APPENDIX 34

Energex expenditure forecast compared to industry benchmarks
Huegin

The Energex expenditure forecast compared to industry benchmarks

An indication of how Energex's proposed expenditure forecast will be viewed in the context of the AER's regulatory framework

huegin

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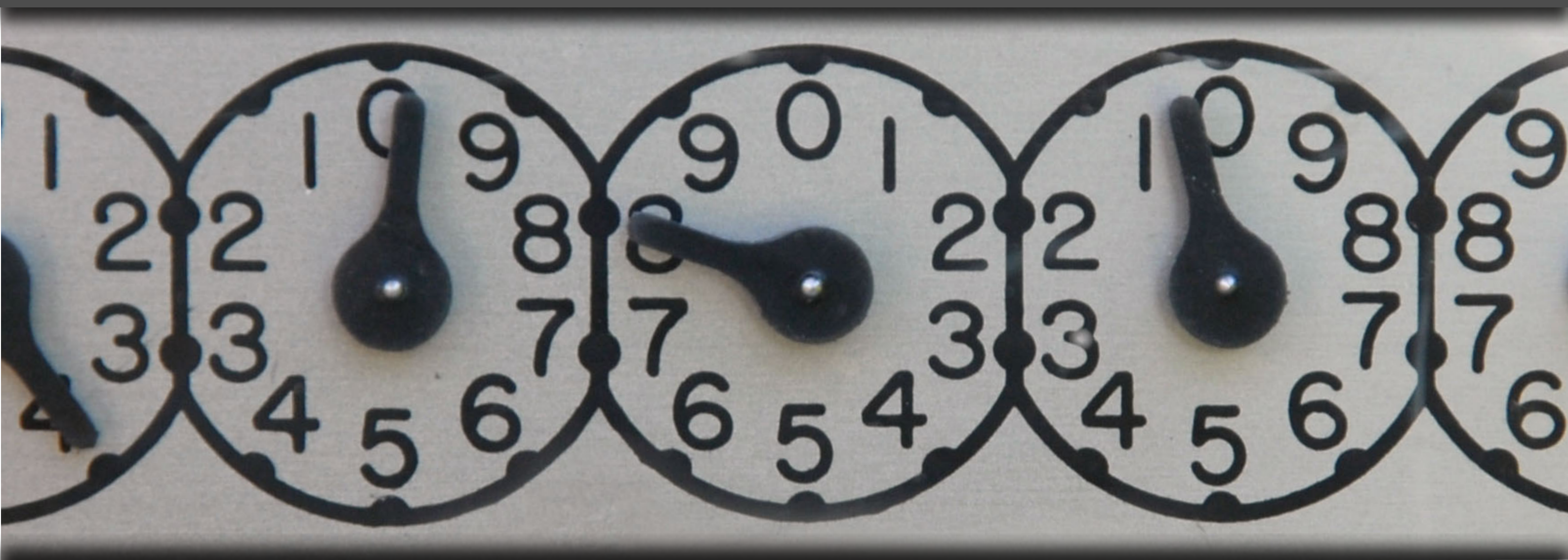
Commercial in confidence



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Executive Summary

Benchmarking Energex expenditure

The AER is introducing a new benchmarking approach

In response to changes in the National Electricity Rules, the Australian Energy Regulator will produce an annual benchmarking report outlining the relative efficiency of DNSPs within the National Electricity Market. These efficiency estimates will be considered by the AER when examining the proposed expenditure of DNSPs.

Benchmarking total expenditure

Multilateral Total Factor Productivity (MTFP) and Data Envelopment Analysis (DEA) are two techniques that the AER have indicated they will use when benchmarking the total expenditure of DNSPs. Using these two techniques Energex appears to be about the median DNSP in the National Electricity Market in terms of productivity.

Replicating the methods outlined by the AER in their Forecast Expenditure Assessment Guidelines, Energex can expect an annual rate of change of between 2.6 - 3.3% over the next regulatory period (excluding inflation).

Benchmarking operational expenditure

Econometric modelling and Opex Partial Factor Productivity (Opex PFP) are two techniques that the AER can use to benchmark Energex's historic and nominated base year opex. The Forecast Expenditure Assessment Guidelines also outlined the methodology the AER could use to estimate an opex growth rate from which to benchmark a DNSP's proposed opex forecast. Using these techniques, Energex's historic opex appears to be close to the industry average but above what would be considered the industry frontier.

Energex's nominated base year opex appears to lie between the industry average and the industry frontier indicated by the chosen model. Energex's proposed annual rate of change is 1.05% whilst the benchmarked rate of change for opex is 1.52% (excluding inflation) - this suggests that Energex's proposed operating expenditure growth rate is below what the AER would forecast using its benchmarking techniques.

Cost drivers and partial productivity

To explore Energex's performance further, analysis of the influential cost drivers and comparison at the partial productivity level shows that Energex's costs are influenced by climatic conditions in particular and that its partial productivity performance is generally improving over time.

Contents

The Australian Energy Regulator's new approach to benchmarking

As a result of changes to the National Electricity Rules, the Australian Energy Regulator must now produce an annual benchmarking report and have regard to this when evaluating the prudence and efficiency of a Distribution Network Service Provider's (DNSPs) capital and operating expenditure.

This chapter explains the AER's objectives in using economic benchmarking, the techniques they have proposed and a brief overview of some of the difficulties in applying economic benchmarking in a regulatory context.

1

The AER has adopted a new approach to benchmarking DNSPs

Changes to the National Electricity Rules now mean that the AER must produce an annual report that describes "in reasonably plain language, the relative efficiency of each Distribution Network Service Provider in providing direct control services over a 12 month period[1]".

The AER has since released its Expenditure Forecast Assessment Guidelines outlining both the techniques they will use to inform their annual benchmarking report and the objectives in conducting economic benchmarking. The AER have suggested that they will use economic benchmarking for three purposes in the context of regulatory oversight[2]. These are:

- To provide a "first pass" assessment of DNSP expenditure at the beginning of a regulatory determination;
- To review the relative efficiency of historic DNSP expenditure and the suitability of base year expenditure to be extrapolated into the future; and
- To forecast feasible rates of growth for both operational expenditure (opex) and capital expenditure (capex).

This new approach will utilise a range of techniques to benchmark total expenditure and operating expenditure

The AER's proposed approach will utilise a range of economic techniques to benchmark total expenditure and operating expenditure of DNSPs within the NEM.

The techniques that have been proposed are Multilateral Total Factor Productivity (MTFP), Data Envelopment Analysis (DEA) and econometric modelling. The table below shows how each of these techniques fit into the AER's objectives.

Expenditure Type	Proposed technique	Objective
Total expenditure	MTFP DEA	first pass assessment relative efficiency of historic expenditure forecast a feasible rate of growth for total expenditure
Operational expenditure	Econometric analysis	relative efficiency of historic opex feasible rates of growth for opex

MTFP may be used to benchmark total expenditure

MTFP is a benchmarking technique that builds upon the principles of partial productivity analysis. For example, opex/km is a measure that is often cited when comparing the operational expenditure of DNSPs. Total Factor Productivity analysis takes this one step further and aggregates all outputs into a single output index and all inputs into a single input index. These indices can then be used to measure the aggregate output a DNSP produces per unit of input. MTFP uses the revenue share of outputs and cost of inputs to calculate an appropriate weight through which to aggregate outputs and inputs.

There are a number of benefits to using MTFP, these include:

- As a non-parametric approach, an industry cost function does not need to be assumed;
- DNSPs are directly compared to other DNSPs within the industry and not a regression line (econometric modelling) or a hypothetical frontier business that is a combination of different businesses (DEA);

1 pg 725, National Electricity Rules Version 62,

2 pg 2, Economic Benchmarking Model: Technical Report, Regulatory Development Branch

- The amount of data required is less exhaustive than for other benchmarking techniques; and
- MTFP benchmarking is transparent and easy to replicate.

There are also a number of disadvantages to using MTFP to infer relative efficiency between DNSPs, these include:

- MTFP does not take into account environmental variables. This means that it is difficult to interpret whether the results are due to inefficiency or different operating environments;
- MTFP does not take into account economies of scale. As is the case with operating environments, this makes it difficult to distinguish between inefficiency and different levels of expenditure that are the result of scale differences between DNSPs;
- MTFP scores can change significantly depending on the choice of inputs and outputs; and
- MTFP does not produce any statistical results which makes it difficult to determine if the results are valid and indicative of true efficiency differences between DNSPs.

The AER has indicated an intent to use results from MTFP analysis to evaluate the historic total expenditure of DNSPs. These results can then be used to provide a "first-pass" assessment of a DNSP's forecast expenditure. This "first-pass" assessment will be done by first using MTFP results to compare the relative efficiency of DNSPs - that is how close a business is to the efficient frontier - and then using these results to forecast a feasible expenditure growth rate given output growth, input price growth and required productivity changes. The MTFP model outlined by the AER is displayed below.

The multilateral Tornqvist index proposed by the AER

$$\ln(MTFP_{st}^{T*}) = \ln(Y_{st}^{T*}) - \ln(X_{st}^{T*})$$
$$= \left[\sum_{i=1}^{N}\left(\frac{\omega_{it}+\overline{\omega}_i}{2}\right)(\ln y_{it} - \overline{\ln y_i}) - \sum_{i=1}^{N}\left(\frac{\omega_{is}+\overline{\omega}_i}{2}\right)(\ln y_{is} - \overline{\ln y_i})\right]$$
$$- \left[\sum_{j=1}^{M}\left(\frac{\omega_{jt}+\overline{\omega}_j}{2}\right)(\ln x_{jt} - \overline{\ln x_j}) - \sum_{j=1}^{M}\left(\frac{\omega_{js}+\overline{\omega}_j}{2}\right)(\ln x_{js} - \overline{\ln x_j})\right]$$

Where;

Y_{st}^{T*} = an index of outputs

X_{st}^{T*} = an index of inputs

ω_{it} = weighting of inputs/outputs

$\overline{\ln y_i}$ = industry average (a bar above any variable indicates the industry average)

DEA may be used as a cross-check of MTFP results[3]

DEA is a linear programming technique for measuring efficiency between businesses. DEA is a non-parametric approach which means that no assumptions are required regarding the relationship between inputs and outputs. DEA uses linear programming to choose weights that maximise the ratio of a linear combination of outputs over a linear combination of inputs. Relative efficiency of a business is then the distance between its output per unit of input (using weights that maximise this value) and that of a business on the frontier.

Advantages of using DEA to benchmark DNSPs include:

- Weights do not need to be arbitrarily assigned to inputs and outputs which can then bias the results, this is a criticism of MTFP which requires an estimation of the relative output weights that are used to aggregate outputs into a single output index;

3 pg7, Economic Benchmarking Model: Technical Report, Regulatory Development Branch

- Assumptions do not need to be made about the relationship between inputs and outputs of a business; and
- The amount of data required is less exhaustive than for other benchmarking techniques such as ordinary least squares, stochastic frontier analysis and corrected least squares.

Disadvantages of using DEA to measure the relative efficiency of DNSPs include;

- DEA is sensitive to outliers;
- The lack of statistical results means it is difficult to say which variables should be included or omitted;
- DEA results can change significantly depending on which inputs and outputs are being used; and
- Businesses will appear more efficient as variables are added.

DEA is a technique that has been proposed by the AER to cross-check the results of MTFP analysis to determine whether the two techniques can provide a consistent set of results. In this sense, DEA may be used to confirm the results obtained from MTFP analysis.

Econometric modelling may be used to benchmark opex

Econometric modelling is a parametric approach used to estimate the relationship between inputs and outputs. In the context of benchmarking opex, this means estimating a relationship between opex (the output) and a number of different inputs that are both measurable and have an impact on opex, either directly or indirectly.

Advantages of using econometric modelling include;

- Econometric modelling estimates the relationship between different inputs and operational expenditure; and
- Econometric modelling produces statistical results that can be used to infer which variables have a significant effect on DNSP expenditure and how well the proposed model explains variations in DNSP expenditure.

Disadvantages of using econometric modelling are:

- The technique requires more data than DEA and MTFP;
- In the presence of multicollinearity coefficients can be unstable;
- A relationship between inputs and operational expenditure needs to be assumed; and
- With a wide range of functional forms and input variables to choose from there may be a number of different models that are statistically valid but produce different estimates.

The AER has proposed using econometric modelling to evaluate the efficiency of a DNSPs historic opex and the suitability of using a DNSPs revealed opex costs as a starting point from which to forecast future opex. Econometric modelling can also be used to forecast a feasible opex growth rate by estimating a partial productivity growth rate. This technique, using an econometric model estimate a productivity growth rate, has been used in the past by Economic Insights[4] and is illustrated below.

Estimating opex partial productivity growth

$$P\dot{F}P_{Opex} = \left(1 - \sum_i \varepsilon_{Y_i}\right) \cdot \dot{Y}^{\varepsilon} - \varepsilon_{X_k} \cdot \dot{X}_k - \varepsilon_{Z_1}\dot{Z}_1 - \dot{g}$$

Where;

$P\dot{F}P_{Opex}$ = opex partial productivity growth

ε_{Y_i} = effect of a change in output on opex, estimated using an econometric model

ε_{X_k} = effect of a change in capital on opex, estimated using an econometric model

ε_{Z_1} = effect of a change in an environmental variable on opex, estimated using an econometric model

$\dot{g}$ = change in opex over time, estimated using an econometric model

4 Econometric Estimates of the Victorian Gas Distribution Businesses' Efficiency and Future Productivity Growth, Economic Insights

Why does the AER's new benchmarking approach matter for Energex?

With the release of the AER's Expenditure Forecast Assessment Guideline and benchmarking data for each of the DNSPs within the NEM, it is possible to examine how DNSPs will benchmark using the AER's proposed economic benchmarking techniques. Following the Guideline released by the AER, DNSPs can estimate how they compare to other DNSPs in the industry and also use benchmarking outcomes to forecast future rates of growth for total expenditure, operating expenditure and therefore capital expenditure. Using the results from the AER's benchmarking techniques, DNSPs can compare their own expenditure forecasts with those the AER is likely to construct. This comparison is particularly important in the context of the "first pass" assessment proposed by the AER in which DNSP forecasts that are below those produced by economic benchmarking may be fast-tracked. Alternatively, DNSPs whose proposed expenditure is above that estimated by the AER's benchmarking techniques may incur a more detailed analysis of its expenditure[5]. With this in mind, understanding where a business will benchmark, either above or below the reference expenditure constructed by the AER, will have a large influence on how it approaches its regulatory proposal.

Regardless of the chosen approach in applying the techniques, there are inherent issues with economic benchmarking in the context of the Australian electricity supply industry (small sample of businesses operating in diverse conditions) that will remain a challenge for any benchmarking effort. Some of these issues are highlighted below.

Why economic benchmarking should not be used deterministically

- **Model specification**: there has been no consistent definition of what constitutes the outputs and inputs of a DNSP, either in regulatory applications or academic research. The AER's benchmarking techniques will produce different results for different specifications implying that some DNSPs are efficient using one specification and at the same time, inefficient using another specification.
- **Data validity**: Among the 13 DNSPs that are being benchmarked there is a variety of business structures, ownership differences, accounting differences and variations in the scope of responsibilities (for example, division of responsibility between DNSPs and councils for vegetation management and public lighting). Given that DNSPs account for costs differently it is unlikely, even if an accurate model specification could be defined, that the data that is being used in the benchmarking analysis is robust enough to produce accurate results.
- **Industry heterogeneity**: Australian DNSPs operate in such a diverse environment that differences between businesses when using the techniques outlined by the AER are more likely to be driven by exogenous factors rather than inefficiency. In addition, it is unlikely that given the heterogeneity of Australian DNSPs there is only 1 efficient frontier against which a DNSP should be measured.

5 pg12, Economic Benchmarking Model: Technical Report, Regulatory Development Branch

How will Energex benchmark on total expenditure?

The AER have proposed using MTFP to benchmark total expenditure with the use of DEA as a cross check for these results.

Based on assumptions about the likely configuration of the models by the AER, Huegin believes that Energex will rank around the middle of the range for efficiency scores across the NEM.

In terms of an annual rate of change of total expenditure* Energex's high historic output growth is likely to offset any productivity adjustments. Using the methods in the AER's Guidelines, Energex can expect an annual rate of change between 2.6 - 3.3% (net of input price growth).

* In the context of AER benchmarking, total expenditure refers to the total of opex, the return of capital and the return on capital

2

The AER may use MTFP to benchmark total expenditure with DEA as a cross check

The AER have indicated in their Forecast Expenditure Assessment Guidelines that they may use their preferred model, outlined below, to obtain raw MTFP scores for DNSPs over time. Given that one disadvantage of using MTFP is the inability to account for environmental factors these raw MTFP scores may then be adjusted using an adjustment technique outlined by Economic Insights and endorsed by the AER[6]. This approach involves two stages:

1) Econometric analysis is used to determine the relationship between the raw MTFP scores and different environmental variables; and

2) The raw MTFP scores are adjusted by adding the sum of the product between the estimated coefficient and the difference between the sample average and a DNSP's actual value.

After adjusting the raw MTFP scores the AER can arrive at an MTFP score for each DNSP over the past eight years. These scores are then used to infer relative efficiency between DNSPs and over time.

It should be noted that whilst this technique of adjusting the raw MTFP scores to account for the impact of different environmental variables was endorsed in the Expenditure Forecast Assessment Guidelines, with the delay in the release of the AER's Annual Benchmarking Report it is uncertain what approach the AER will adopt. Given that the stated objective of the Annual Benchmarking Report, as outlined in the National Electricity Rules, is to detail the relative *efficiency* of DNSPs it remains uncertain whether the AER will assume that a productive DNSP is an efficient one or whether MTFP scores will be adjusted to take into account exogenous factors that have an influence on productivity scores but are out of the control of DNSP management.

The AER have proposed the use of DEA to check the results obtained using MTFP.

The AER's preferred model

Quantity	Value	Price
Outputs		
Customers (no.)	Revenue*Cost share	Value/Customers
*System capacity (kVA*kms)*	Revenue*Cost share	Value/kVA*kms
Interruptions (customer minutes)	-1*Customer minutes*VCR per customer minute	-1*VCR per customer minute
Inputs		
Nominal opex/Weighted average price index	Opex	Weighted average of ABS EGWWS WPI and five ABS producer price indexes
Overhead lines (MVA-kms)	Annual user cost (return of and on overhead capital)	Overhead annual user cost/MVA-kms
Underground cables (MVA-kms)	Annual user cost (return of and on underground capital)	Underground annual user cost/MVA-kms
Transformers and other (MVA)	Annual user cost (return of and on transformers and other capital)	Transformers and other annual user cost/ MVA

6 pg 5, Economic Benchmarking Model: Technical Report, Regulatory Development Branch

The application of the MTFP method

Huegin have used two different scenarios to represent the range of outcomes Energex can expect using the AER's benchmarking techniques for total expenditure[7]. These scenarios are;

- Scenario 1 - Energex's historic total expenditure with Feed-in-Tariffs removed.
- Scenario 2 - Energex's historic expenditure with 2012/13 opex replaced with the adjusted base-year value of $326M (nominal) and the raw results adjusted for customer density[8].

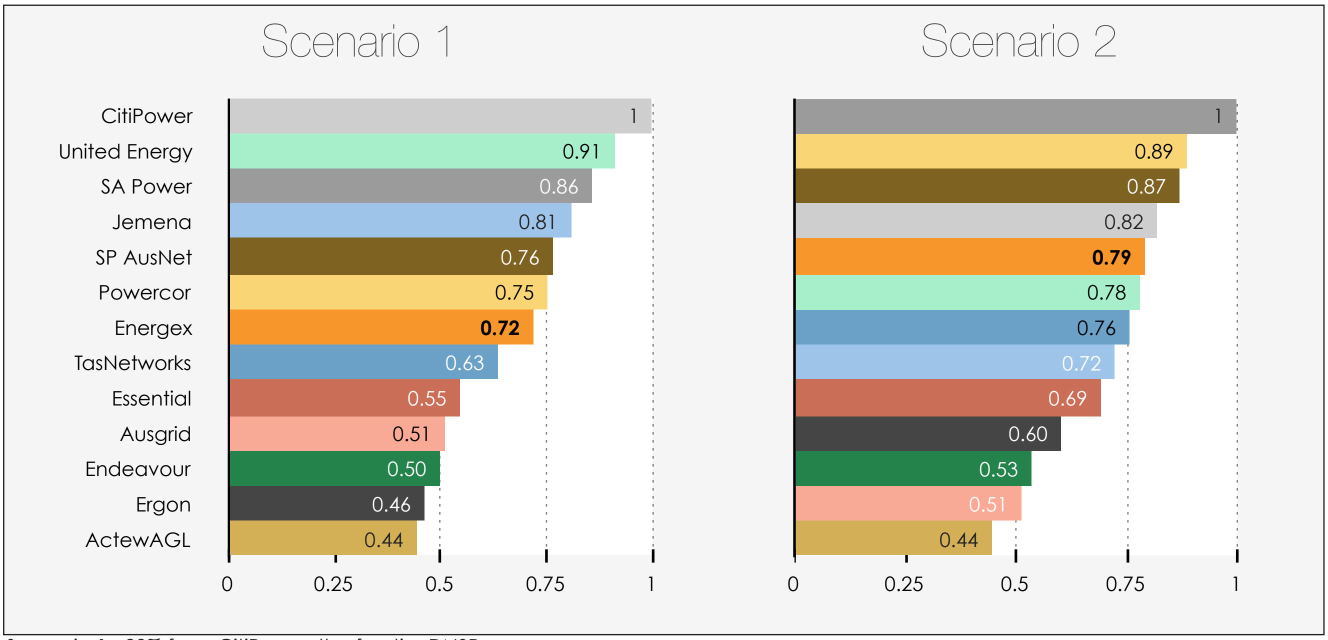
These scenarios give Energex an indication of where they benchmark relative to other DNSPs using the historic data collected by the AER (Scenario 1), where they may benchmark in terms of their proposed expenditure forecast and if the raw productivity scores are adjusted using customer density (Scenario 2).

Choosing output weights

In order to aggregate outputs into a single output index, output weights first need to be calculated. Both scenarios in this report use a weighting of 75:25 (customer connections:system capacity). These weights were derived using a Leontief cost function, a technique outlined in "*Economic benchmarking of Electricity Network Service Providers*" - a Report released by the AER. The results and further explanation of this technique is outlined in the Annex (part A).

Energex is between 20-30% below the most productive DNSP in 2013

The graph below illustrates the efficiency scores obtained for each DNSP using the AER's preferred model and the MTFP technique. Energex is between 28% and 21% below the most productive DNSP in 2013 for both scenarios. The most productive DNSP is referred to as the frontier DNSP.



Scenario 1 - 28% from CitiPower, the frontier DNSP.

Scenario 2 - 21% from SA Power Networks, the frontier DNSP. Looking at the results from the first scenario, it appears as through DNSPs with higher customer densities generally benchmark better than those with lower customer densities. Adjusting for customer density, high customer density DNSPs have their MTFP scores reduced whilst those with lower than average customer density have their scores increased. In the case of Energex, with a customer density slightly below the industry average in 2013, the MTFP score increases.

7 Total expenditure is the sum of opex, the return of capital and the return on capital

8 Customer density is the density variable with the highest correlation with MTFP scores, customer density is also a metric that is readily available over the eight years

Results for all DNSPs over time for each scenario are presented in the Annex (part B).

Using DEA as a cross check

The graphic below compares the rankings of DNSPs using MTFP and DEA for Scenarios' 1 and 2 (scenario 2 MTFP results below are the raw results - that is, not adjusted for customer density - to ensure consistency with the DEA method which does not need adjustment). The AER suggests that DEA should be used to check the consistency of MTFP results. The results below indicate DNSPs that rank high using MTFP will also rank high using DEA and vice versa. This may be confirmation of the approach taken by the AER to use one method to check the other, however it is more likely a result of using the same model specification.

Change in rank using DEA and MTFP

Scenario 1 (Actual 2013 opex)

MTFP	DEA
CitiPower	Essential Energy
United Energy	SA Power
SA Power	CitiPower
Jemena	United Energy
SP AusNet	Powercor
Powercor	SP AusNet
Energex	Ergon Energy
Aurora	Jemena
Essential Energy	Energex
Ausgrid	Aurora
Endeavour Energy	Ausgrid
Ergon Energy	Endeavour Energy
ActewAGL	ActewAGL

Scenario 2 (Adjusted base year opex)

MTFP	DEA
CitiPower	Essential Energy
United Energy	SA Power
SA Power	CitiPower
Jemena	United Energy
SP AusNet	Powercor
Powercor	SP AusNet
Energex	Energex
Aurora	Ergon Energy
Essential Energy	Jemena
Ausgrid	Aurora
Endeavour Energy	Ausgrid
Ergon Energy	Endeavour Energy
ActewAGL	ActewAGL

Energex is the median (ranked 7th) DNSP for 3 out of the 4 sets of results. Generally, DNSPs that benchmark well using MTFP also benchmark favourably using DEA with the exception of Ergon Energy and Essential Energy. These results suggest that, in terms of productivity (as defined by the AER's choice of inputs and outputs), Energex is around the median of DNSPs within the NEM.

Putting it all together - Energex's "first pass" benchmarking assessment

Using the results of the MTFP analysis, the AER has proposed forecasting an annual rate of total expenditure growth using the following formula:

Annual rate of growth = input price growth + output growth - productivity adjustment

This formula indicates that there are three components that will affect Energex's annual rate of change. These are:

- Input price growth: A weighted average growth of opex and capex prices, this growth rate will be estimated exogenously and a value of 2.93% has been used in this analysis [9];
- Output growth: The average growth rate of a DNSPs output index taken from the MTFP analysis; and
- Productivity adjustment: The sum of a DNSP's individual productivity adjustment (catch-up to the frontier) and an industry productivity adjustment (the shift in the frontier) taken from the MTFP analysis.

9 Growth rate in the ABS All Groups CPI between March 2013 and March 2014

Using this relationship between input growth, output growth and productivity adjustment, we can forecast the annual rate of change that Energex can expect from the AER's benchmarking techniques using Scenarios 1 and 2. The breakdown and total of the annual rate of change are shown in the following table.

	Scenario 1	Scenario 2
Input price growth	2.93%	2.93%
Output growth	5.37%	5.37%
Industry efficiency adjustment*	0%	0%
Individual efficiency adjustment**	2.82%	2.09%
Total Annual Rate of Change	**5.48%**	**6.21%**

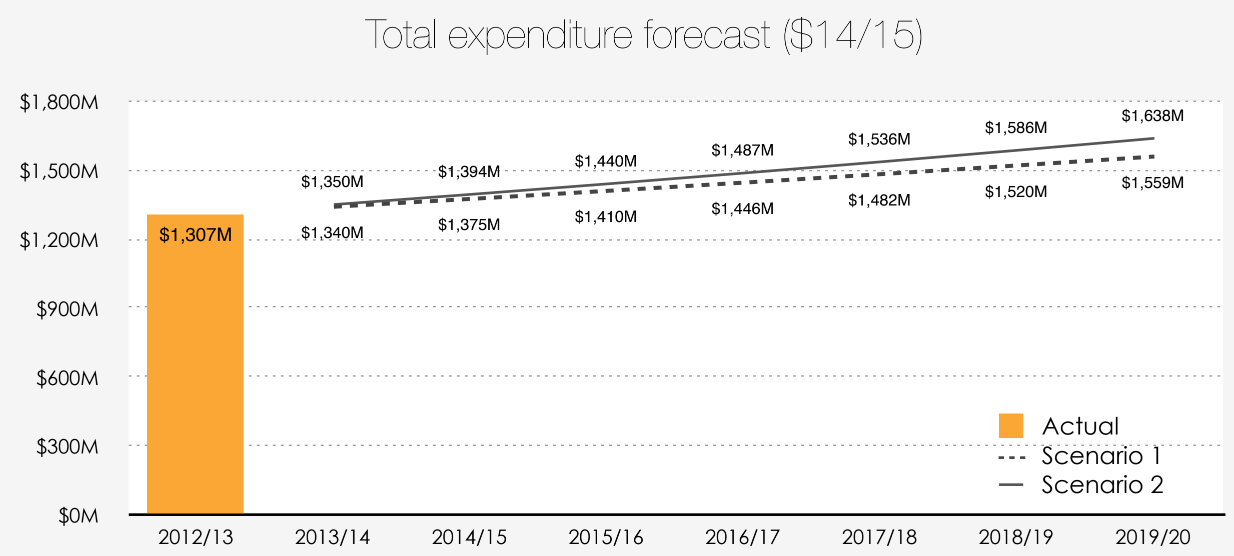
* For both scenarios, industry productivity was found to be negative. This suggests the industry frontier is moving backwards over time. Huegin has made an assumption that the AER will not use a negative industry efficiency adjustment when calculating an annual rate of change and has used a value of 0% for these scenarios.

* * An efficiency catch up period of 10 years has been assumed. For example if Energex was 20% from the frontier then this would represent a 2% individual efficiency adjustment to catch-up to the frontier over 10 years.

This annual rate of change is the allowable compounding growth rate of expenditure (opex and the return of and on capital) extrapolated forward from the current level (or an adjusted base value) based on the assumption that historical output growth rates are applicable to the future. Using this approach, the AER can estimate a level of expenditure for Energex that it considers would be appropriate for a DNSP catching up to the efficient frontier.

Applying the annual rate of change

The annual rate of change can be applied to Energex's current total expenditure to produce a forecast efficient level of expenditure. The results of this analysis are shown below. Note that technically this rate of change should be applied to revenue, however it can be used as a guide for expenditure.



Projected increase in total expenditure using the benchmarked annual rate of change derived from Scenario 1 (2.55%) and Scenario 2 (3.28%), both scenarios exclude input price growth of 2.93%.

Note that a forecast total expenditure that is less than the forecast using the annual rate of change from MTFP analysis does not guarantee acceptance of the Energex proposal - for example the AER could allow a shorter time for efficiency catch-up (10 years has been used in this analysis).

Also, a forecast total expenditure that is less than the forecast using the annual rate of change from MTFP analysis does not guarantee individual adjustments will not be made through the econometric benchmarking (opex) or the individual category analysis.

Total Expenditure Benchmarking Key Points

Efficiency Catch Up

The specification and form of the MTFP model dictates that Energex will not be near the frontier. It is unlikely that the approach adopted by the AER will account for the statistical error and residual 'noise' inherent in the modelling - therefore Energex can expect an efficiency catch up will be applied to their forecast expenditure. Huegin believes this will be in the range of 20 to 30% - *to be applied over a time period of the AER's choice*.

Strong Output Growth

Energex has one of the highest historical output index growth rates in the group based on the MTFP model specification. If the AER applies the MTFP model as it has advised, this output growth rate will be projected forward as the forecast network growth rate. This large output growth is driven by improving reliability (measured by customer minutes off supply) and increasing distribution capacity (measured in MVA-kms).

Benchmarked and Proposed expenditure

The high output growth rate more than offsets the individual and industry efficiency rates of change - resulting in a positive annual rate of change in the MTFP forecast of total expenditure. It is important to note that total expenditure in the context of AER benchmarking is the total revenue obtained from the building blocks method. This means that, if the AER follows the process outlined in its Expenditure Forecast Assessment Guidelines, the results of Energex's first pass assessment will depend on the differences between the proposed revenue requirements put forward by Energex and the benchmarked annual growth rate estimated by the AER.

How will Energex benchmark on operating expenditure?

3

The AER may use econometric modelling to determine the relative efficiency of historic opex and to forecast an opex annual rate of growth. Another technique that can be used to examine the efficiency of Energex's base year operating expenditure is Opex Partial Factor Productivity (Opex PFP).

Using econometric modelling and Opex PFP, Energex's nominated base year opex appears to below the industry average but above what would be considered the industry frontier.

Energex's proposed annual rate of growth appears to be below that benchmarked using econometric modelling.

Econometric modelling may be used to benchmark opex

The AER has indicated that it may use econometric modelling to examine the relative efficiency of a DNSP's historic opex and also to forecast an annual rate of growth of opex. By estimating an industry opex cost function the AER could compare a DNSP's modelled opex with their actual opex to determine whether a revealed cost approach is appropriate or whether a base year adjustment is necessary. This means that if a DNSP's actual opex is below that predicted by an industry opex cost function then the base year can be used as the starting point from which an annual rate of growth can be applied.

The functional form chosen by the AER will be the result of running a number of different models and choosing one they believe is most reflective of the industry opex cost function. A major consideration will be the stability of each model. Models become unstable where two or more of the variables are highly correlated with each other - an issue known as multicollinearity. For the purpose of this report, we have selected a Cobb-Douglas expenditure function and used the random effects technique to estimate the model.

Huegin does not endorse using econometric modelling to infer relative levels of efficiency between DNSP operating expenditure. Sensitivity of model selection aside, we believe econometric modelling is unable to disentangle cost differences driven by network heterogeneity and inefficiency. This is particularly relevant for distribution networks in which these heterogeneous conditions (such as network design, regulatory environment and network density measures) change little over time. As econometric modelling seeks to model the *change* in costs with the *change* in explanatory variables then it is unlikely, given the static nature of many DNSP cost drivers, that modelling can adequately account for cost differences due to heterogeneity and cost differences due to inefficiency.

Nonetheless, given the AER have indicated the potential use of econometric modelling to benchmark operating expenditure, Huegin has estimated an opex industry model. This model specification is represented below:

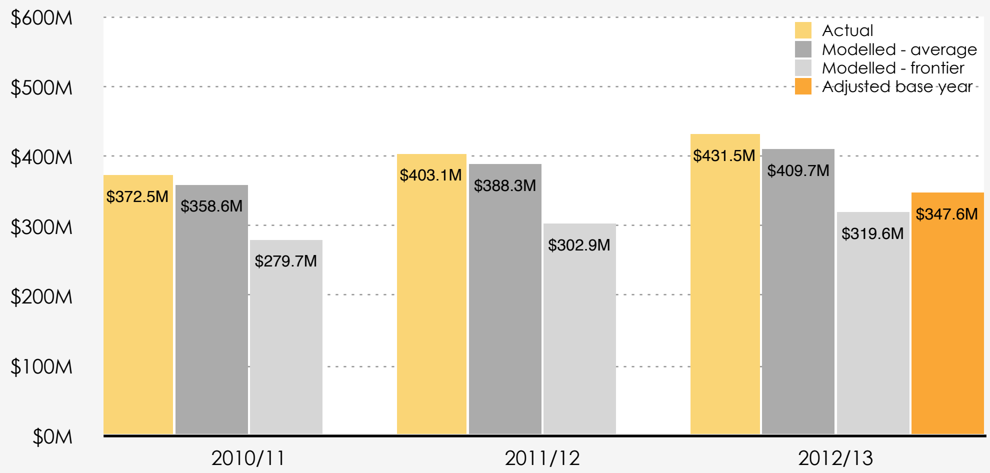
$$\text{lnOpex} = b_0 + b_1\text{lnSystem Capacity} + b_2\text{lnCustomers} + \text{lnW}_{OM} + b_3\text{Share of single stage transformation} + b_4\text{lnRAB} + b_5\ \ln \text{Demand density} + b_6\text{Time}$$

Linear homogeneity in opex price is imposed (a 1% increase in the price of opex results in a 1% increase on opex) and the RAB has been adjusted to $2013, the statistical attributes of the model are contained within the Annex (part D).

Benchmarking Energex's historic opex

Once the AER have calculated a model they believe represents an industry operating cost function, estimates can be obtained using the network characteristics of each DNSP. The graph below illustrates Energex's modelled operating expenditure using the model specification described above. The modelled expenditure represents the average expenditure that would be incurred by a network with Energex's characteristics. Using a technique known as Corrected Ordinary Least Squares, a frontier line can also be calculated - this is also included below and represents where the frontier firm would benchmark given Energex's network characteristics.

Historic, predicted and adjusted opex ($14/15)



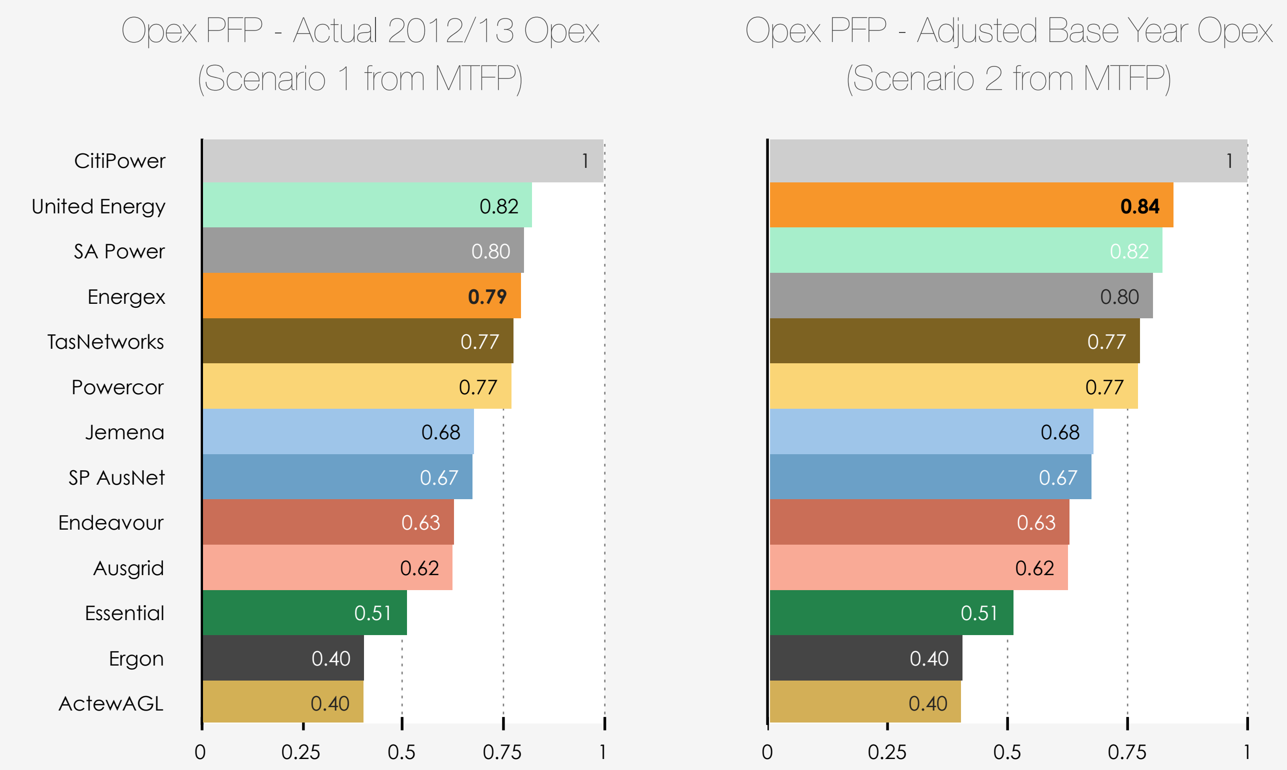
Between 2010/11 and 2012/13 Energex's actual opex was above that modelled. Energex's nominated base year opex is well below its actual 2012/13 opex and also below that modelled.

The previous graph shows that, using the outlined model, Energex's historic operating expenditure is above what would be expected of a DNSP with Energex's characteristics. However, the base year opex nominated by Energex is below what would be the industry average and therefore may be an efficient starting point from which to extrapolate future expenditure using econometric modelling - although it is above the modelled frontier. It is important to note, that different model specifications and functional forms will produce varying forecasts - underlining the sensitivity of this particular benchmarking technique.

Using opex partial productivity index to benchmark Energex's historic opex

Another technique available to the AER to benchmark a DNSP's operating expenditure is an opex partial productivity index. This technique uses the same aggregate output index used in the MTFP benchmarking relative to a DNSP's operating expenditure (i.e. overhead MVA-kms, underground MVA-kms and transformer capacity are omitted from the input index, leaving only opex).

The graph below highlights Energex's opex partial productivity in 2013 relative to other DNSPs in the NEM, included are the results using actual 2012/13 opex (after feed-in-tariffs have been removed) and the nominated base year figure of $326.2M (nominal).



Using the combination of outputs and inputs from the AER's preferred specification, Energex's nominated base year opex productivity is above the industry average but below the frontier DNSP.

Finding an annual rate of opex growth using econometric modelling

The AER may use the coefficients from an econometric model to estimate partial productivity growth rates for DNSPs. This technique was described in page 4 of this report and has been used by Economic Insights in the past[10]. This opex partial productivity growth rate could then be used to estimate an annual rate of growth for operating expenditure using the equation outlined below.

Calculating the annual opex growth rate

Opex annual growth rate = Output growth rate + Input price growth rate - Opex partial productivity growth rate

The components and annual opex rate of change are detailed below.

	Rate of change (%)
Partial productivity growth	1.38%
Opex price escalation*	2.93%
Output growth rate	2.9%
Annual opex rate of change	4.45%

* Growth rate in the ABS All Groups CPI between March 2013 and March 2014

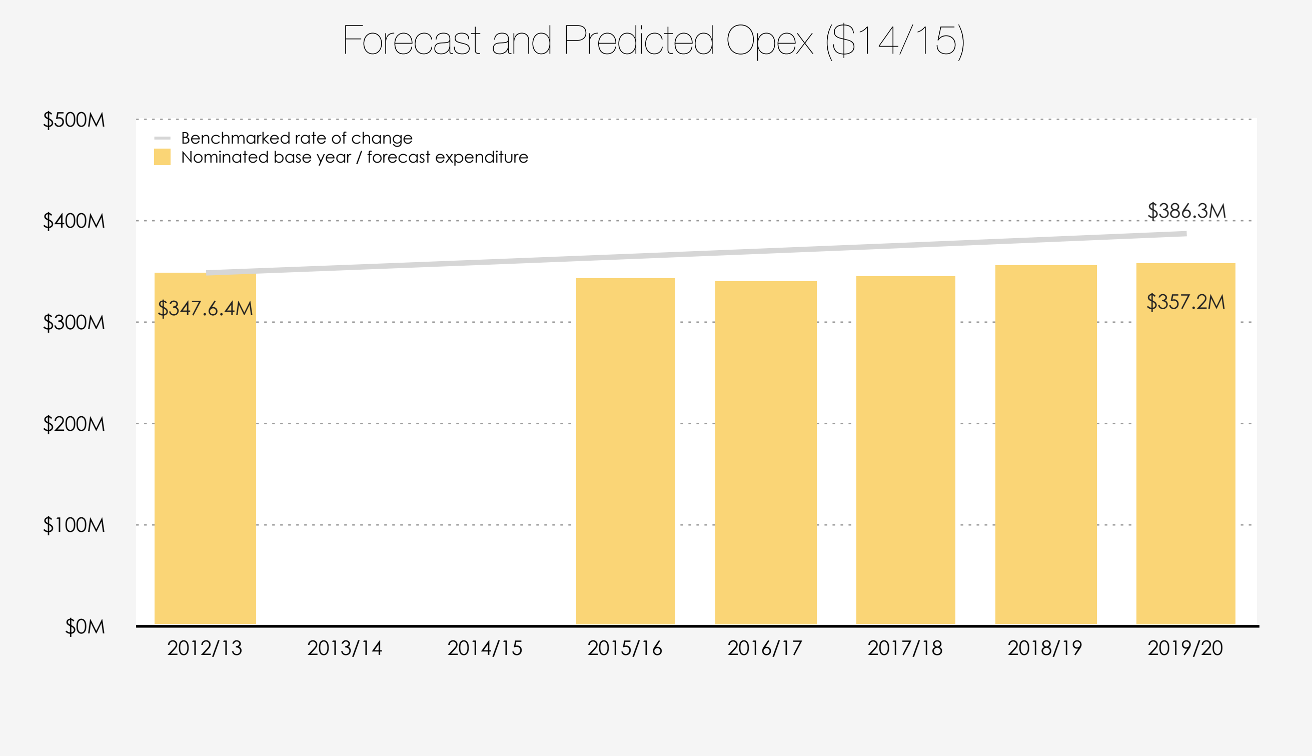
As with total expenditure benchmarking, Energex's high output growth rate[11] offsets its productivity growth factor, resulting in a positive rate of change in real terms. However, similar to the MTFP analysis for total expenditure, this does not guarantee that adjustments will not be made to Energex's opex forecast. Given the latitude the AER has in selecting functional form, variables and other assumptions, the risk of an unfavourable outcome is in fact greater for opex than for total expenditure.

10 Econometric Estimates of the Victorian Gas Distribution Businesses' Efficiency and Future Productivity Growth, Economic Insights

11 The output growth rate is lower using econometric modelling because reliability has not been included as a model output

Putting it all together - comparing Energex's predicted and forecast opex

The predicted future opex (using the annual rate of change) can be compared against Energex's proposed opex. Without knowing whether the AER will make base year adjustments or not presents a challenge in comparing the two forecasts (Energex's and the econometric model prediction). For the purposes of the analysis in this document, we have assumed that there is no adjustment made to the adjusted base year opex nominated by Energex. The result of this analysis is shown below.



As shown, if the AER adopts a similar econometric model to the one employed for this report and makes similar assumptions, Energex's forecast opex is likely to be below that predicted by the econometric model. For the model and assumptions used in this report, the total opex forecast by Energex for the period between 2015/16 and 2019/20 is $136 million lower than that predicted by the econometric model. Energex's high historic output growth and low proposed opex growth rate (1.05%) mean that any growth rate derived from econometric benchmarking (which uses historic data) is likely to be above that forecast by Energex.

Operating Expenditure Benchmarking Key Points

Output Growth Rates and Productivity Improvement

As with total expenditure, the opex modelling suggests that Energex's strong historic output variables growth rates offset any productivity shift required, resulting in an overall net positive growth rate. As with total expenditure, these results cannot be relied upon as an indication that no adjustments will be made by the AER.

Model Specification Sensitivity

Econometric modelling requires many assumptions about functional form and variables and there are a vast array of potential outcomes based on the specification choices made. For that reason, it is difficult to either predict how it will be used or defend a particular model over another.

Other Considerations

Whilst the example in this section shows Energex's forecast is below the predicted value, there are many other considerations that need to be taken into account such as differences in structures, cost allocation methods, treatment of costs such as demand side management - not just for Energex, but for all businesses (as the results rely on industry average comparisons).

Understanding cost drivers

The error and sensitivity inherent in the economic modelling techniques, and the lack of clarity regarding the AER's intended application, compels businesses to evaluate their own cost performance against their peers and over time. Partial productivity analysis is a common means of simplifying the comparison of cost performance. Partial productivity analysis carries its own limitations and risks, not the least of which include:

- An understanding the network environment and operating conditions is imperative if the context of the productivity indicator is to be considered; and
- Used in isolation, partial productivity analysis can provide signals of inefficiency that are actually differences attributable to accounting and structural differences.

This chapter provides a view of Energex's partial productivity performance, with consideration of influencing factors wherever possible.

4

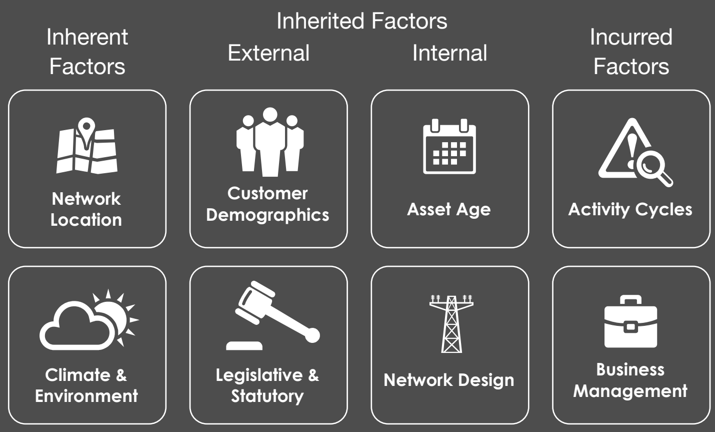
Understanding network cost drivers

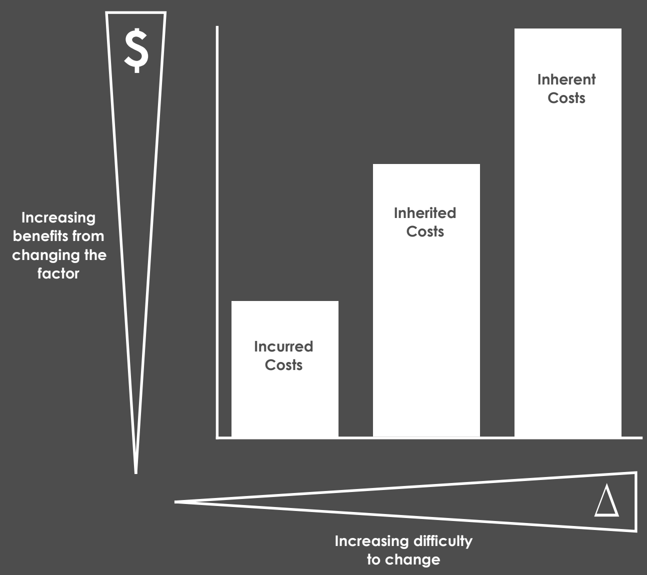
In previous benchmarking studies, Huegin has posited that a number of cost drivers exist that influence costs and the presence and influence varies across networks. We have refined the list to eight important cost drivers shown to the right and categorised as follows:

- Inherent factors - these are beyond the control of the distribution business.
- Inherited factors (external) - these can be influenced by the distribution business, but not controlled. The level of influence is not usually significant.
- Inherited factors (internal) - these can be directly influenced by the distribution business, but any material change in these factors generally takes much longer than a regulatory period to take effect.
- Incurred factors - these are mostly the outcome of management decisions, and are more readily influenced, although the changes may not be significant.

There is often an inverse relationship between the level of control management has for each category and the magnitude of impact that results from changes in the factors. That is, those factors that are hardest to influence or control are generally those that would deliver the most benefit if change were possible.

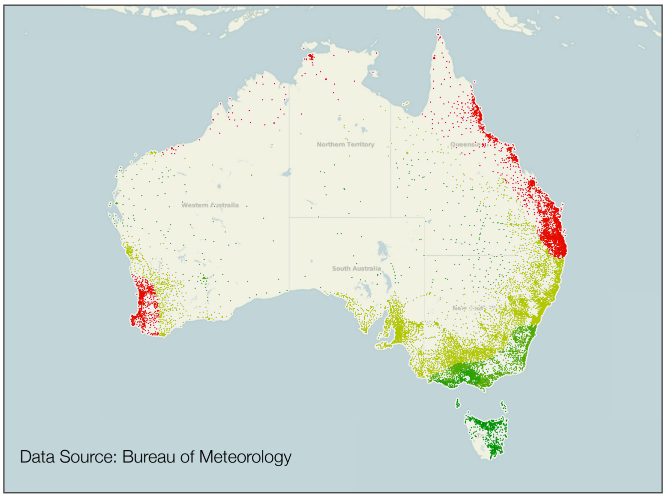
Each of these factors can be represented by certain network or environmental attributes. Some of these are presented in the following pages.





Network location

There are many reasons a network's location will influence costs, some physical, some logistical. The graphs below show some of the important locational differences for factors that influence network costs.

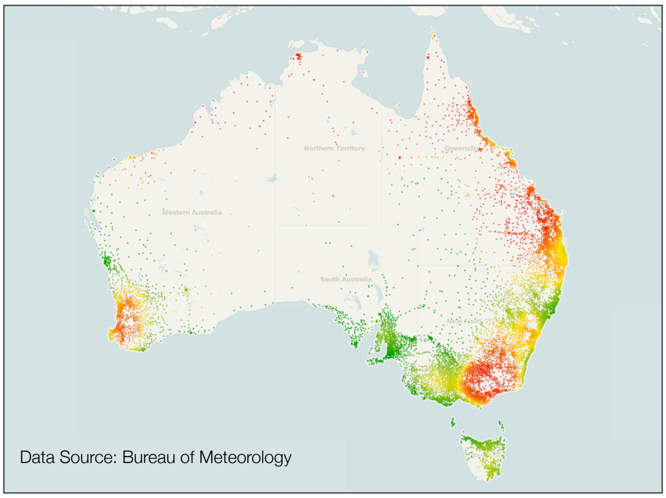


Termite Exposure

The graphic to the left shows the variation in termite risk zones across Australia by post code. As shown all of the east coast of Queensland and the South West of Western Australia are highest risk areas. Of course this risk factor combines with climate risk factors to pose specific degradation issues for wooden poles.

Activities impacted by this cost driver:

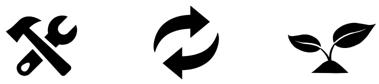
Maintenance Opex | Replacement Capex



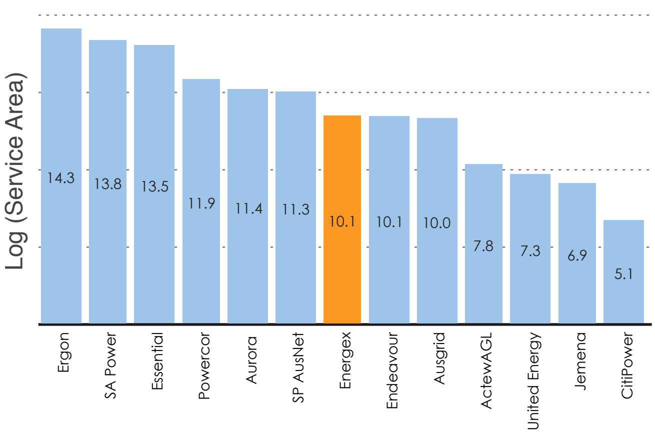
Bushfire Risk

The graphic to the left shows the variation in bushfire risk across Australia by post code. This is an issue for fire starts through contact with electricity assets. Vegetation management and pole inspection costs are influenced most significantly by this factor.

Activities impacted by this cost driver:



Maintenance Opex | Replacement Capex | Vegetation Management



Service Area

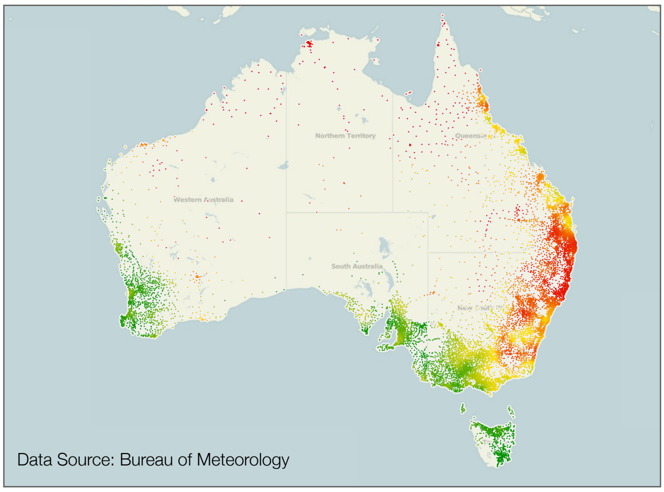
The graphic to the left shows the variation in network area serviced. A logarithmic scale is required to illustrate the comparison due to the significant range between the smallest (CitiPower, 157 sq km) and largest (Ergon Energy, 1,700,000 sq km). Property, fleet and other corporate overhead costs increase with increasing service area. The data source for these results is the annual RINs.

Activities impacted by this cost driver:

Non-network Expenditure

Climate and Environment Impacts

The impacts of climate and environment vary broadly across Australia. In larger networks they vary broadly across a single distribution business also.



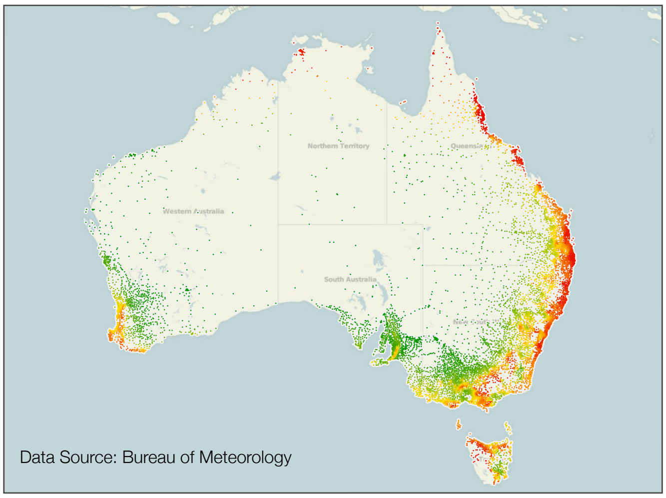
Data Source: Bureau of Meteorology

Severe Storms (thunder days)

The graphic to the left shows the range in number of thunder days per annum by post code across Australia. As shown, South East Queensland and the north coast of New South Wales have the most storm activity in Australia. High storm activity indicates areas that are more prone to weather related outages, increasing network switching and emergency response operations.

Activities impacted by this cost driver:

- Emergency Response
- Network Control
- Customer Service



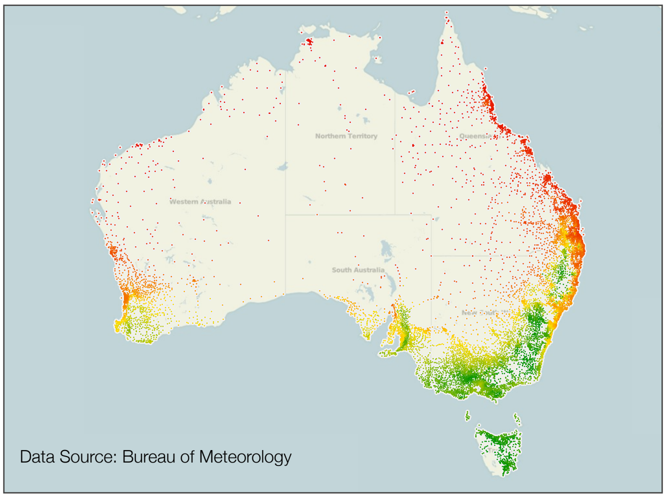
Data Source: Bureau of Meteorology

Rainfall (mm)

The graphic to the left shows the variation in annual mm of rain by postcode across Australia. As shown, the east coast of Australia and north west Tasmania have the highest falls. High rain fall accelerates the degradation of wooden poles - particularly in the presence of high temperatures - which increases the maintenance and replacement rates of poles.

Activities impacted by this cost driver:

- Maintenance Opex
- Replacement Capex



Data Source: Bureau of Meteorology

Maximum Temperature (degrees)

The graphic to the left shows the variation in maximum recorded temperatures by postcode across Australia. The north east coast and north west coast of Australia experience the highest temperatures. High temperatures place pressure on networks through customer demand, but also the sag on overhead lines. Both of these factors increase the likelihood of outages.

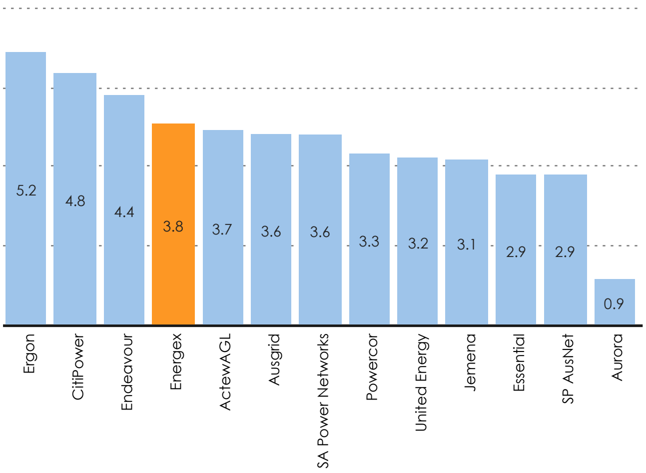
Activities impacted by this cost driver:

- Emergency Response
- Network Control Opex
- Customer Service
- Augmentation Capex

Customer Demography Impacts

Consumer behaviour and statistics vary across the NEM. These behaviours place different pressures on the networks in terms of demand management and network control. The data below is sourced from the Economic Benchmarking RINs.

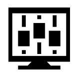
Demand Density (kVA/customer) - FY13

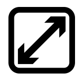


Demand Density (kVA/customer)

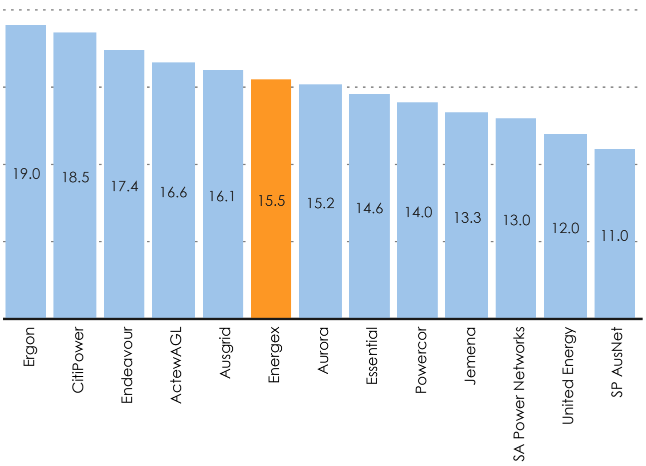
The graphic to the left shows the variation in demand density. Energex has a similar demand density to ActewAGL and Ausgrid.

Activities impacted by this cost driver:


Network Control


Augmentation Capex

Energy Density (MWh/customer) - FY13

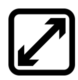


Energy Density (MWh/customer)

The graphic to the left shows the variation in energy density. Like demand density, Energex's energy density is close to Ausgrid and ActewAGL.

Activities impacted by this cost driver:

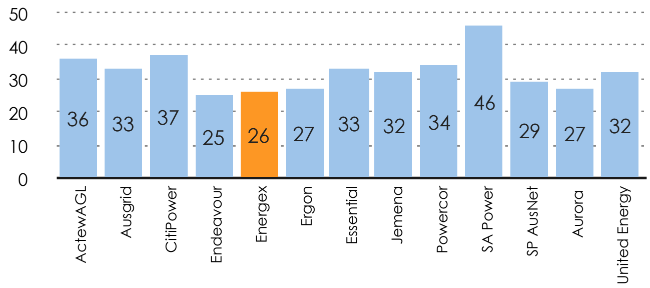

Network Control


Augmentation Capex

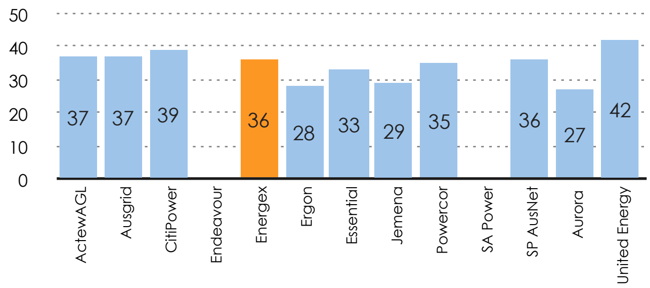
Asset Age

The growth of networks across Australia occurred at various periods in the past and have been replaced at various rates. The result is a broad range of age profiles across networks, which impacts replacement and maintenance costs. The data below is sourced from the Category Analysis RINs and is based on FY13.

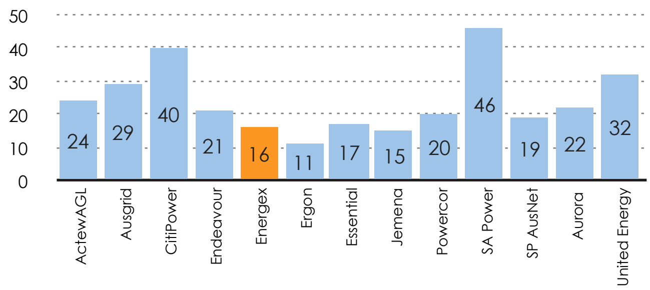
Average Pole Age



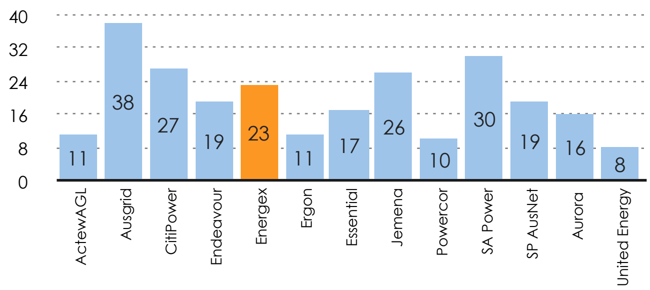
Average OH Asset Age



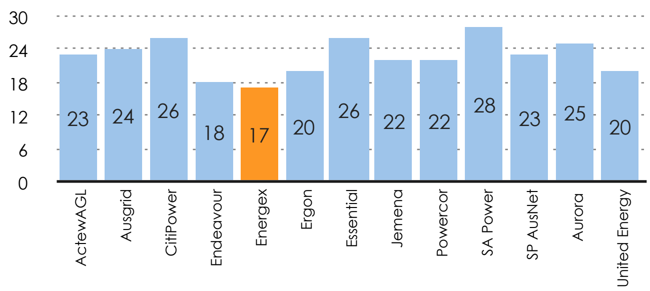
Average LV (incl 11kV) UG Age



Average HV (33kV and above) UG Age



Average Distribution Transformer Age



Average Age (years)

The graphs to the left show average ages of various asset classes. Whilst the individual age profiles - the distribution of the population of an asset across the age range - reveals more about the need to replace assets than the average does, average age provides a high level comparison of the immediate pressures on asset replacement for an asset class.

Activities impacted by this cost driver:

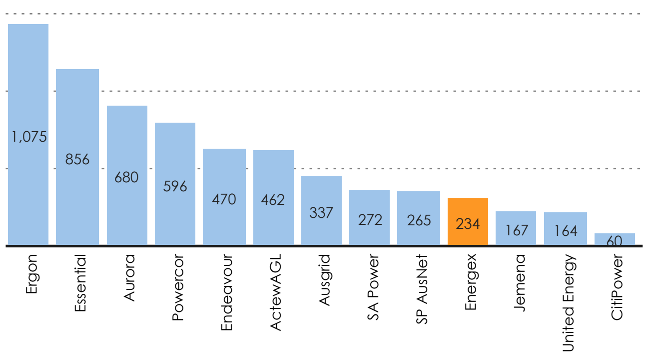
Maintenance Opex

Replacement Capex

Network Design Factors

Network design is perhaps the single largest influence on costs. Variations in line capacity, undergrounding and network redundancy all impact construction and maintenance costs. The data below is sourced from the Category Analysis and Economic Benchmarking RINs.

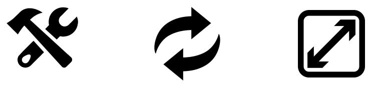
Line Capacity (kVA-kms) per Customer - FY13



Line Capacity per Customer

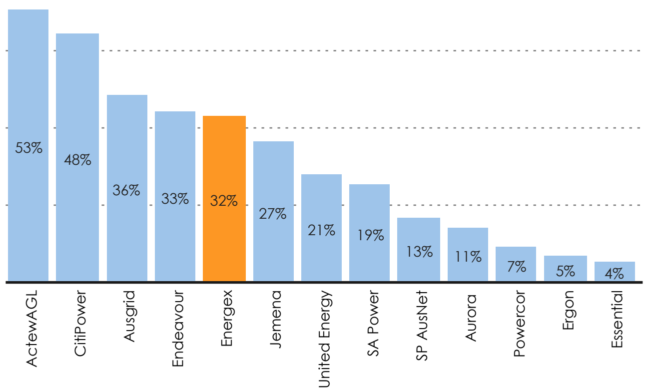
The graphic to the left shows the variation in line capacity per customer of each of the businesses. The line capacity (the length of feeders multiplied by their capacity) per customer provides an indication of both the length and design voltage required to deliver energy to end users.

Activities impacted by this cost driver:



Maintenance Opex | Replacement Capex | Augmentation Capex

Network Underground (%) - FY13



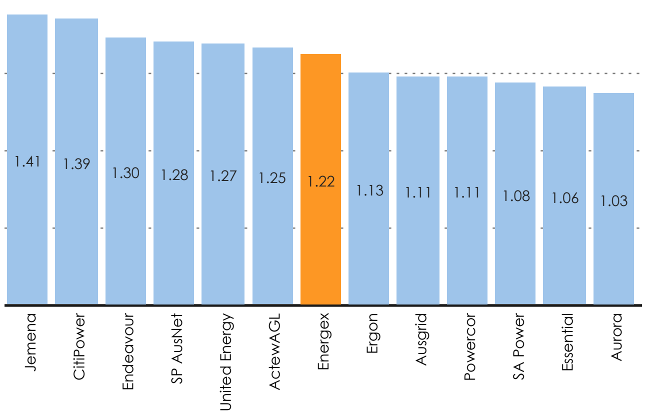
Proportion of Underground

The graphic to the left shows the proportion of the network that is underground by circuit length. Undergrounding assets is generally more expensive during construction than overhead assets, however underground assets are more resilient and generally have lower total lifecycle costs due to the lower maintenance requirements.

Activities impacted by this cost driver:

Maintenance Opex | Emergency Response | Vegetation Management

Circuit Density (times) - FY13



Circuit Density (circuit km vs route km)

The graphic to the left shows the variation in circuit density - the length of network circuit divided by the route length. This measure gives an indication of the radial nature of lines and also the redundancy within routes. Whilst only a high level indicator,

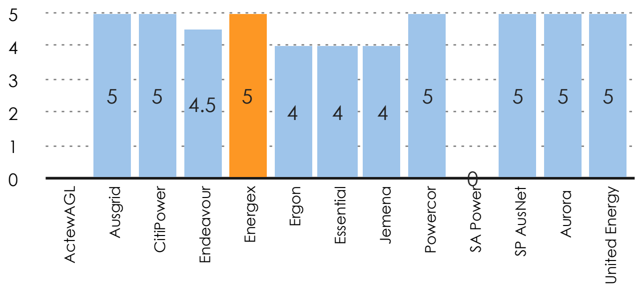
Activities impacted by this cost driver:

Maintenance Opex | Network Control

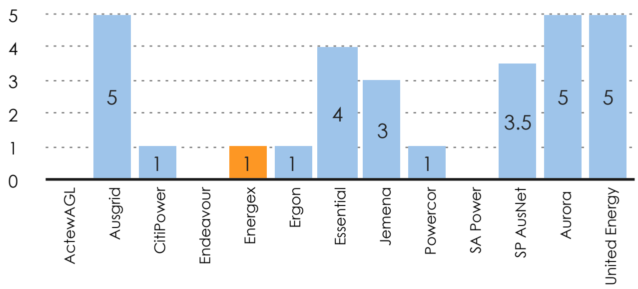
Activity Scheduling

Inspection cycles have a significant impact on maintenance costs. A high degree of maintenance costs for an electricity network are preventative activities such as inspections, and the period for inspection by asset class will determine the workload, and therefore costs. The data below is sourced from the Category Analysis RINs and is based on FY13.

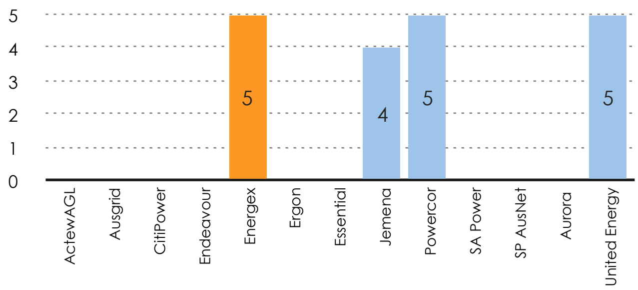
Pole Inspection Cycle



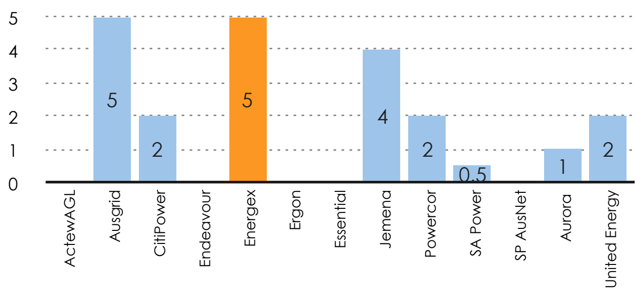
OH Asset Inspection Cycle



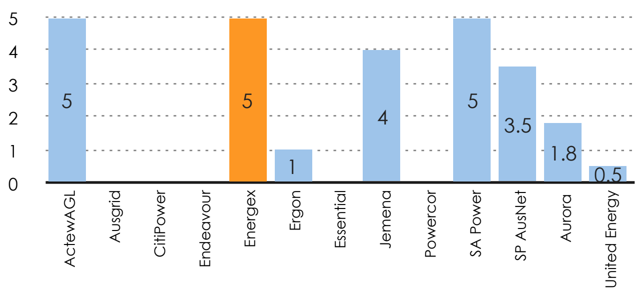
LV (up to 11kV) UG Inspection Cycle



HV (33kv and above) UG Inspection Cycle



Distribution Transformer Inspection Cycle



inspection Cycles (years)

The graphs to the left show inspection cycles of various asset classes. These cycles have a direct influence on the amount of expenditure over time spent on conducting preventative maintenance on the assets. Where some of the fields are blank, the DNSP may not have provided the data in the RIN or may have a run-to-failure maintenance strategy.

Activities impacted by this cost driver:

Maintenance Opex

Partial Productivity Analysis

Using data available across the NEM, business can compare common partial productivity indicators (cost ratios of disaggregated cost categories) against other business, over time and in relation to environmental or other explanatory variables.

This chapter provides a range of indicators.

5

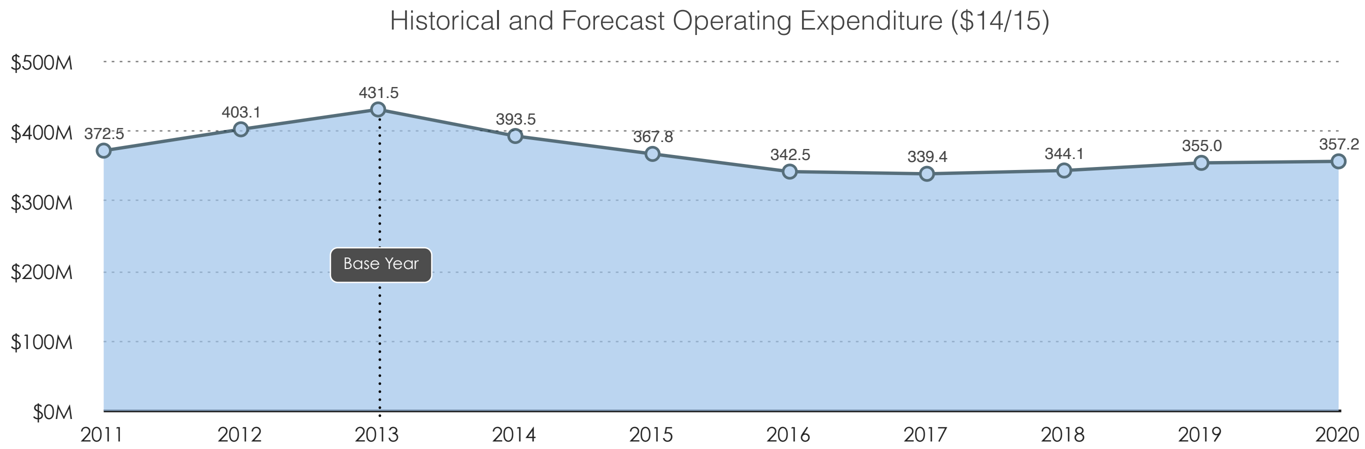
Trend analysis shows changes in costs between regulatory periods

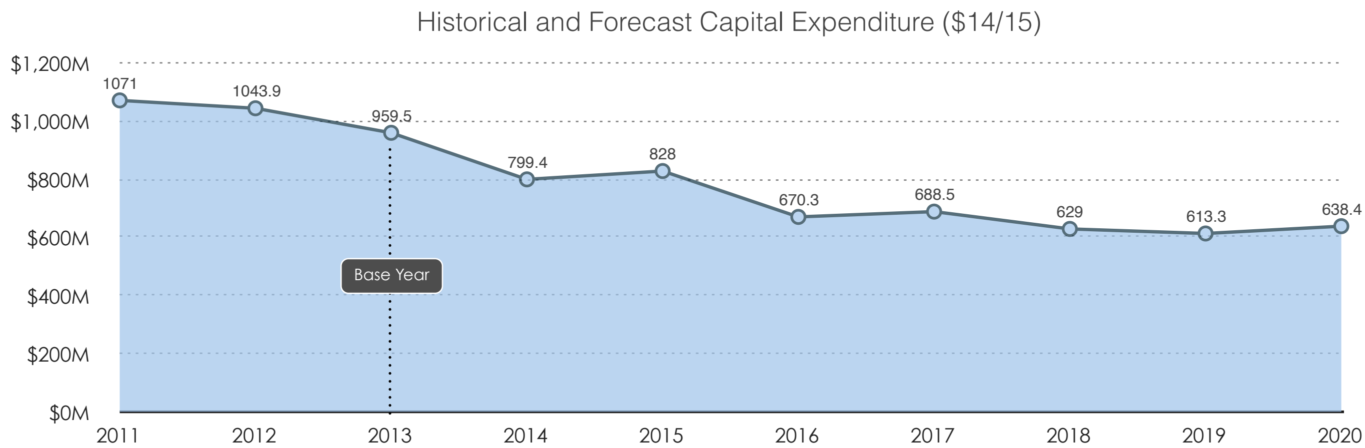
Driven by significant reductions in augmentation expenditure, Energex's total expenditure in FY20 is forecast to be lower than it was in FY11, this is despite growth in Energex's line length and customer connections.

In real terms, Energex is forecasting significant reductions in total expenditure, total expenditure per customer and total expenditure per km (historic and forecast costs sourced from Energex, historic customer and kilometre numbers from the Economic Benchmarking RIN, forecast customer numbers and kilometres provided by Energex):

- Total expenditure will be reduced by 31% (from $1,444 in FY11 to $996 in FY20)
- Total expenditure per customer will be reduced by 37% (from $1,088 in FY11 to $676 in FY20)
- Total expenditure per km will be reduced by 37% (from $28,432 in FY11 to $17,849 in FY20)

The reductions in operating expenditure and capital expenditure are shown below.





Assessing partial productivity at the functional level

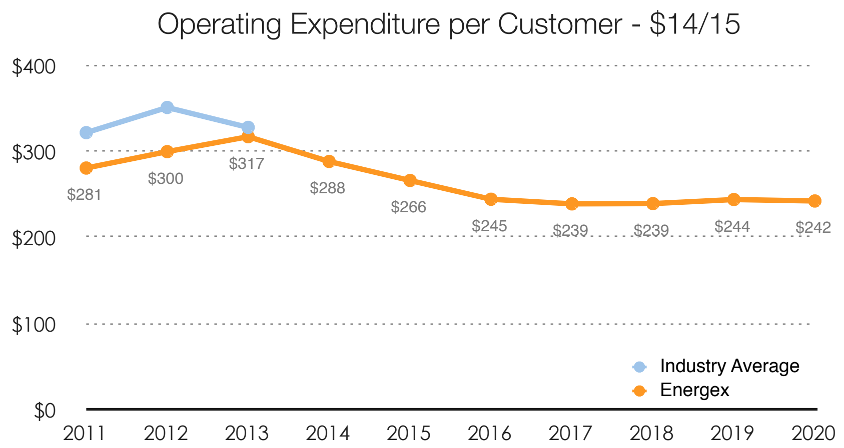
As discussed throughout this report, Energex's ability to rely upon the economic benchmarking techniques introduced by the AER as a guide to the likely evaluation of its expenditure forecast is limited based on:

- The uncertainty that remains around the specification of the economic benchmarking models adopted by the AER;
- The sensitivity of the models to changes in assumptions; and
- The lack of clarity in how the models will be employed in the determination process.

To gain further insight into Energex's current and recent performance, as well as forecast performance, partial productivity analysis can at least provide signals of productivity at the functional level of costs. The following sections provide some common measures of partial productivity, comparing Energex over time and against industry peers.

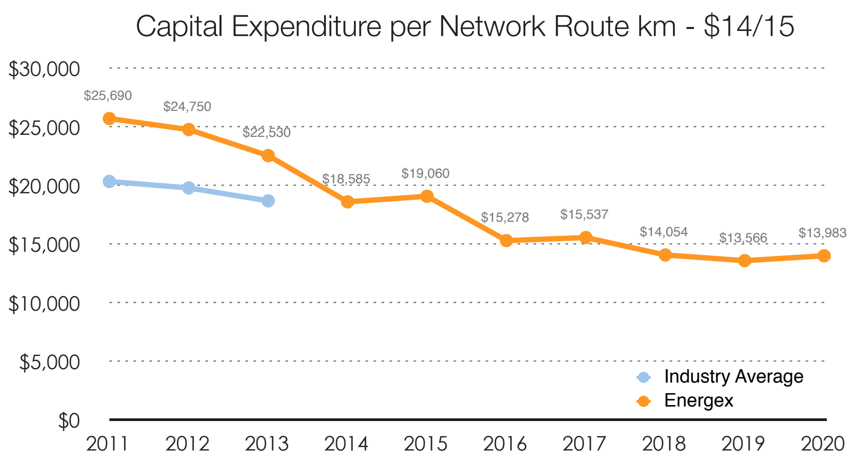
High level trends provide a guide to relative performance

At the very highest levels, opex and capex partial productivity analysis (below) shows that Energex is achieving long term reductions in both high level measures. Energex will start the upcoming period below the industry average for both measures.



Opex Partial Productivity

Energex's operating expenditure per customer began the current period at just below the industry average, with the gap widening during the period until the last year (in which Energex incurred significant redundancy payments). The forecast Energex operating expenditure and anticipated customer growth rate result in a long term reduction in this partial productivity indicator in real terms (after inflation and considering output growth).



Capex Partial Productivity

Energex's capital expenditure per km began the current period above the industry average, with the gap narrowing during the period. The forecast Energex capital expenditure and anticipated km growth rate result in a long term reduction in this partial productivity indicator in real terms (after inflation and considering output growth).

Partial productivity indicators for lower levels of cost disaggregation are presented in the following pages.

System Capital Expenditure

Partial Productivity Analysis

System capital expenditure is predominately comprised of replacement and augmentation expenditure. These costs make up to 50% of industry expenditure across the NEM.

Replacement Capex

Replacement capex is driven by age and condition. Age profiles vary across to the NEM as do operating conditions that deteriorate assets. Replacement capex can be measured relative to the asset size or value, but normalisation is generally required. Average unit costs per item replaced by asset class can also be measured.

Augmentation Capex

Augmentation is difficult to benchmark, as there is no system level indicator that appropriately reflects the need to invest in new assets. Single year partial productivity measures for augmentation capex are significantly flawed - not just for this reason, but also because projects often run over multiple years and the capacity and expenditure do not necessarily occur in the same financial year.

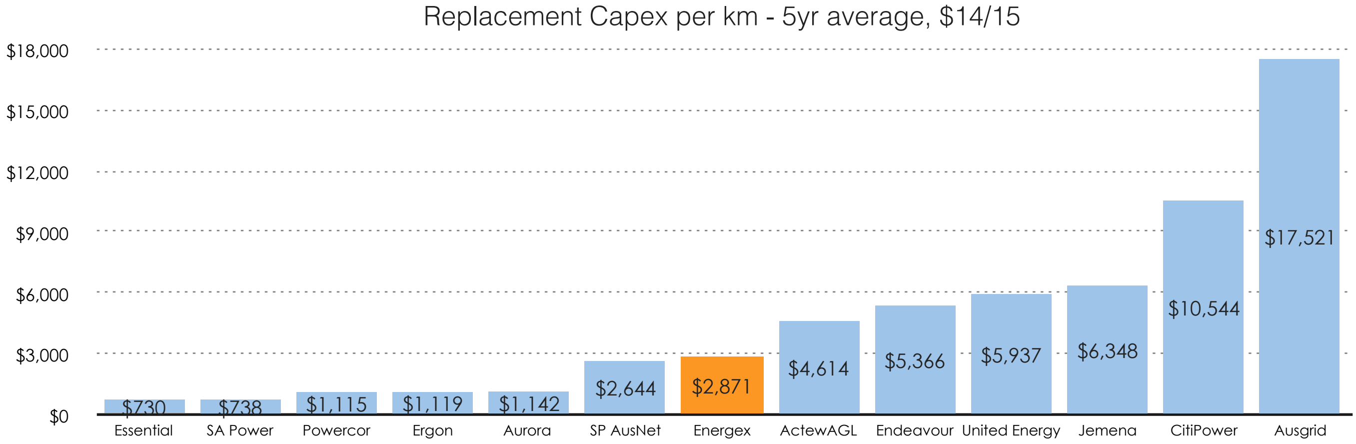
Benchmarking analysis and measures

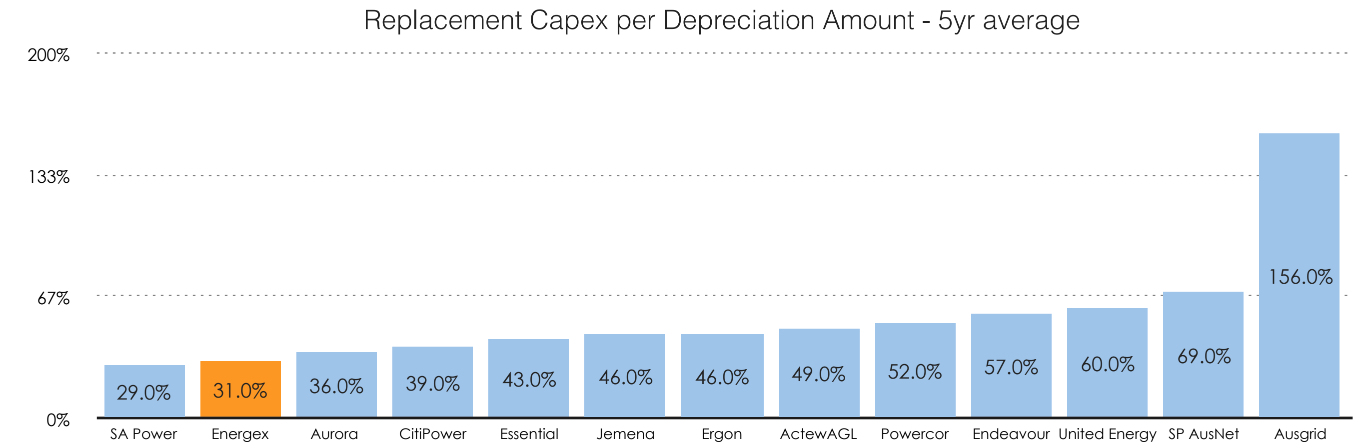
The table below shows the benchmarking analysis and measures included in this section.

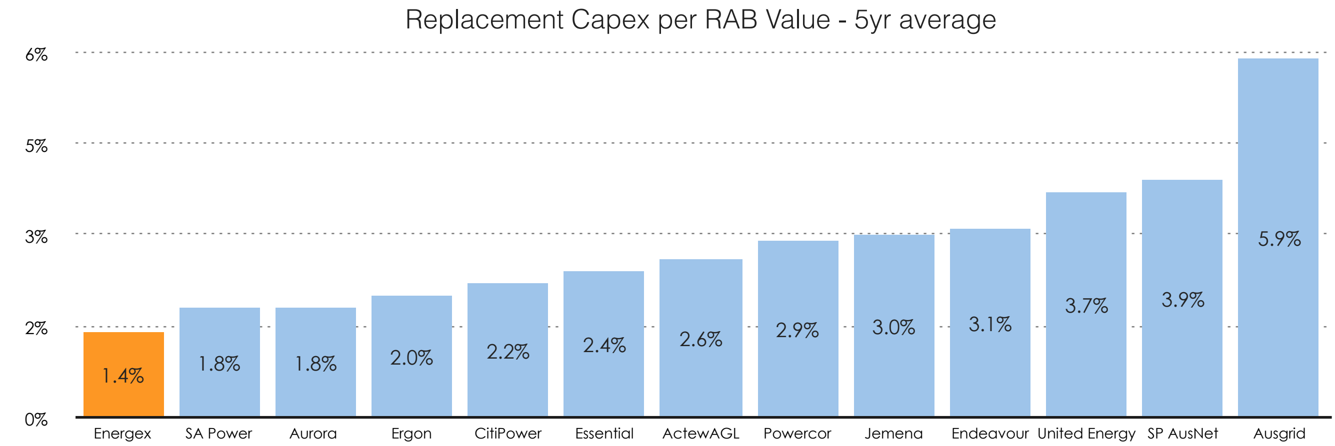
Category	Measure	Type
Replacement Expenditure	Repex per km	Comparison
	Repex per $ Depreciation	Comparison
	Repex per $RAB	Comparison
	Repex per km	Trend
	Repex per km Growth Rate	Comparison
	Average Replacement Costs	Comparison
Augmentation Expenditure	Total Augmentation per MVA Zone Substation Capacity Added	Comparison
	Total Augmentation per MVA Line Capacity Added	Comparison
	Total Augmentation per MVA-kms of System Capacity Added	Comparison

Replacement capital expenditure

There are many common replacement partial productivity indicators - using size or value of the asset, or some other physical measurement - as the denominator to allow for scale differences. Unfortunately with electricity networks, comparison complexity is complicated by several other factors that influence replacement costs. The following pages provide comparison of common replacement partial productivity measures - showing direct comparisons, trends and average asset replacement costs.





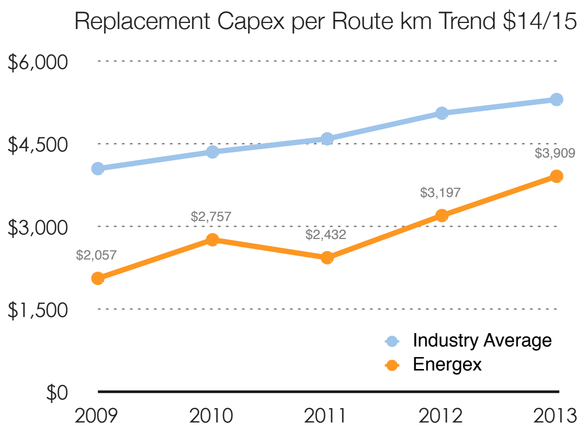


Replacement capex trends show performance relative to industry

Whilst absolute comparisons are difficult to draw conclusions from due to the differences in networks, rates of growth of the partial productivity factor can at least indicate relative performance of an individual DNSP against the industry trends.

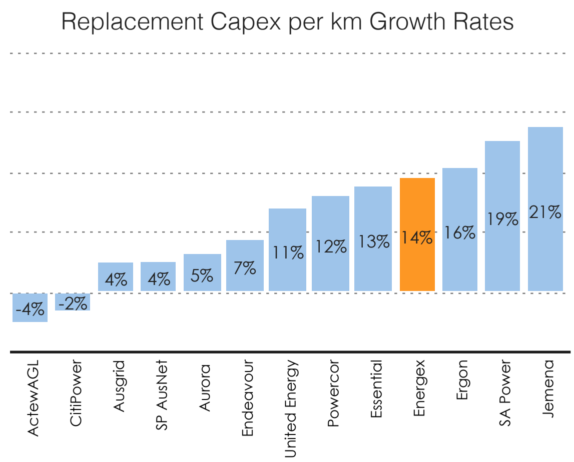
Replacement Capex (partial productivity trend)

The graphs below show replacement capex partial productivity indicator trends compared to individual and industry average rates of growth for the indicator.



5.5% Industry Annual Growth Rate

14% Energex Growth Rate FY09-FY13

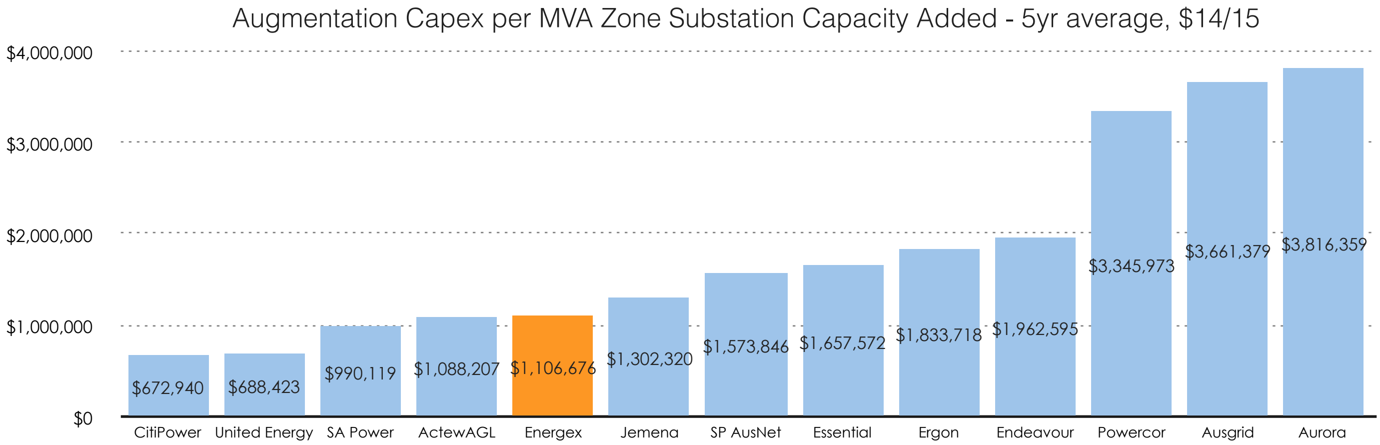


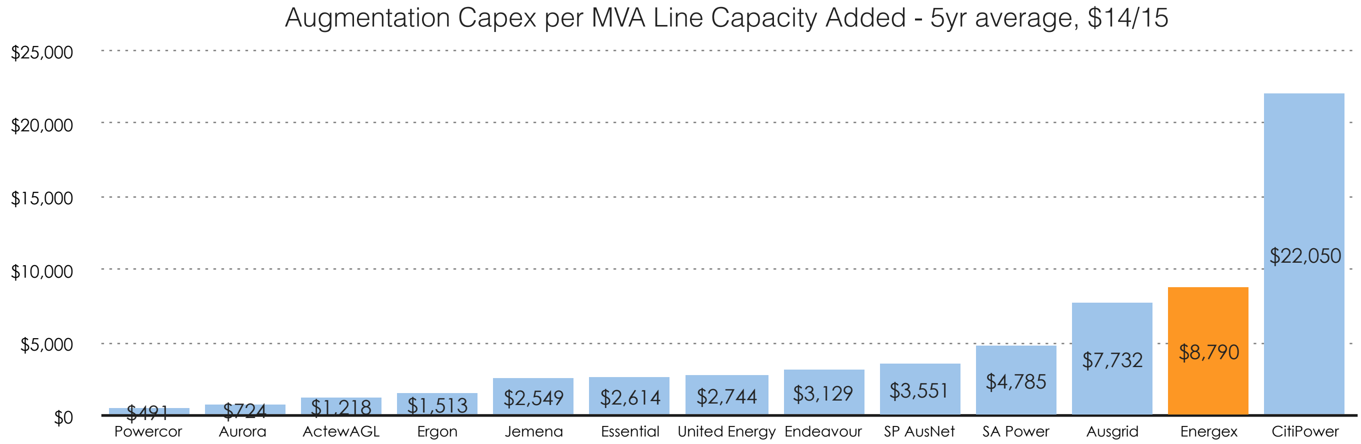
Replacement Expenditure Benchmarking Key Point

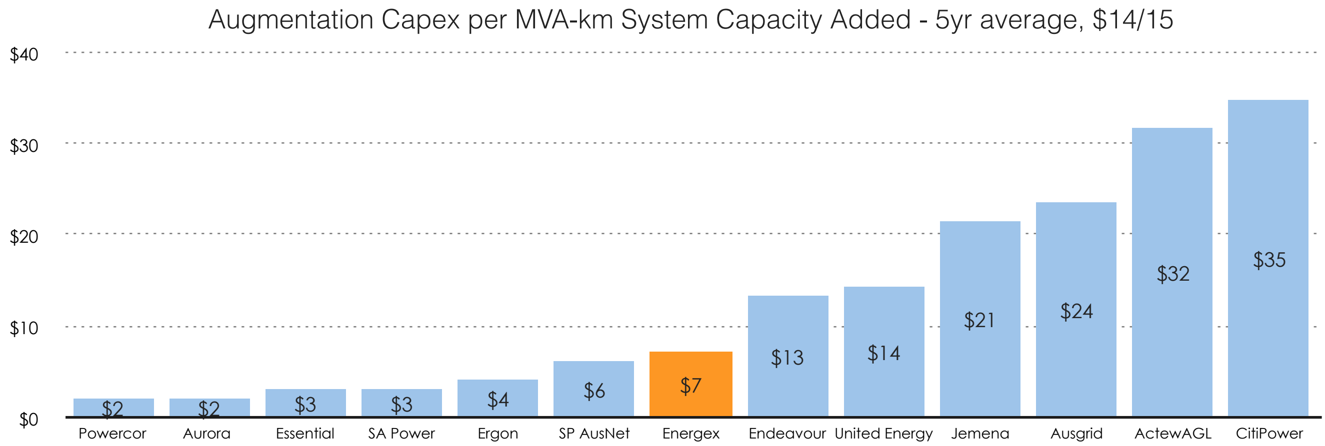
Energex's replacement expenditure is historically low compared to other DNSPs. This may be due to lower unit rates of equipment replacement, lower levels of replacement activity or a combination of both.

Augmentation capital expenditure

Augmentation capital expenditure is difficult to benchmark due to manner in which it is triggered (by localised demand constraints) and the means by which it is accounted for (capitalisation of the expenditure versus commissioning of the capacity). The latter can be somewhat mitigated by measuring over a longer time period, but the measures at a system level will always be difficult to compare without knowledge of the constraints and types of projects undertaken







Maintenance & Vegetation Opex

Partial Productivity Analysis

Maintenance, emergency response and vegetation management opex are the major asset driven components of opex.

Maintenance Opex

Maintenance opex is driven primarily by inspection cycles, asset condition and work practices. A large amount of network maintenance is preventative actions such as inspections, although inspections often lead to discovery of defects that trigger corrective maintenance.

Emergency Response Opex

Emergency response maintenance is generally driven by network design and environmental factors but will also be influenced by the condition and resilience of the asset. It can fluctuate with long term weather patterns.

Vegetation Management Opex

Vegetation management opex is influenced by design and environmental factors through exposure of overhead assets and types and growth rates of local vegetation.

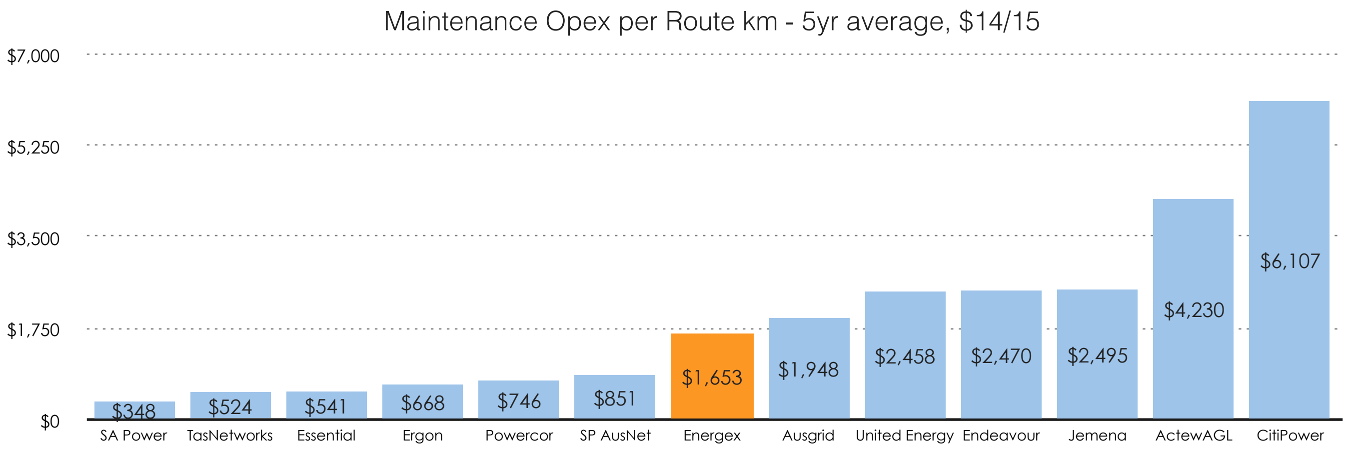
Benchmarking analysis and measures

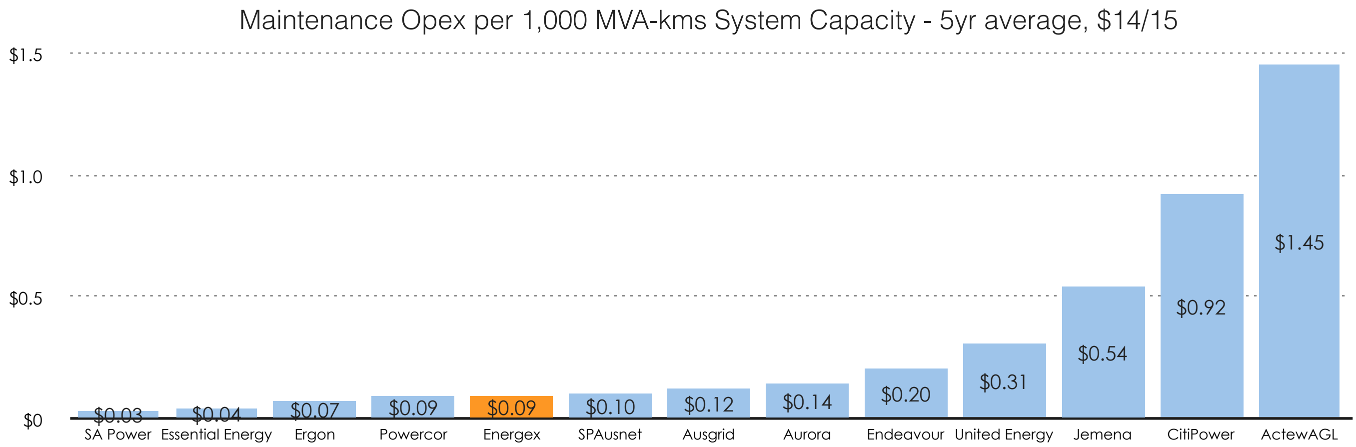
The table below shows the benchmarking analysis and measures included in this section.

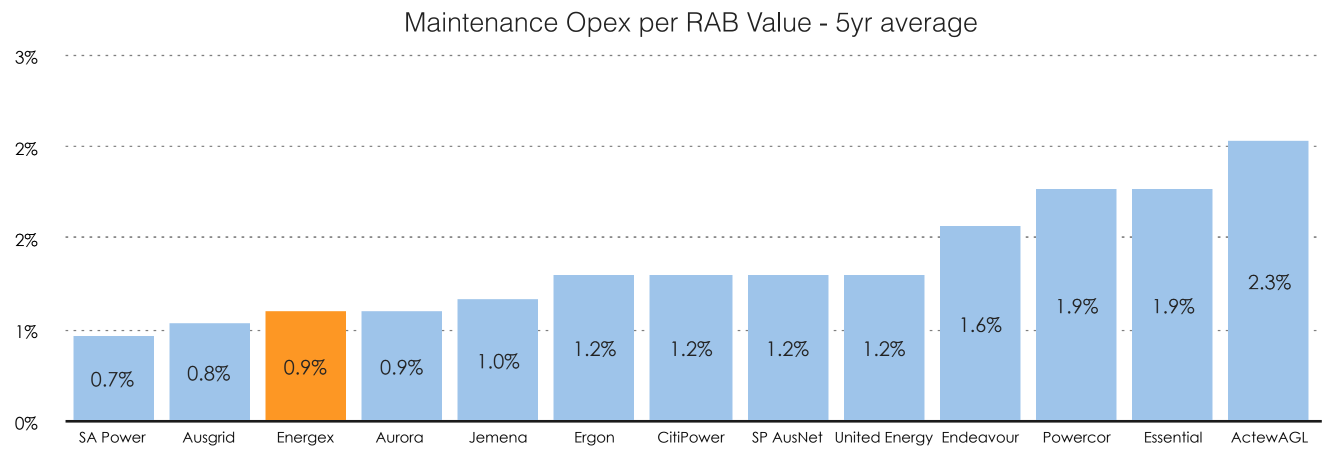
Category	Measure	Type
Maintenance Expenditure	Maintenance per km	Comparison
	Maintenance per System Capacity	Comparison
	Maintenance per $RAB	Comparison
	Maintenance per km	Trend
	Maintenance per km Growth Rate	Comparison
	Maintenance per km and Line Capacity Density	Relationship
	Maintenance per km and Circuit km per Route km	Relationship
Emergency Response Expenditure	Emergency Response per Maintenance Dollar	Comparison
	Emergency Response per km	Trend
	Emergency Response per km Growth Rate	Comparison
Vegetation Management Expenditure	Vegetation Management per Overhead km	Comparison
	Vegetation Management per Overhead km	Trend
	Vegetation Management per Overhead km Growth Rate	Comparison

Maintenance opex is more readily compared than many other cost categories

There are many common maintenance partial productivity indicators - using size or value of the asset, or some other physical measurement - as the denominator to allow for scale differences. Unfortunately with electricity networks, comparison complexity is complicated by several other factors that influence maintenance costs. The following pages provide comparison of common maintenance partial productivity measures - showing direct comparisons, trends and the relationship with several explanatory variables.





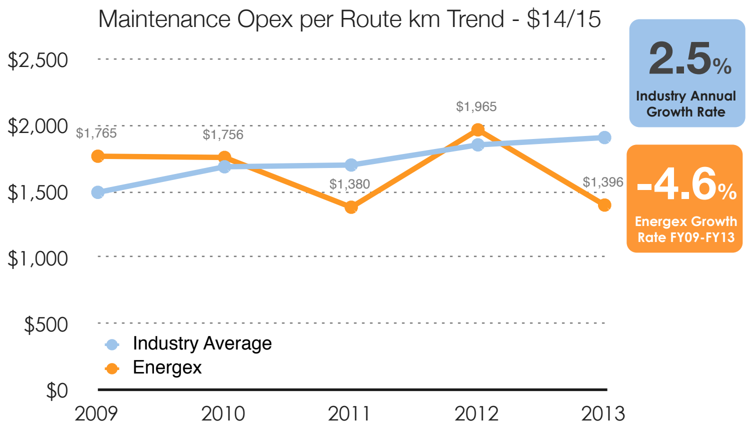


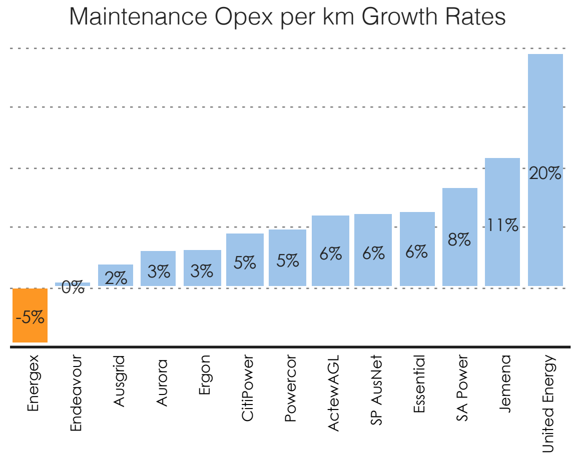
Maintenance opex trends show performance relative to industry

Whilst absolute comparisons are difficult to draw conclusions from due to the differences in networks, rates of growth of the partial productivity factor can at least indicate relative performance of an individual DNSP against the industry trends.

Maintenance Opex (partial productivity trend)

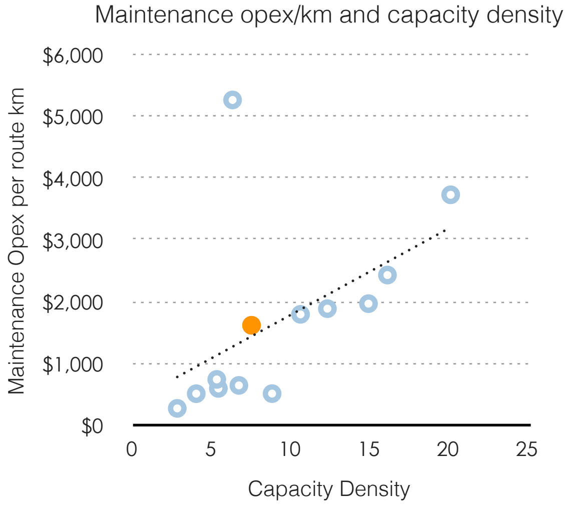
The graphs below show maintenance partial productivity indicator trends compared to individual and industry average rates of growth for the indicator.

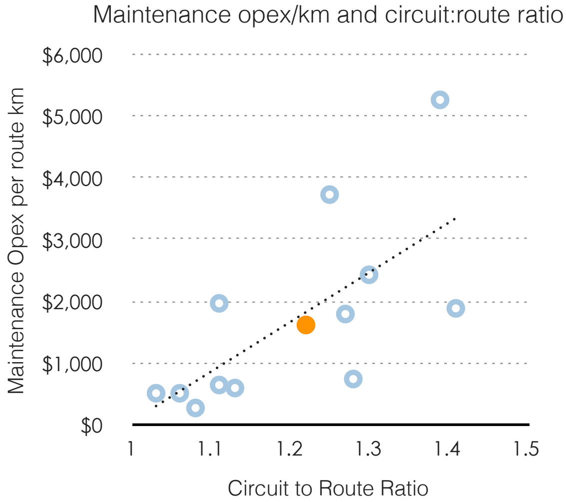




Maintenance Opex (explanatory variables)

The graphs below show relationships between maintenance indices and two explanatory variables. As shown, capacity density (measured as MVA-kms of line per km network length) is reasonably strongly correlated with the maintenance costs per km of line with the exception of one outlier. There is some relationship between maintenance opex per km and the number of circuit kilometres per route kilometre, but other factors are influencing the result.



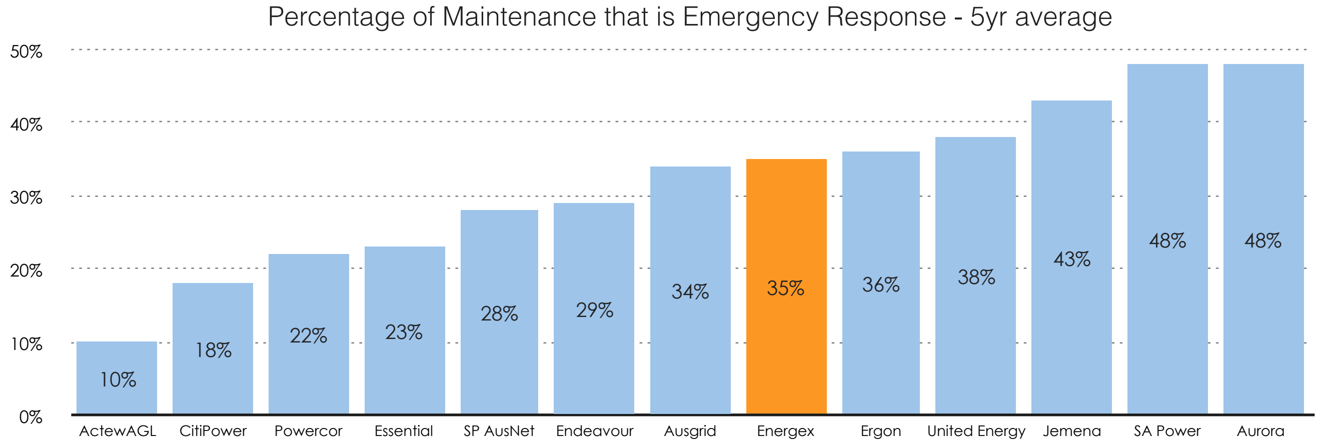


Maintenance Benchmarking Key Point

The Category Analysis RINs have been used for the comparison of expenditure between businesses in this category. However Huegin notes that the basis of categorisation for these costs in the historical RIN information and the categorisation for Energex's proposal have a different basis and cannot therefore be compared across time periods.

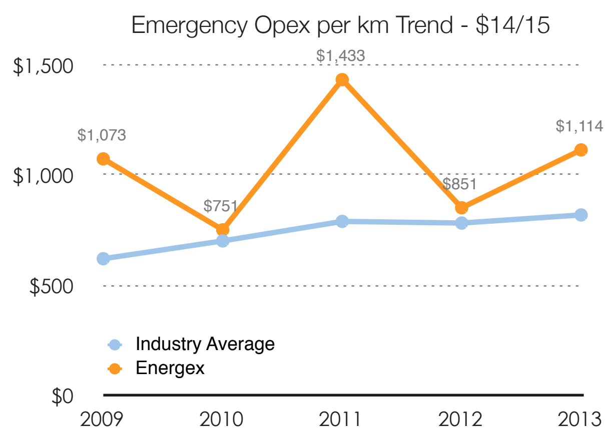
Emergency response

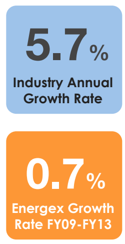
Network design and environmental and weather patterns all influence emergency response opex, but as a measure it is difficult to benchmark. Without an understanding of the nature of the events that trigger the response it is difficult to understand if a business is spending the appropriate amount on emergency response. Ideally, all maintenance would be planned, but that is impossible for an electricity network. The percentage of maintenance that is emergency response related is shown below.

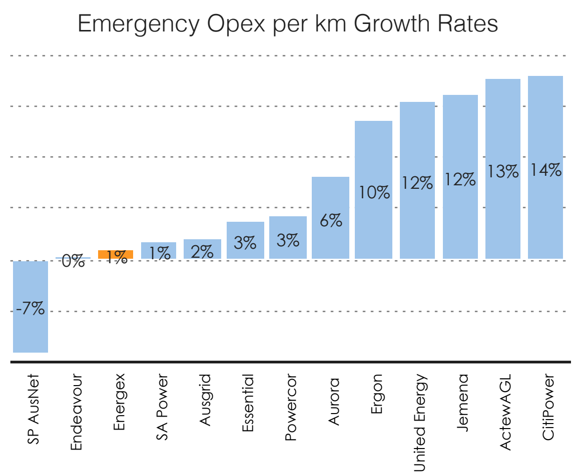


Emergency Response (partial productivity trends)

Looking at emergency response opex per km of network is not particularly useful from a comparison point of view, however trending the proportion of emergency response opex over time is likely only to show seasonal variations. To provide some illustration of the emergency response impost over time, response opex per km is shown below.





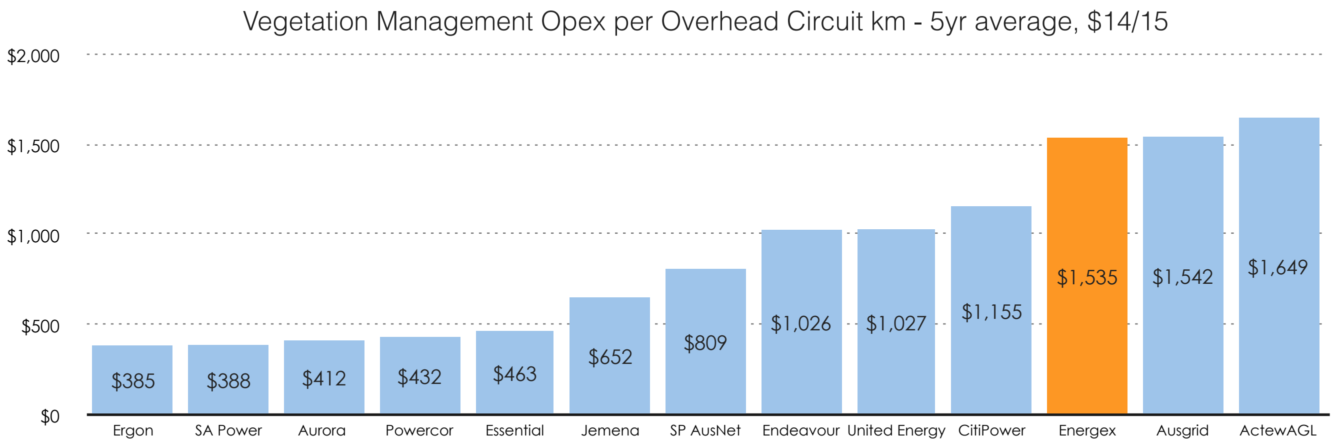


Emergency Response Benchmarking Key Point

The Category Analysis RINs have been used for the comparison of expenditure between businesses in this category. However Huegin notes that the basis of categorisation for these costs in the historical RIN information and the categorisation for Energex's proposal have a different basis and cannot therefore be compared across time periods.

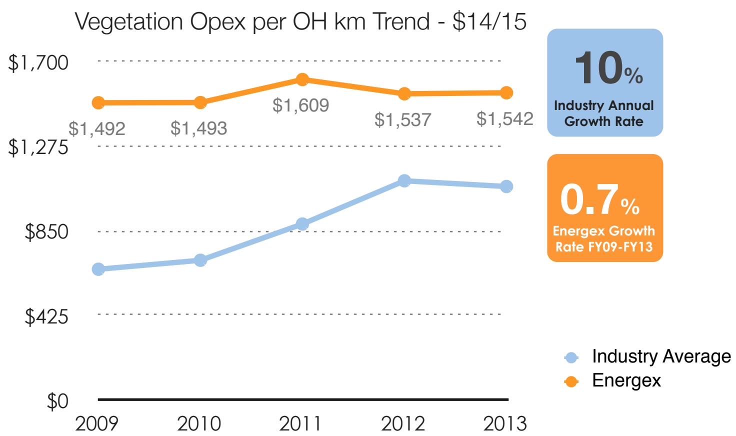
Vegetation management costs have not increased in QLD as much as other states

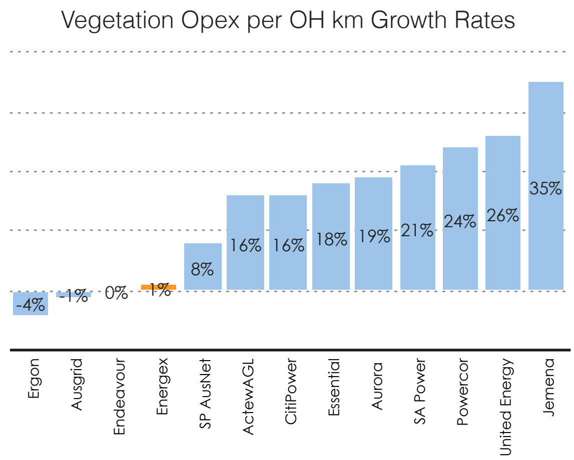
Vegetation management costs per overhead kilometre of network are reasonably comparable, but differences in scope between businesses exist, different standards apply and the cost of cutting trees in dense urban areas carries a cost premium.



Vegetation Management Opex (partial productivity trends)

The graphs below show vegetation management partial productivity indicator trends compared to individual and industry average rates of growth for the indicator.





Non-network Expenditure

Partial Productivity Analysis

Fleet management, IT and property are three major components of this spend category that can be benchmarked across businesses.

Fleet Management

Capital and operating expenditure associated with the management of cars, light and heavy commercial vehicles are driven by the location of the network and management policies.

Information Technology

Generally there are no physical network factors that should affect information technology expenditure. Rather, differences in IT spend will occur through business model differences and nature of non-recurrent expenditure.

Property Management

Capital and operating expenditure associated with the management of land and buildings are driven by the location of the network and management policies.

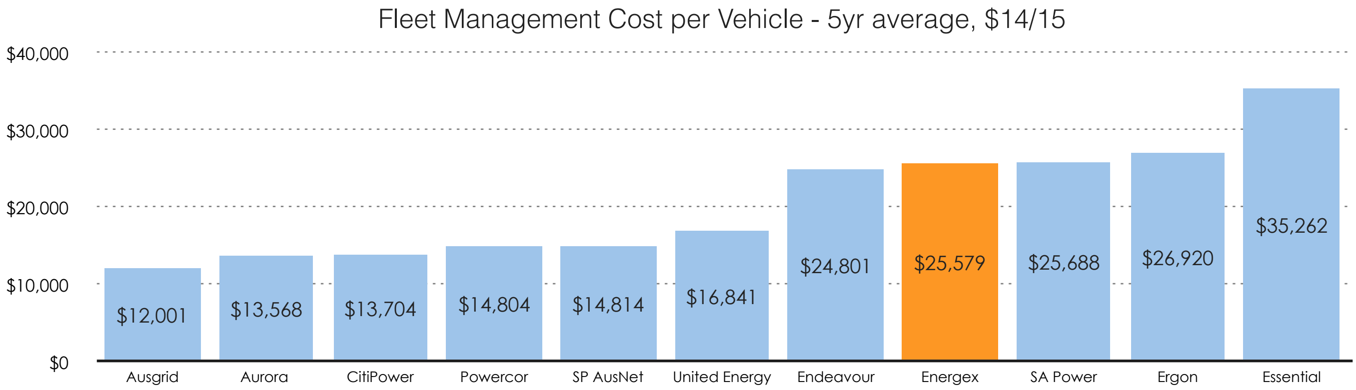
Benchmarking analysis and measures

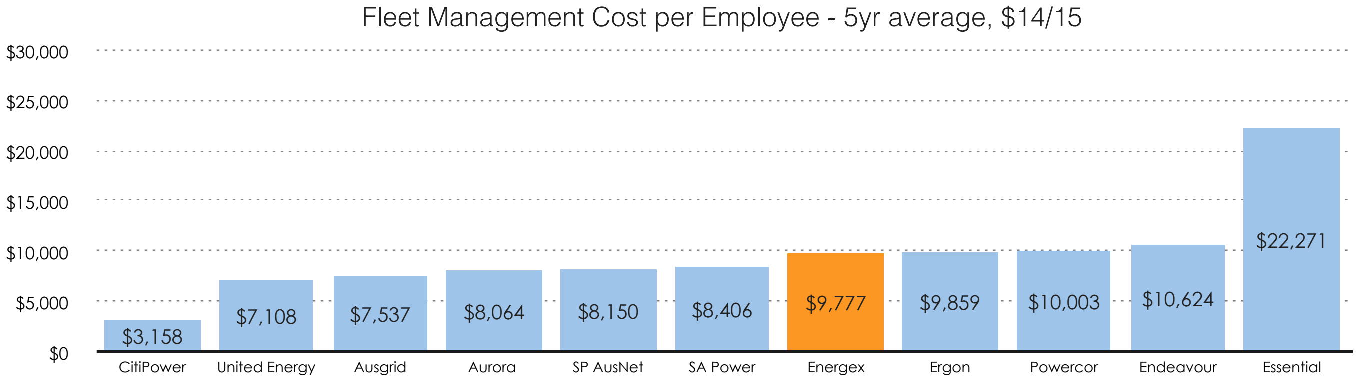
The table below shows the benchmarking analysis and measures included in this section.

Category	Measure	Type
Fleet Management	Fleet Expenditure per Vehicle	Comparison
	Fleet Expenditure per FTE	Comparison
	Fleet Expenditure per Vehicle	Trend
	Fleet Expenditure per Vehicle Growth Rate	Comparison
Information Technology Expenditure	Emergency Response per Maintenance Dollar	Comparison
	Emergency Response per km	Trend
	Emergency Response per km Growth Rate	Comparison
Property Management Expenditure	Property Management per Employee	Comparison
	Property Management per Employee	Trend
	Property Management per Employee Growth Rate	Comparison

Fleet management costs

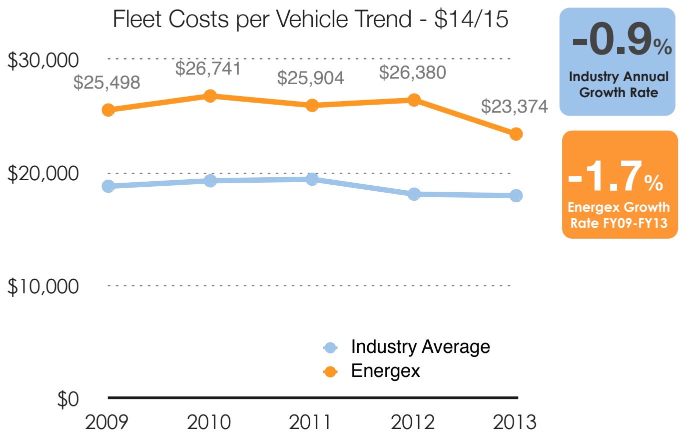
Fleet management is a significant non-system expense for most electricity networks. The fleet expenditure reported in the analysis here is for cars, light commercial and heavy commercial vehicles only - that is, it excludes trailers, cranes, EWPs, etc.

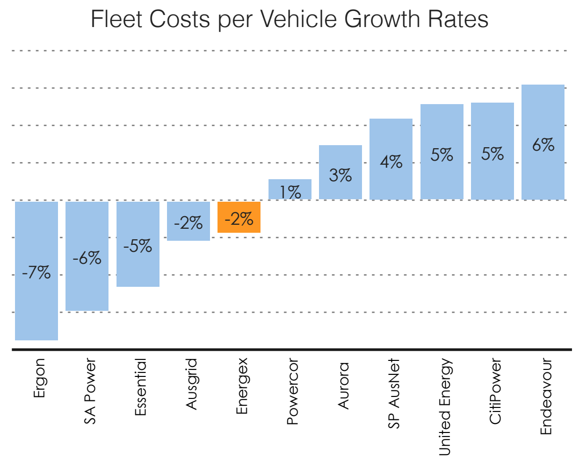




Fleet Management Expenditure (partial productivity trends)

Fleet costs per vehicle depend on location, fleet type, distances travelled and ownership policies, making direct comparison challenging. Trends over time for fleet expenditure per vehicle are shown below.



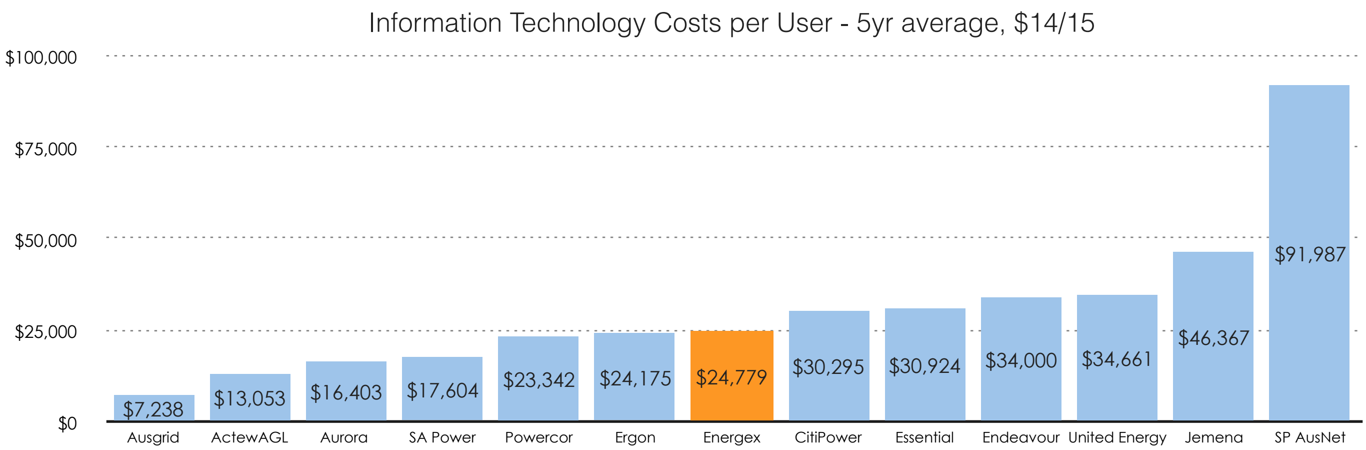


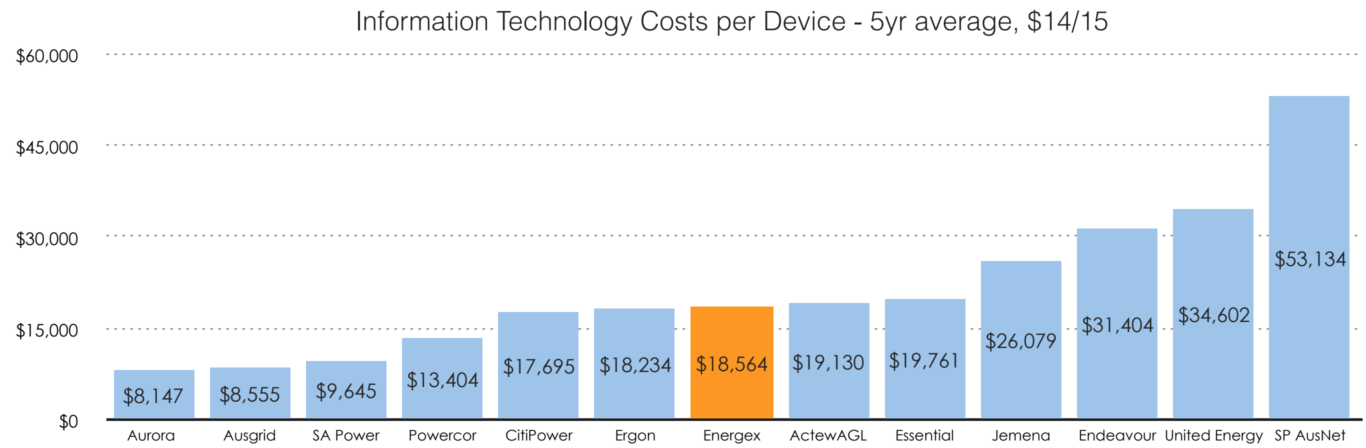
Fleet Management Benchmarking Key Point

Energex owns its fleet equipment. As the costs above include gross capex (i.e. without adjustment for the benefit of disposals) total costs for Energex and other businesses that own part or all of its fleet will be overstated compared to businesses that fully lease all fleet items.

Information technology costs

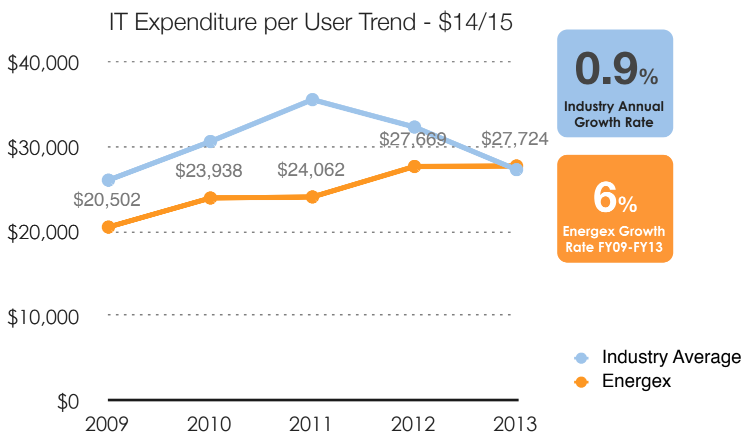
Business models for IT service delivery vary across the NEM. In particular, Ergon Energy and Energex have a shared IT service provider, Sparq Solutions and many of the privatised businesses have shared corporate services. IT costs can be reported by user or device, but it must be considered that these costs may include large, discrete IT projects.

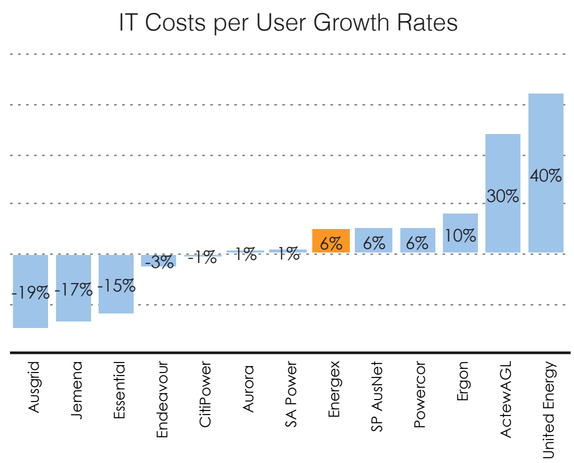




IT Expenditure (partial productivity trends)

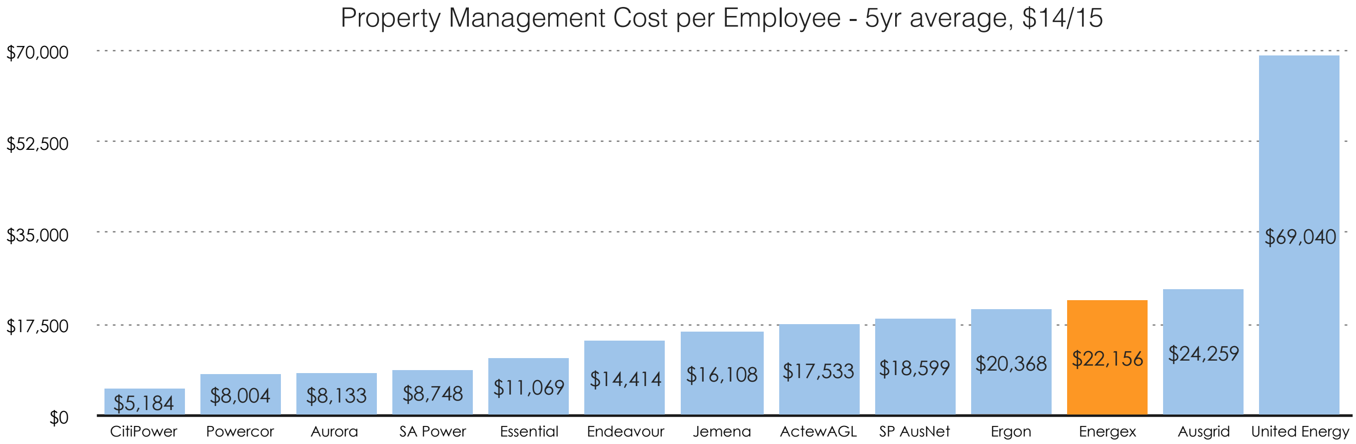
Total IT expenditure per user can be misleading as it includes non-recurrent expenditure which will often be large system upgrades and therefore not driven by user numbers. Trends over time for IT expenditure per user are shown below.





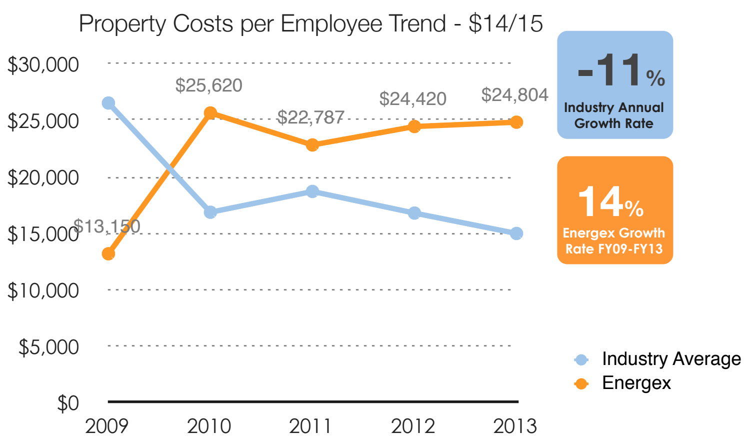
Property management costs

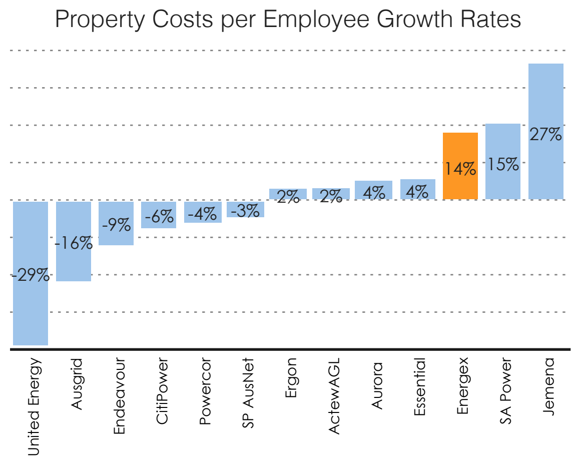
Property management costs can carry a premium for both CBD businesses and large, rural businesses - through either cost per square metre or quantity of buildings required respectively.



Property Management Expenditure (partial productivity trends)

Property costs per employee depend on location, and ownership policies. Single construction projects in a period can skew these measures when taken over a short period. Trends over time for property expenditure per employee are shown below.





Annex - Supporting material

- Estimating output weights
- MTFP scores over time
- Econometric models statistics

A

A. Estimating output weights

Scenario 1 - Leontief cost function

This analysis uses the Leontief cost function to derive the output cost share weights. The model assumes that inputs are used in fixed proportions for each output, and costs are given by:

$$C(y^t, w^t, t) = \sum_{i=1}^{M} w_i^t \left[\sum_{j=1}^{N} (a_{ij})^2 y_j^t (1 + b_i t) \right]$$

where there are M inputs and N outputs, wi is an input price, yj is an output and t is a time trend representing technological change. The input/output coefficients aij are squared to ensure that the outputs are non-negative, i.e. that outputs cannot be increased by reducing an input.

The coefficients aij and bj were estimated by the input demand equations:

$$x_i^t = \sum_{j=1}^{N} (a_{ij})^2 y_j^t (1 + b_i t) .$$

The input demand equations were fitted separately by non-linear regression for each DNSP using data for the years 2006 to 2013, with 2006 corresponding to t=1 and 2013 corresponding to t=8.

The output cost shares were then calculated for each output using the formula:

$$h_j^t = \frac{\sum_{i=1}^{M} w_i^t \left[(a_{ij})^2 y_j^t (1 + b_i t) \right]}{\sum_{i=1}^{M} w_i^t \left[\sum_{j=1}^{N} (a_{ij})^2 y_j^t (1 + b_i t) \right]} .$$

Results

The tables below list the output cost shares for each DNSP for each year and output. The weighting of 75% customer connections and 25% system capacity is obtained by finding the weighted average of these cost shares.

DNSP	Year	H1	H2
Essential Energy	*2006*	0.721	0.279
Essential Energy	*2007*	0.671	0.329
Essential Energy	*2008*	0.592	0.408
Essential Energy	*2009*	0.565	0.435
Essential Energy	*2010*	0.489	0.511
Essential Energy	*2011*	0.466	0.534
Essential Energy	*2012*	0.467	0.533
Essential Energy	*2013*	0.423	0.577
ActewAGL	*2006*	0.858	0.142
ActewAGL	*2007*	0.829	0.171
ActewAGL	*2008*	0.784	0.216
ActewAGL	*2009*	0.78	0.22
ActewAGL	*2010*	0.722	0.278
ActewAGL	*2011*	0.726	0.274

ActewAGL	*2012*	0.739	0.261
ActewAGL	*2013*	0.71	0.29
Aurora	*2006*	0.751	0.249
Aurora	*2007*	0.687	0.313
Aurora	*2008*	0.681	0.319
Aurora	*2009*	0.701	0.299
Aurora	*2010*	0.684	0.316
Aurora	*2011*	0.671	0.329
Aurora	*2012*	0.66	0.34
Aurora	*2013*	0.665	0.335
Ausgrid	*2006*	0.866	0.134
Ausgrid	*2007*	0.853	0.147
Ausgrid	*2008*	0.846	0.154
Ausgrid	*2009*	0.831	0.169
Ausgrid	*2010*	0.836	0.164
Ausgrid	*2011*	0.825	0.175
Ausgrid	*2012*	0.813	0.187
Ausgrid	*2013*	0.816	0.184
CitiPower	*2006*	0.785	0.215
CitiPower	*2007*	0.757	0.243
CitiPower	*2008*	0.737	0.263
CitiPower	*2009*	0.746	0.254
CitiPower	*2010*	0.733	0.267
CitiPower	*2011*	0.746	0.254
CitiPower	*2012*	0.733	0.267
CitiPower	*2013*	0.716	0.284
Endeavour Energy	*2006*	0.977	0.023
Endeavour Energy	*2007*	0.972	0.028
Endeavour Energy	*2008*	0.968	0.032
Endeavour Energy	*2009*	0.962	0.038
Endeavour Energy	*2010*	0.958	0.042
Endeavour Energy	*2011*	0.956	0.044
Endeavour Energy	*2012*	0.953	0.047
Endeavour Energy	*2013*	0.946	0.054
Energex	*2006*	0.79	0.21
Energex	*2007*	0.751	0.249
Energex	*2008*	0.735	0.265
Energex	*2009*	0.714	0.286

Energex	*2010*	0.704	0.296
Energex	*2011*	0.699	0.301
Energex	*2012*	0.691	0.309
Energex	*2013*	0.687	0.313
Ergon	*2006*	0.969	0.031
Ergon	*2007*	0.98	0.02
Ergon	*2008*	0.982	0.018
Ergon	*2009*	0.988	0.012
Ergon	*2010*	0.989	0.011
Ergon	*2011*	0.99	0.01
Ergon	*2012*	0.992	0.008
Ergon	*2013*	0.992	0.008
Jemena	*2006*	0.853	0.147
Jemena	*2007*	0.809	0.191
Jemena	*2008*	0.744	0.256
Jemena	*2009*	0.735	0.265
Jemena	*2010*	0.673	0.327
Jemena	*2011*	0.648	0.352
Jemena	*2012*	0.619	0.381
Jemena	*2013*	0.565	0.435
Powercor	*2006*	0.893	0.107
Powercor	*2007*	0.864	0.136
Powercor	*2008*	0.831	0.169
Powercor	*2009*	0.813	0.187
Powercor	*2010*	0.778	0.222
Powercor	*2011*	0.772	0.228
Powercor	*2012*	0.756	0.244
Powercor	*2013*	0.741	0.259
SA Power	*2006*	0.599	0.401
SA Power	*2007*	0.507	0.493
SA Power	*2008*	0.495	0.505
SA Power	*2009*	0.429	0.571
SA Power	*2010*	0.408	0.592
SA Power	*2011*	0.408	0.592
SA Power	*2012*	0.356	0.644
SA Power	*2013*	0.346	0.654
SP AusNet	*2006*	0.304	0.696
SP AusNet	*2007*	0.336	0.664

SP AusNet	*2008*	0.424	0.576
SP AusNet	*2009*	0.372	0.628
SP AusNet	*2010*	0.498	0.502
SP AusNet	*2011*	0.492	0.508
SP AusNet	*2012*	0.509	0.491
SP AusNet	*2013*	0.56	0.44
United Energy	*2006*	0.715	0.285
United Energy	*2007*	0.714	0.286
United Energy	*2008*	0.715	0.285
United Energy	*2009*	0.718	0.282
United Energy	*2010*	0.729	0.271
United Energy	*2011*	0.744	0.256
United Energy	*2012*	0.723	0.277
United Energy	*2013*	0.719	0.281

B. MTFP indices over time

After adjusting the raw MTFP results we were able to examine each DNSPs MTFP score both over time and relative to other DNSPs. The results are presented in the tables below;

Scenario 1 - Using Energex's historic data as reported in their Economic Benchmarking RIN (solar feed in tariffs excluded)

DNSP	2006	2007	2008	2009	2010	2011	2012	2013	Efficiency in 2013
ActewAGL	1.00	1.00	1.02	1.02	0.99	0.90	0.91	0.92	**0.44**
Ausgrid	0.98	1.06	0.89	0.90	0.96	0.95	0.95	1.05	**0.51**
CitiPower	2.25	2.22	2.31	2.17	2.10	2.26	2.04	2.07	**1.00**
Endeavour	1.15	1.11	1.00	1.05	1.10	1.09	1.03	1.03	**0.50**
Energex	1.42	1.48	1.41	1.44	1.45	1.44	1.47	1.48	**0.72**
Ergon	0.87	1.06	0.94	0.90	0.88	0.91	0.91	0.95	**0.46**
Essential	1.18	1.26	1.22	1.14	1.25	1.21	1.09	1.13	**0.55**
Jemena	1.68	1.66	1.88	1.77	1.71	1.76	1.67	1.67	**0.81**
Powercor	1.75	1.75	1.82	1.51	1.59	1.73	1.62	1.55	**0.75**
SA Power	1.94	1.87	2.02	1.93	1.75	1.74	1.85	1.77	**0.86**
SP AusNet	1.65	1.59	1.72	1.43	1.66	1.62	1.66	1.58	**0.76**
TasNetworks	1.36	1.33	1.32	1.22	1.15	1.25	1.20	1.31	**0.63**
United Energy	2.05	2.03	2.02	2.04	2.04	1.86	1.76	1.88	**0.91**

Scenario 1 - In summary

Using an output weight of 75% on customer connections, Energex is 28% from CitiPower - the most productive DNSP in 2013 using the AER's model specifications

Scenario 2 - Energex's nominated base year opex used (raw results)

DNSP	2006	2007	2008	2009	2010	2011	2012	2013	Efficiency in 2013
ActewAGL	1.00	1.00	1.02	1.02	0.99	0.90	0.91	0.92	**0.44**
Ausgrid	0.98	1.06	0.89	0.90	0.96	0.95	0.95	1.05	**0.51**
CitiPower	2.25	2.22	2.31	2.17	2.10	2.26	2.04	2.07	**1.00**
Endeavour	1.15	1.11	1.00	1.05	1.10	1.09	1.03	1.03	**0.50**
Energex	1.42	1.48	1.41	1.44	1.45	1.44	1.47	1.51	**0.73**
Ergon	0.87	1.06	0.94	0.90	0.88	0.91	0.91	0.95	**0.46**
Essential	1.18	1.26	1.22	1.14	1.25	1.21	1.09	1.13	**0.55**
Jemena	1.68	1.66	1.88	1.77	1.71	1.76	1.67	1.67	**0.81**
Powercor	1.75	1.75	1.82	1.51	1.59	1.73	1.62	1.55	**0.75**
SA Power	1.94	1.87	2.02	1.93	1.75	1.74	1.85	1.77	**0.86**
SP AusNet	1.65	1.59	1.72	1.43	1.66	1.62	1.66	1.58	**0.76**
TasNetworks	1.36	1.33	1.32	1.22	1.15	1.25	1.20	1.31	**0.63**
United Energy	2.05	2.03	2.02	2.04	2.04	1.86	1.76	1.88	**0.91**

Scenario 2 - In summary

Reducing Energex's 2013 opex has moved it marginally closer to the frontier DNSP (CitiPower) in 2013.

C. Opex forecasting model

$$\ln Opex = b_0 + b_1 \ln System\ Capacity + b_2 \ln Customers + \ln W_{OM} + b_3 Share\ of\ single\ stage\ transformation + b_4 \ln RAB + b_5 \ln Demand\ density + b_6 Time$$

Coefficient	Estimate	t-statistic	Coefficient	Estimate	t-statistic
b_0	3.212	1.48	b_4	0.013	0.12
b_1	0.175	2.74	b_5	-0.258	-2.18
b_2	0.439	2.06	b_6	0.032	3.88
b_3	-0.885	-3.12			

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