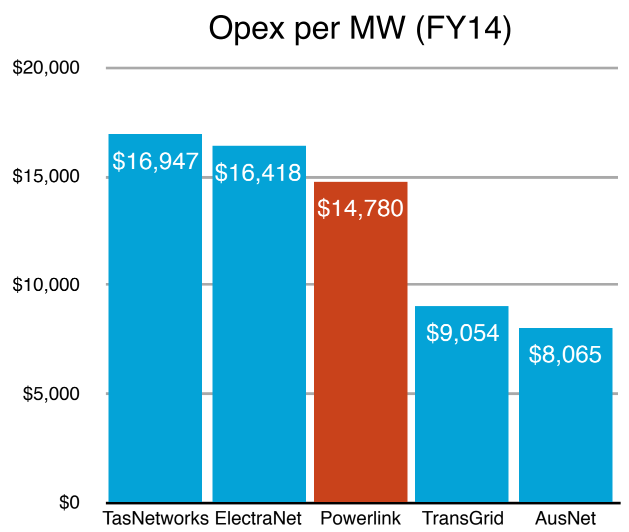
Partial Productivity Indicators

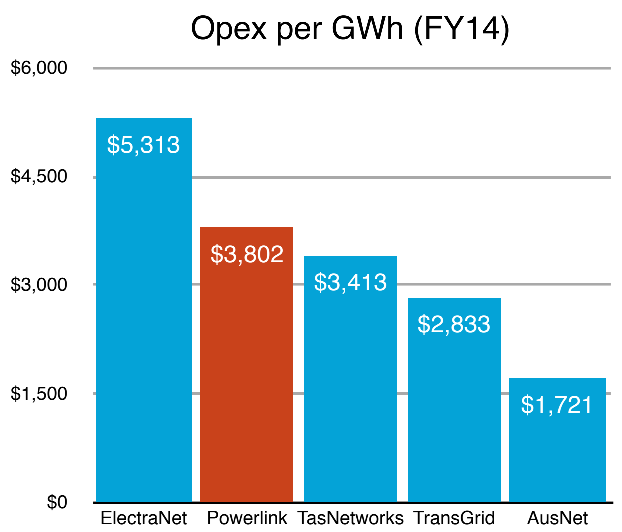
Whilst PPIs can be limited in explanatory value, the advantage is that categories of opex can be matched with the most appropriate variables as the denominator. As shown below, dividing opex by the four output variables of the AER MTFP model for Powerlink indicates that opex per circuit length and weighted voltage of exit and entry points has reduced, whilst opex per MW of peak and GWh of energy have increased over time.



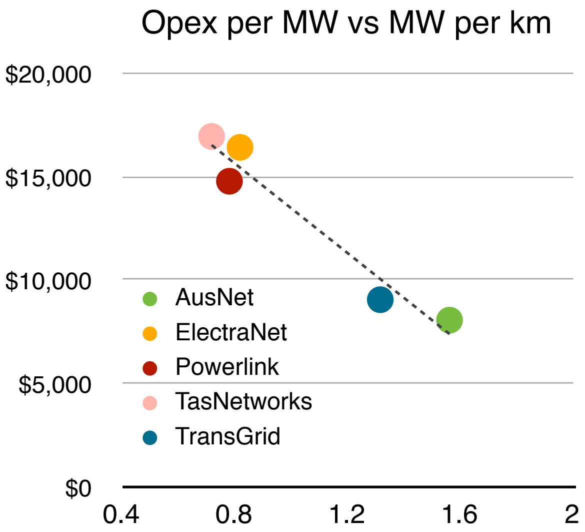
This diagram illustrates the issue with using variables that are not suitable proxies for cost. Performance against peak demand and energy consumption has declined, because there has not been (and would not expect to be) a decrease in opex associated with the reduction in demand and consumption (on the basis that this decline has not materially reduced the requirement to maintain and operate the existing asset base).

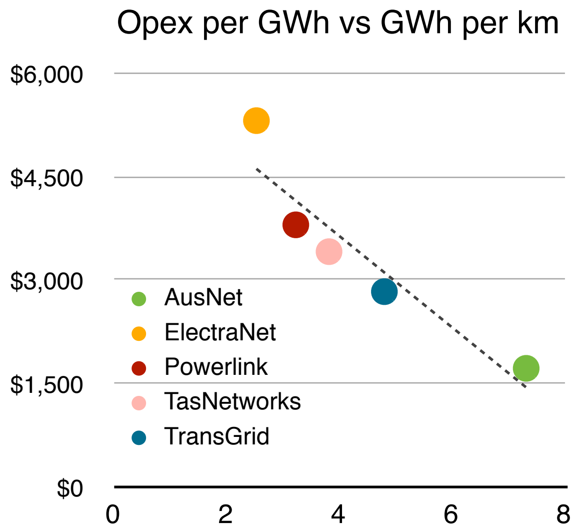
Most opex is spent on either maintaining the network and vegetation adjacent to it, or is embedded in fixed overhead costs such as control rooms and corporate services. Demand and energy usage are not useful comparators for these costs. On the simple ratios, there appears to be a broad range of opex results for the transmission networks, as shown below.



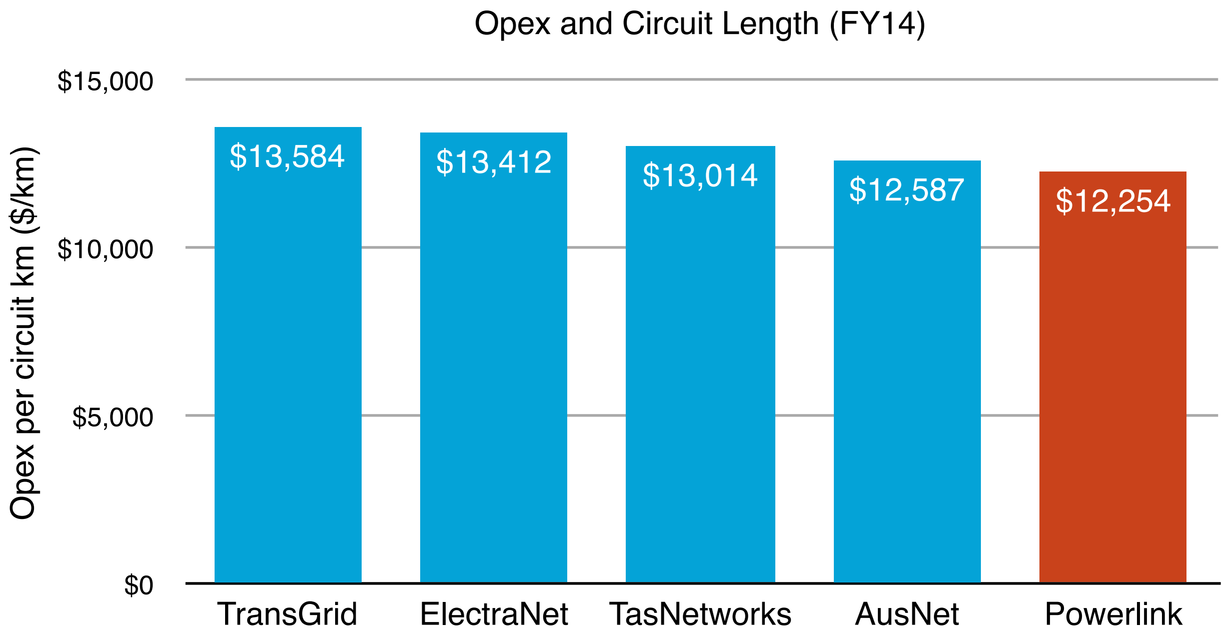


However when these results are considered in terms of the load density (and energy density) metrics raised earlier, it can be seen that there is very little difference in networks in this context.





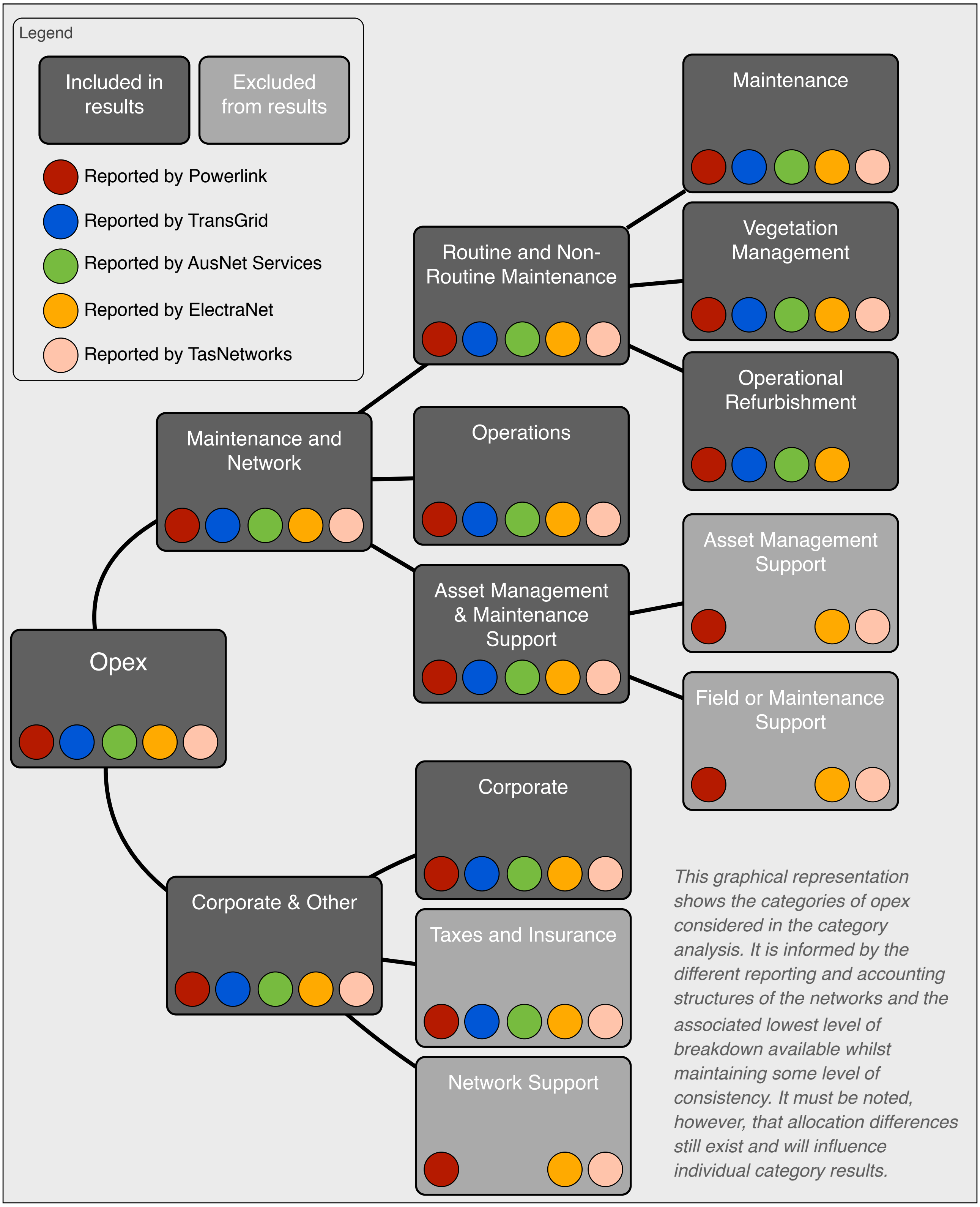
Unlike opex indicators that use energy usage and load as denominators, the amount of opex spent per kilometre of network is very similar across the states.



Other partial productivity indicators, as averages over the period and in the context of environmental variables are shown on the following pages.

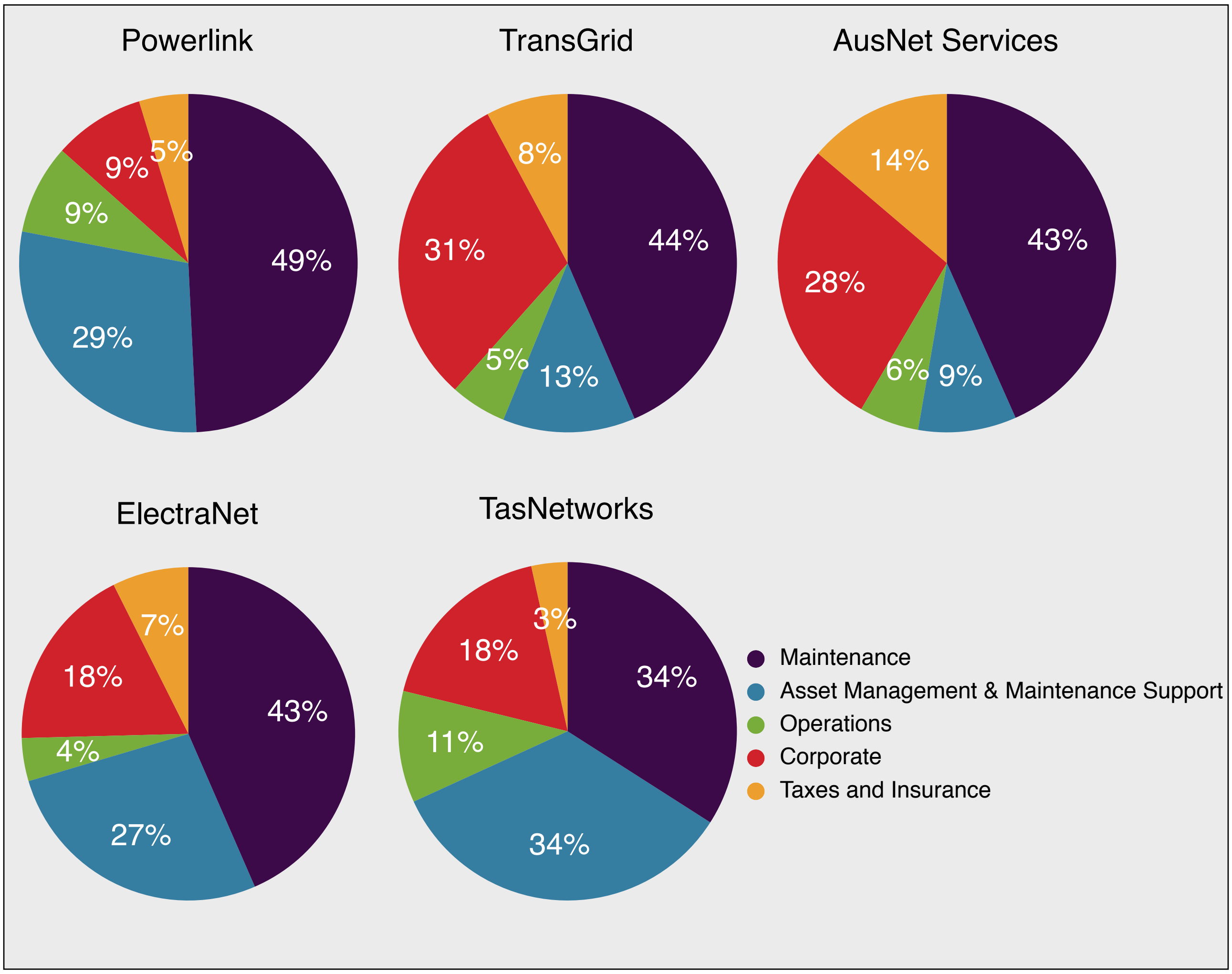
Category Analysis

To determine whether there are any anomalous areas of cost in Powerlink's operating expenditure performance, disaggregated category analysis has been used to compare Powerlink to its peers. The following analysis uses the most appropriate determinants of each cost category to compare costs. The presentation of the analysis is ordered in accordance with the category contribution to total opex, which is broken down below.



This graphical representation shows the categories of opex considered in the category analysis. It is informed by the different reporting and accounting structures of the networks and the associated lowest level of breakdown available whilst maintaining some level of consistency. It must be noted, however, that allocation differences still exist and will influence individual category results.

To highlight the differences in cost allocation and categorisation across the networks, the following graphic depicts the contribution of each primary opex category to the total opex based on the past six year average costs.

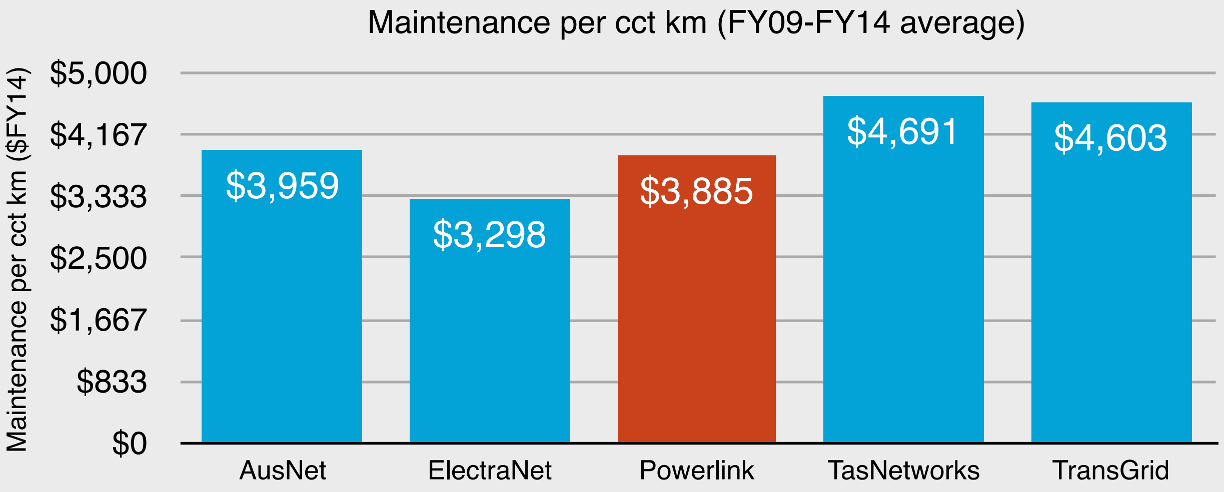


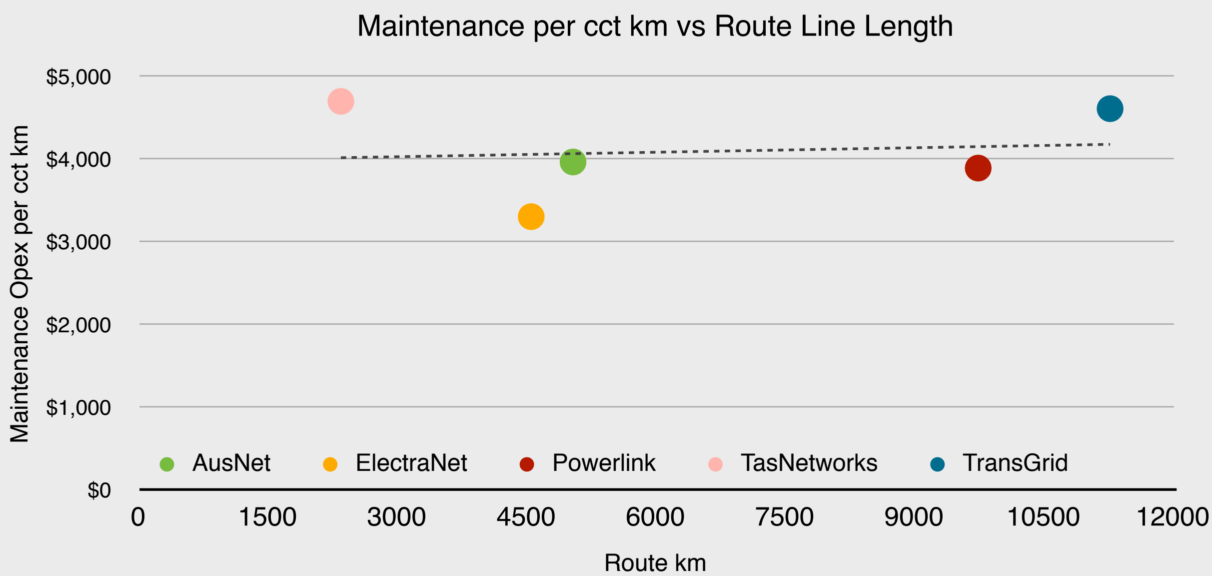
As shown, there are significant differences in the proportion of opex allocated to Asset Management and Maintenance Support and Corporate Costs across networks. Whilst this can partly be attributed to scale (corporate costs include many fixed costs and will be a higher proportion for smaller networks such as ElectraNet and TasNetworks) it can also be attributed to cost allocation. For example, of the three larger networks, those that have a high proportion of corporate costs have a low proportion of asset management and maintenance support costs and vice versa. This must be kept in mind when viewing disaggregated opex measures. The mapping used to allocate the various network RIN reported costs into common categories is shown in Appendix 1.

Each of the opex categories and subcategories identified in the previous pages are analysed over the following pages. For each category and subcategory we have selected a primary cost driver as the metric denominator for comparison and a primary environmental factor to test normalisation across networks. We have also re-aggregated some of the cost categories to account for misalignment of allocations across networks when opex is broken down to too low a level of detail.

Routine and Non-Routine Maintenance Costs

Maintenance opex is the largest category of opex and includes routine and non-routine maintenance conducted by a combination of Powerlink staff and contractors. The actual asset base and condition, maintenance strategies, outsourcing arrangements and depot locations will all influence maintenance costs, but are also reasons that the comparison of costs cannot be used to directly infer efficiency or productivity. At the highest level, Powerlink's maintenance costs are closest to AusNet per circuit kilometre basis. We have excluded major operating project/operational refurbishment costs from the analysis to ensure that maintenance opex includes only comparable activities and not refurbishment projects which are less consistent across networks and time. Note that TasNetworks data does not isolate theses costs from maintenance.





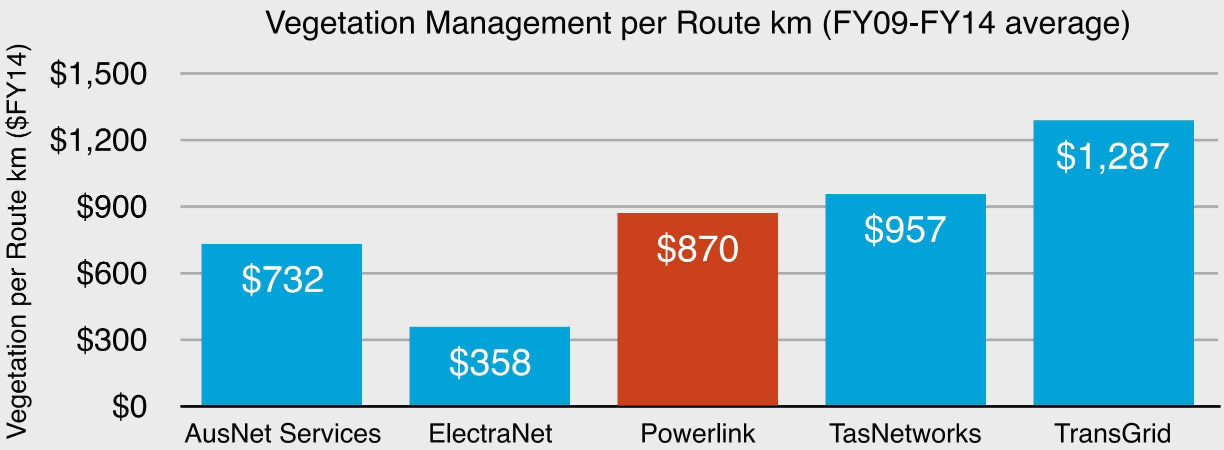
Considering that the data did not allow adjustment of TasNetworks opex for any refurbishment projects it may have in its maintenance costs, there is some relationship between the maintenance costs per circuit kilometre and the route kilometres (as a metric of physical scale) for each network. In any case, at the disaggregated level the variation in costs per circuit kilometre is not material (given errors present through allocation differences) and therefore not sufficient to say that there is any difference in efficiency in these costs.

Vegetation Management Costs

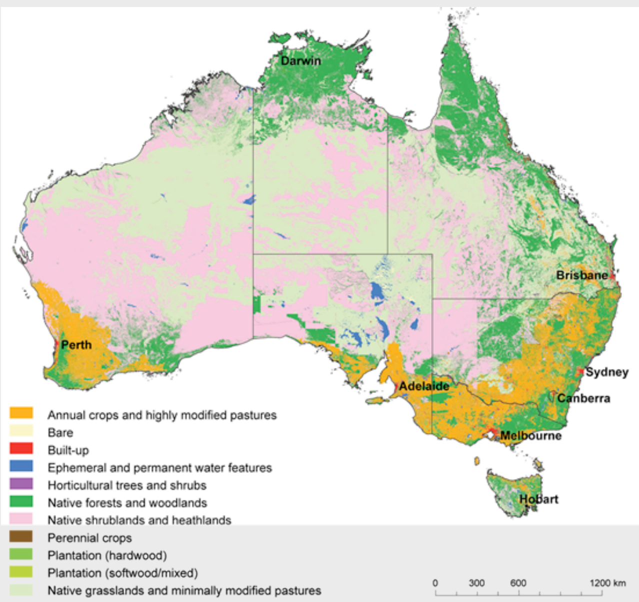
The best variable to view vegetation management costs by is the route kilometres associated with the network, however comparison across businesses is complicated by a number of factors, including:

- Different vegetation types, locations and climates.
- Different vegetation management standards.
- Different divisions of responsibility between networks, DNSPs, landowners and councils.

ElectraNet and TasNetworks are examples of networks operating in states with very different vegetation conditions. With its coastal location and warmer climate, Powerlink could be expected to experience higher vegetation growth rates than its southern counterparts. Factors such as accessibility, prevalence of national parks, etc. must also be considered.



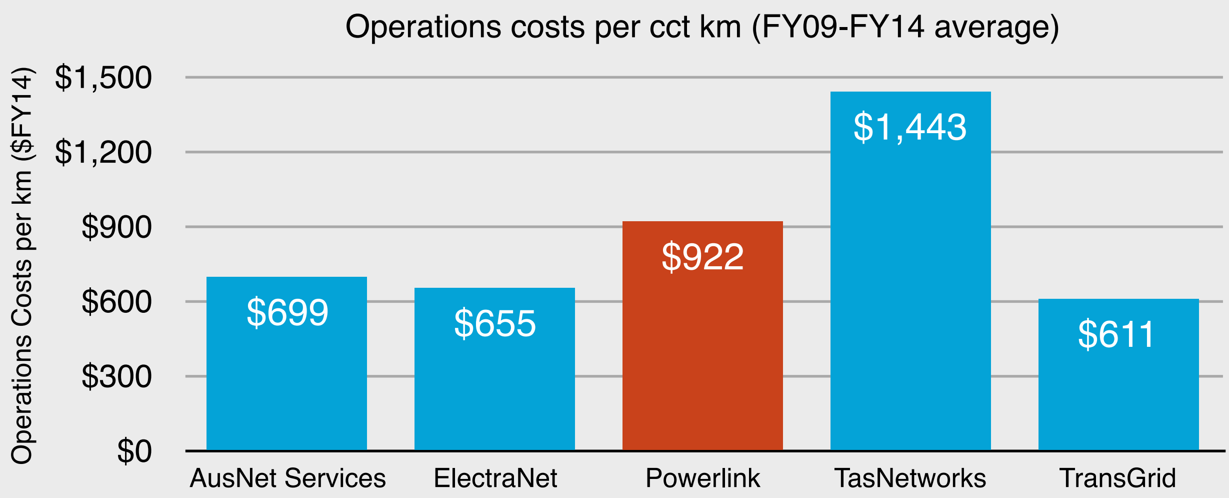
There is no single index or variable that appropriately captures the variation by state in vegetation that would cause differences in vegetation management costs, but the image below highlights the states where highly populated areas correlate with cleared/crop land (SA and Vic) and others where native forests and plantations coincide with highly populated areas (Tas and coasts of NSW and QLD).

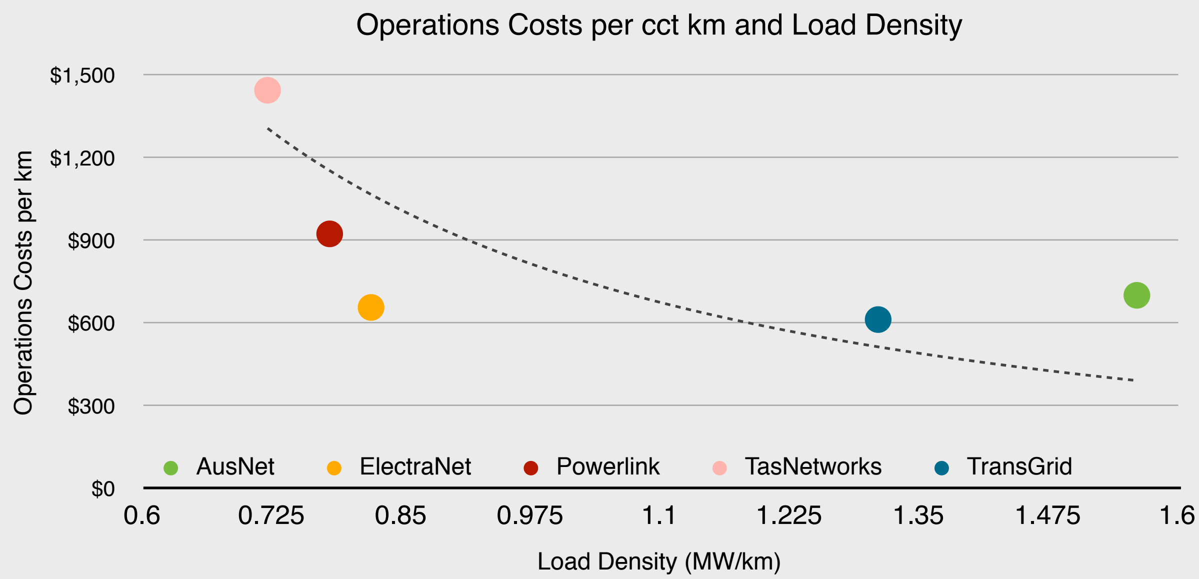


Source: Australian Bureau of Agricultural and Resource Economics and Sciences

Operations Costs

Operations costs include the network control and monitoring and systems operations costs for each network. Operations opex is difficult to benchmark definitively due to the combination of both fixed (e.g. control room) and variable (systems operations) costs included in this category. The analysis below shows that per circuit km, TasNetworks and Powerlink spend more on operations opex than the other networks.

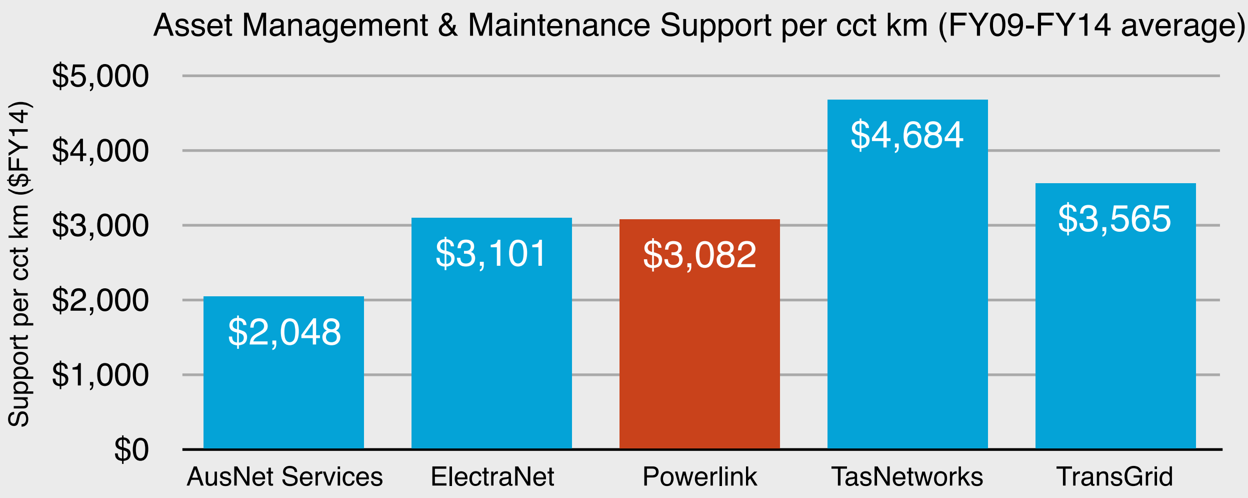




Whilst there is evidence that the networks with lower operations opex per cct km also have the highest load density, the magnitude of the difference in costs suggests that there is a significant difference in the allocation of operations costs across businesses and/or other material factors are driving these costs.

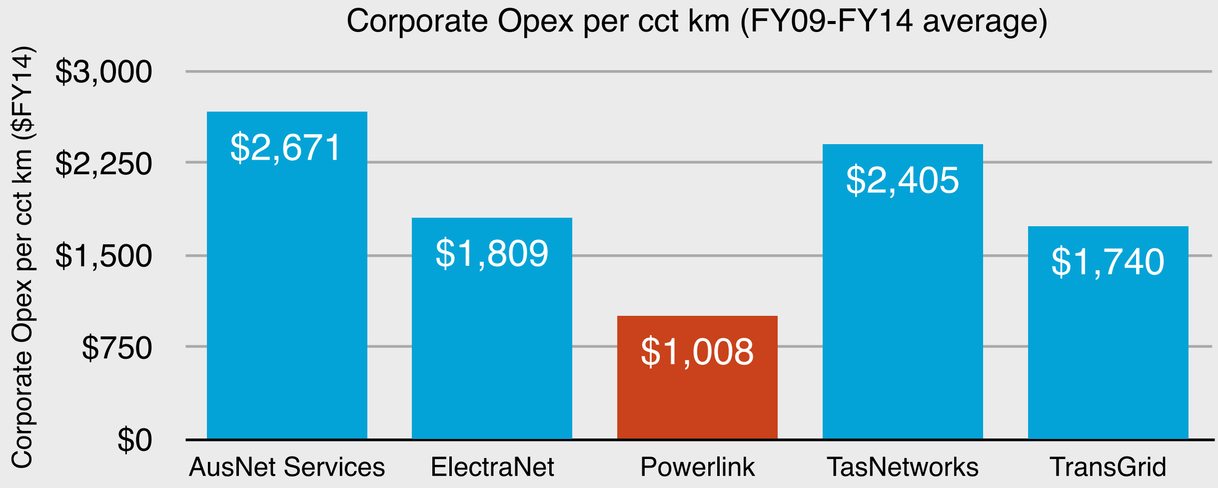
Asset Management and Maintenance Support

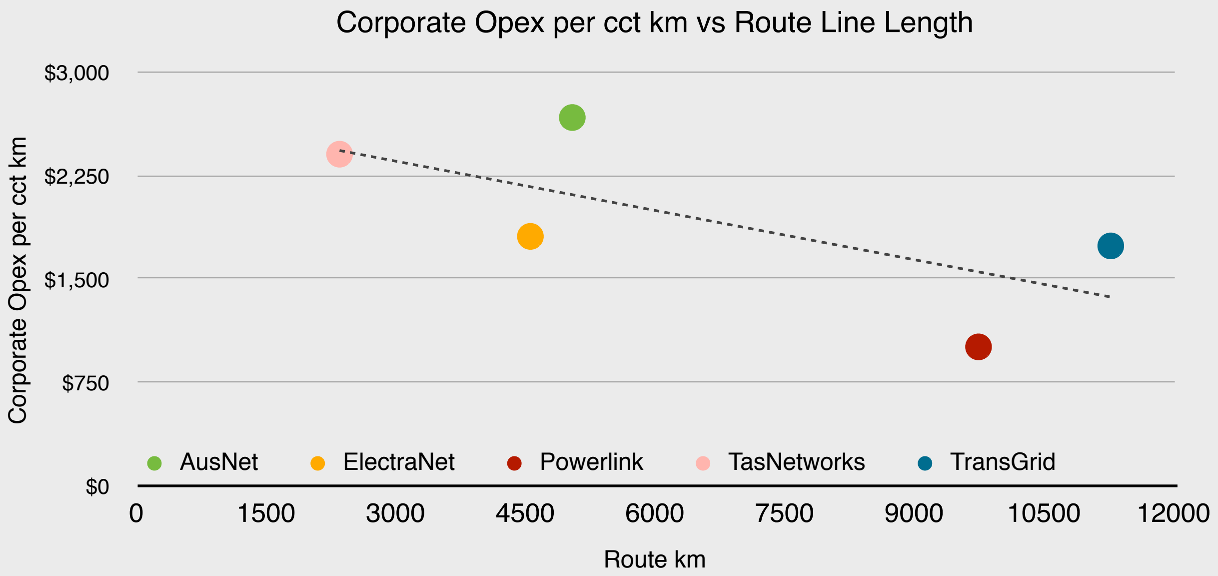
Asset Management and Maintenance Support includes asset management planning, maintenance policy management and scheduling, and other engineering and maintenance support activities. The asset scale and complexity drives many of these costs, and as shown below (using circuit km as a denominator) these support costs generally decrease with scale. It is worth noting in the below analysis that AusNet Services share many of these costs with its distribution business and also rely on AEMO to do some of its planning.



Corporate Costs

Corporate costs include HR, Finance, Regulatory and other business support functions. The extent of capitalisation will influence the difference in corporate opex across businesses as will the variation in cost allocation methodologies. As shown below, Powerlink has the lowest corporate opex cost per cct km in the industry due to its larger scale and allocation of cost differences. Whilst there would be some diseconomies of service area associated with Powerlink's network, it would also benefit from economy of scale, given that many corporate opex costs have a significant fixed component (e.g. regulatory function).





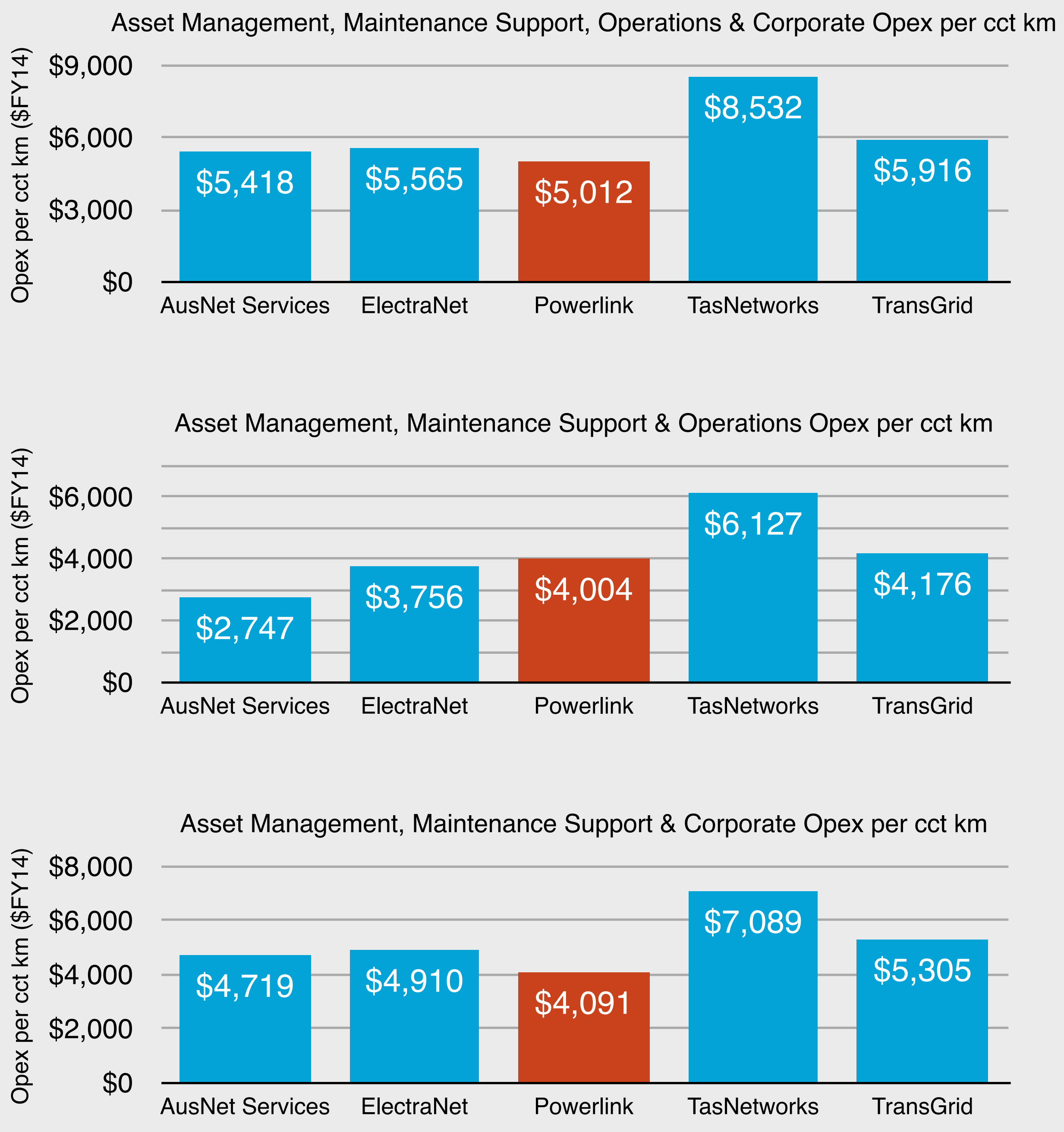
As shown above, there is some relationship between lower corporate costs and the longer networks (as a proxy for scale).

As discussed earlier in this report, variation across businesses in the allocation of costs between Operations opex, Asset Management and Maintenance Support, and Corporate opex limits the comparability of partial index benchmarks at this disaggregated level. To counter the misalignment (which increases as opex is divided into lower levels of disaggregation), we also tested:

1. Combined Asset Management and Maintenance Support, Operations and Corporate Support opex;
2. Combined Asset Management and Maintenance Support and Operations opex; and
3. Combined Asset Management and Maintenance Support and Corporate opex.

The results are shown below. As shown, the more aggregated the costs, the more closely they align to scale.

Combined cost metrics



Category Analysis Summary

The benefit of breaking down opex into categories is that more suitable variables - ones that are more closely correlated with the conditions that drive that category of opex - can be selected for each category. The limitation of the analysis is that relative inefficiency can be incorrectly inferred when in fact the variation across businesses may be driven by different cost allocations across opex categories or variations in the suitability of the chosen variable to describe opex for each business. Given that each business spends very similar amounts of opex for every circuit kilometre of network that they manage, and at the category level there are more and less favourable metrics for each business, there is no evidence that Powerlink's historic opex is inefficient. In summary:

- Powerlink's total opex per circuit kilometre is the lowest in the NEM.
- Powerlink's maintenance opex on a per circuit kilometre basis is amongst the lowest in the group (only ElectraNet has a lower rate) when operational refurbishment costs are removed. There is a broad range of refurbishment costs included in maintenance opex across the networks, indicating very different allocation strategies which makes comparison difficult if these costs are not excluded.
- Powerlink's vegetation management per route kilometre is around the industry average.
- Powerlink's operations costs are higher than its peers (with the exception of TasNetworks). Lower load density would explain some of the variation in costs, but there are also likely to be other causes of variation of opex performance across networks for this category.
- Powerlink's corporate opex is at the lower end of the industry range, aligned closely with TransGrid.
- Powerlink's non-network opex on a per route kilometre basis is higher than its peers, but on a per employee basis it is in line with expectations of a smaller customer base and/or less densely populated service area.

Powerlink's large service area, highly radial network, low load density and sparsely populated customer base are all factors that will influence Powerlink's opex. Given the existence of these factors, the limitations of category analysis benchmarking and indications at the total and disaggregated level of opex, there is no reason evident in the analysis to suggest that Powerlink's historic opex is inefficient.

Powerlink historic opex efficiency conclusions

Notwithstanding the limitations of benchmarking, businesses and the regulator must understand the opex efficiency performance of the networks relative to peers and historically as the basis for the forecast opex for the next period. We consider;

- Powerlink's Opex PFP performance has improved since 2006.
- Powerlink's opex performance relative to the more stable outputs of circuit length and weighted average voltage of exit and entry points has improved; the fall in peak demand and energy transported - which are beyond Powerlink's control and also do not provide the opportunity to reduce opex - have impeded further improvement in opex partial factor productivity performance.
- Powerlink's opex performance is similar to peers when important environmental factors such as load and energy density, population density and service area are considered.
- At the category analysis level there is no suggestion that Powerlink's opex is materially inefficient relative to its peers - just differently distributed across categories.

Setting a Target Base Year Opex

This section includes consideration of an efficient base year opex for Powerlink.

4

Base year opex efficiency testing challenges

Given the limitations of the AER's benchmarking models in setting efficient opex and the lack of suitable comparator businesses, setting an efficient amount of base year opex remains challenging for transmission networks in Australia. We note that in lieu of a definitive method of calculating individual network efficiency, the AER defaulted to the absence of evidence of *inefficiency*:

> **We have no evidence to suggest that TransGrid's revealed base year expenditure is materially inefficient. In arriving at this conclusion we had regard to the results of various benchmarking analysis. On the whole, our benchmarking analysis for TransGrid is inconclusive.**
>
> Draft decision: TransGrid transmission determination 2015-18, Attachment 7 - Operating Expenditure, AER, page 7-33

We consider from the information included in this report that a similar lack of evidence of exists to demonstrate any material inefficiency in Powerlink's revealed opex. Further, we believe that in comparison to TransGrid and in the context of the environmental factors faced (particularly capitalisation differences) there is further evidence that Powerlink is operating at least with the efficiency of its peers.

An analysis framework for base year opex efficiency

Despite the lack of evidence of material inefficiency in Powerlink's revealed costs, we consider that an opex target should be set. Powerlink already achieves the lowest opex per km of network in the NEM, and as shown in previous analysis it is unllikely that Powerlink will meet the opex per MW or GWh of TransGrid, for example, due to load and energy density differences driven by geographic and demographic factors.

Whilst the Opex PFP model has its limitations, and is volatile to changes in variables not directly related to opex, such as reliability, it provides a reasonable baseline for measurement over time. We considered three approaches to finding a suitable range for base year opex using the Opex PFP model.

1. Setting the target by applying the industry growth rates from the benchmarking model used in NSW and a 2013/14 starting point;
2. Setting the target by deducing the opex required in FY15 to match the average productivity score over the current period;
3. Using the historical trend of opex.

The results are shown in the next section.

Base year opex range for FY15

The AER analysis runs over the period 2006-13. Over this period, the Opex PFP has changed significantly. This is partially due to structural changes to businesses, falling demand, volatility of variables that don't necessarily represent opex and other limitations of the modelling.

Assuming a Powerlink base year of FY2015, we applied the three approaches outlined above to come up with opex estimates. The results are shown in the following sections.

Projecting the AER model forward

The AER model used in the NSW decision was applied up to 2013 and had the following growth rate attributes:

1. 0.36% for output growth; and
2. 0.86% for productivity.

In Queensland, Energex and Ergon Energy both have higher output growth rates (1.21% and 1.36% respectively) than the NSW distribution networks (Ausgrid 0.78%, Endeavour Energy 1.09% and Essential Energy 0.43%). As such, we expect that Powerlink would have a higher output growth rate than TransGrid. Using the 2006 to 2014 data, we can estimate the historical Powerlink output growth rate at **2.05%** per annum. To calculate an annual rate of change, we can use the difference between the output growth rate and the Fisher Productivity Index for Powerlink. The annual growth rate of the Fisher Index for Powerlink over 2006 to 2014 was **0.35%** per annum. As such, Powerlink's annual rate of change is 1.7% per annum.

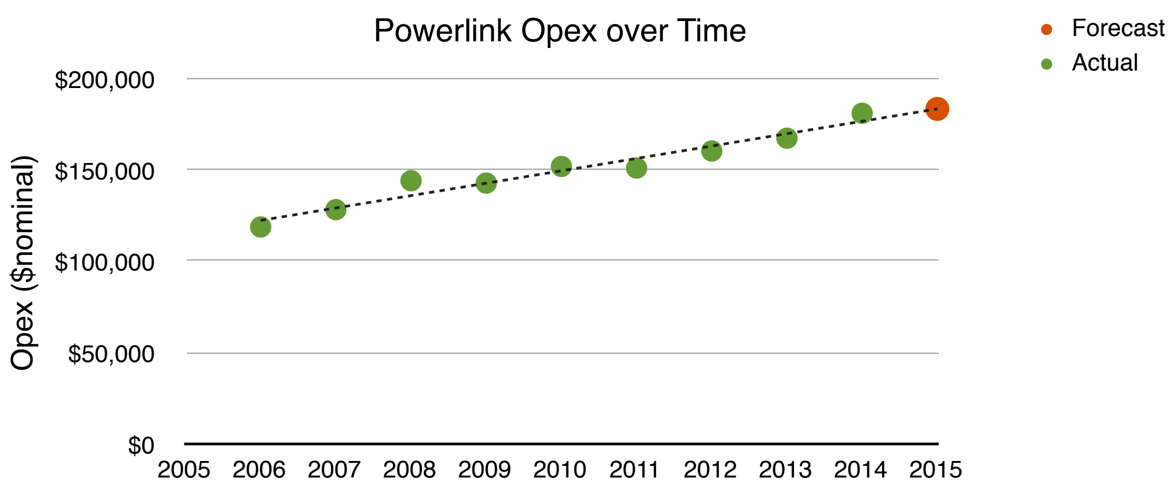
Using these rates to escalate the FY2014 opex of Powerlink forward to FY2015, we calculate a base year opex of **$184.1 million** (in $FY14). This value is without consideration of base year adjustments.

Matching current period productivity

The other method used for estimating efficient base year opex in FY2015 was to determine the level of opex required to match the average productivity score from the Opex PFP model in the current period. This process involved solving the opex requirement for FY2014 using the average productivity score over the period 2011 to 2014 and escalating it forward to FY2015. The value of base year opex found using this method was **$177.9 million** (in $FY14).

Using historical opex trends

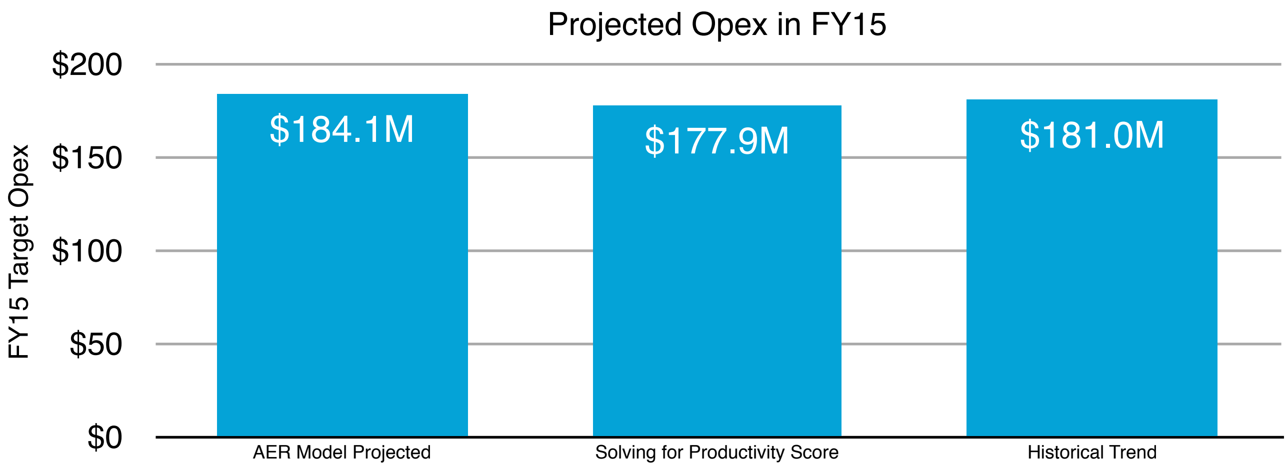
Powerlink's historic opex between 2006 and 2014 is shown below with a trendline extending to 2015.



Using historical trends (of nominal opex), Powerlink's FY15 opex would be $183.4 million in FY15 dollars. This is approximately **$181 million** in FY14 dollars.

Base year opex summary and conclusion

The values of opex in FY15 for each of the three approaches outlined in this section are shown below.



With nothing to suggest that Powerlink's historic opex is inefficient, an FY15 opex of between $177.9 million and $184.1 million should be considered an efficient starting point. Note that this range excludes any step changes or non-recurrent costs that have occurred in FY14 or FY15.

Opex Category Mapping

Appendix 1

TNSP	Opex Category	Map To (First order):	Map To (Second order):
AusNet Services	Maintenance - Secondary Systems	Maintenance	Maintenance
	Maintenance - Substations	Maintenance	Maintenance
	Maintenance - Lines	Maintenance	Maintenance
	Maintenance - Communications	Maintenance	Maintenance
	Maintenance - Easements	Maintenance	Maintenance
	Maintenance - Asset Management Support	Asset Management Support	Asset Management and Maintenance Support
	Operations	Operations	Operations
	OHS	Corporate	Corporate
	Taxes and Charges	Taxes	Taxes and Insurance
	Insurance	Insurance	Taxes and Insurance
	Asset Works Program	Operational Refurbishment	Maintenance
	Asset Works Program - Asset Management Support	Field or Maintenance Support	Asset Management and Maintenance Support
	Finance	Corporate	Corporate
	HR	Corporate	Corporate
	IT	Corporate	Corporate
	Other	Asset Management and Maintenance Support	Asset Management and Maintenance Support
	Management Fee	Corporate	Corporate
	Self Insurance Costs	Insurance	Taxes and Insurance
	Inventory Adjustment	Other	Other
	Availability Rebate	Other	Other
	Easement Tax	Easement Tax	Other
ElectraNet	Maintenance Communications	Maintenance	Maintenance
	Maintenance Lines	Maintenance	Maintenance
	Maintenance Secondary Systems	Maintenance	Maintenance
	Maintenance Substations	Maintenance	Maintenance
	Maintenance Easements	Maintenance	Maintenance
	Field Support	Field or Maintenance Support	Asset Management and Maintenance Support
	Operations	Operations	Operations
	Asset Manager Support	Asset Management Support	Asset Management and Maintenance Support
	Insurance	Insurance	Taxes and Insurance
	Corporate Support	Corporate	Corporate
	Network Support	Network Support	Network Support
Powerlink	Field Maintenance - Routine	Maintenance	Maintenance
	Field Maintenance - Condition-based	Maintenance	Maintenance
	Field Maintenance - Corrective	Maintenance	Maintenance
	Maintenance Support	Field or Maintenance Support	Asset Management and Maintenance Support
	Refurbishment	Operational Refurbishment	Maintenance
	Insurance Premiums	Insurance	Taxes and Insurance
	Self Insurance	Insurance	Taxes and Insurance
	Network Operations	Operations	Operations
	Asset Management Support	Asset Management Support	Asset Management and Maintenance Support
	Corporate Support	Corporate	Corporate
	Revenue Reset	Corporate	Corporate
	Debt Management Costs	Other	Other
	Grid Support	Network Support	Network Support
TasNetworks	Field Operations and Maintenance	Maintenance	Maintenance
	Transmission Services	Field or Maintenance Support	Asset Management and Maintenance Support
	Transmission Operations	Operations	Operations
	Asset Management	Asset Management Support	Asset Management and Maintenance Support
	Corporate	Corporate	Corporate
	Network Support	Network Support	Network Support
	Insurance	Insurance	Taxes and Insurance
	Self-Insurance	Insurance	Taxes and Insurance
TransGrid	Maintenance - Lines	Maintenance	Maintenance
	Maintenance - Substations	Maintenance	Maintenance
	Maintenance - Communications	Maintenance	Maintenance
	Maintenance - Secondary Systems	Maintenance	Maintenance
	Maintenance - Land & Easement	Maintenance	Maintenance
	Maintenanace Support and Asset Management	Asset Management and Maintenance Support	Asset Management and Maintenance Support
	Operations / Control Room	Operations	Operations
	Grid Planning	Asset Management and Maintenance Support	Asset Management and Maintenance Support
	Taxes & Insurance	Taxes and insurance	Taxes and insurance
	Property Management	Corporate	Corporate
	Corporate and Regulatory Management	Corporate	Corporate
	Business Management	Asset Management and Maintenance Support	Asset Management and Maintenance Support
	Other Opex	Asset Management and Maintenance Support	Asset Management and Maintenance Support

Team Member CVs

Appendix 2

Jamie **Blair,** B.Eng (Chem)

Role: Project Lead

Jamie is a Director of Huegin Consulting Group and our project lead and electricity benchmarking expert. Jamie has significant experience in cost analysis and benchmarking in the electricity industry and often presents Huegin's work at industry conferences and academic forums. Jamie has extensive asset management experience, both in industry and consulting.

Relevant Skills

	Industry benchmarking
	Performance assessment
	Regulatory support, including revenue proposal analysis and review
	Risk management
	Safety reporting
	Maintenance and cost modelling
	Analytical decision support and statistical analysis

Relevant Experience

Jamie is an experienced engineer and consultant with specific expertise in the areas of investment analysis, cost analysis and performance benchmarking. His work is primarily for clients who own, manage or operate large physical assets. Relevant experience includes:

- Led over twenty independent benchmarking studies of domestic and international electricity networks.
- Facilitated the corporate strategic planning of an electricity distribution business and a utilities maintenance organisation.
- Developed the asset management frameworks for a major transport infrastructure manager and a large Defence weapons logistics management organisation.
- Led the analytical review of five recent regulatory determinations on behalf of network service providers.
- Developed and implemented the investment decision support framework and systems of a large network operator.
- Developed and implemented the investment decision support framework and systems of a ports operator.

Professional Summary

Jamie Blair is a Director of Huegin Consulting. Jamie has 20 years of management and consulting experience across a number of industries including utilities, construction, military aviation, banking and finance and fast moving consumer goods.

Prior to joining Huegin in 2008, Jamie has worked in industry specialist consultancies, management consultancies, military engineering and mining. His industry experience includes engineering, maintenance and logistics management of high value fleets of equipment and assets and his consulting experience spans all phases of the asset management lifecycle from investment planning and strategy to operations and maintenance and disposal and divestment.

Oliver **Skelding,** B.A.(Economics), M.Ec (Econometrics)

Role: Econometrician

Oliver is a senior analyst in our Sydney office who has experience in the regulation of monopoly industries, economic benchmarking and the application of econometric techniques.

Relevant Skills

	Knowledge of the regulatory framework within the National Electricity Market
	Knowledge of Australian electricity network cost structures
	Total factor and partial productivity analysis
	Econometric modelling

Relevant Experience

Oliver has worked with a number of Australian electricity network service providers to identify expenditure outcomes relative to other operators within the Australian electricity supply industry. Recent engagements include;

- Working with a Victorian DNSP to benchmark expenditure relative to other businesses in the NEM. This project involved using both the AER's benchmarking techniques and other available benchmarking techniques such as Data Envelopment Analysis.
- Assisting an Australian TNSP with benchmarking in preparation for its revenue proposal to the Australian Energy Regulator.
- Working with a number of DNSPs to highlight possible outcomes of the application of the AER's preferred benchmarking techniques.
- Developed performance reports and conducted performance analysis for a number of functions for a large infrastructure manager.
- Developed safety and risk analysis and reports for electrical safety incidents for a state safety regulator.

Professional Summary

Oliver has completed a Master of Economics, specialising in Econometrics. Prior to working with Huegin he worked for the NSW Department of Finance and Services.

At Huegin, Oliver has responded on behalf of Australian DNSPs to the Australian Energy Regulator's Better Regulation Paper regarding the difficulties of using econometric benchmarking techniques within the context of Australian DNSPs and TNSPs. Oliver has also assisted with the benchmarking of Australian DNSPs and TNSPs in preparation for revenue proposals to the Australian Energy Regulator.

Naomi **Donohue,** B.Bus (Accountancy and Computer Applications), CPA

Role: Regulatory Expert

Naomi is our Brisbane based senior manager. Naomi was involved in the AER's Better Regulation process and has expertise in distribution network service provider regulation and cost constructs. Naomi was key in unpacking the regulatory environment and cost breakdowns examined in the report.

Relevant Skills

	Regulatory Determination knowledge and experience
	Industry Operational knowledge
	Industry Regulation knowledge
	Benchmarking experience

Relevant Experience

Naomi is a qualified CPA with extensive experience in regulation and finance of electricity energy distributors. Naomi has specific expertise in the areas of regulatory determinations and national electricity market rule changes.

- Management and co-ordination of the financial related components of the revenue determination for an electricity distribution network service provider.
- Participation and involvement in the AER's Better Regulation program.
- In-depth understanding and knowledge of the energy regulation environment in Australia..
- Identification and strategic management of regulated and non-regulated revenue risks and opportunities, collation and presentation of expected costs for operations and infrastructure investment, and compliance with relevant national electricity law and regulatory requirements.
- Responsible for compilation and AER approval of a network service providers' Cost Allocation Model.
- Completion of all financial modelling to a support a network service providers' Regulatory proposal utilising AER models without any compliance or regulatory issues.

Professional Summary

Naomi has significant experience working in the regulated electricity sector, having worked in a distribution network service provider's regulatory and financial departments for over 8 years prior to joining Huegin. She is also experienced working with government agencies to achieve both commercial and social outcomes. Naomi is a qualified CPA with over 20 years experience in management accounting, strategic planning, process improvement and regulation.

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