Western Power's productivity performance

Applying AER benchmarking techniques in context of AA4 submission

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Executive Summary

Synergies has been engaged to undertake productivity analysis of Western Power's historical operating and capital expenditure using economic benchmarking techniques along the lines of those applied by the Australian Energy Regulator. The results of our analysis are used to form a view on the likely efficiency of Western Power's expenditure forecasts incorporated in its Access Arrangement 4 (AA4) for the 2017-18 to 2021-22 regulatory period.

Regulatory context for use of economic benchmarking techniques

We consider that benchmarking techniques should form an important part of a balanced combination of top-down (benchmarking analysis) and bottom-up (program-specific analysis) assessment techniques applied to Western Power's expenditure forecasts. Such an approach is consistent with the assessment criteria in Chapters 6 and 6A of the National Electricity Rules (NER).

However, we do not consider that economic benchmarking techniques provide results that are sufficiently precise to deterministically set efficient expenditure allowances.

Our report provides a top-down assessment of Western Power's historic expenditure since 2006/07 and forecasts for its AA4. Program-specific analysis of its underlying expenditure programs are beyond the scope of our report.

Our main findings can be summarised in terms of:

- network characteristics and operating environment
- multilateral total factor productivity (MTFP) results.
- distribution network opex efficiency results using the stochastic frontier analysis (SFA) and data envelope analysis (DEA) benchmarking techniques.

Network characteristics and operating environment

Western Power has a mid to large-sized distribution network in terms of route line length, customer numbers, energy throughput and maximum demand compared to distribution networks in the NEM.

It is one of only a small number of networks that have CBD, urban, short rural and long rural sub-components (the only others are SA Power Networks and Ausgrid). Western Power also has a relatively large rural sub-network, which results in its customer density being relatively low and more closely aligned to the primarily rural rather than CBD/urban distributors in the NEM.

Our comparison of the distribution networks of Western Power and distribution network service providers (DNSPs) in the NEM indicate that the former's distribution network is most like the following networks, primarily because of the strong rural component of the networks:

- SA Power Networks (South Australia)[1]
- Powercor (Victoria)
- Ausnet Services (Victoria)
- Essential Energy (New South Wales)
- Ergon Energy (Queensland).

Given these characteristics, it is reasonable to assume that these networks are likely to face comparable underlying cost drivers. As a result, we consider that these DNSPs are the most suitable as peers for Western Power for the purpose of distribution MTFP analysis. This group of peers also includes a good distribution of private and government owned networks across jurisdictions. However, for thoroughness and transparency reasons, we have also presented results for Western Power's productivity performance compared to all NEM DNSPs.

There are only six TNSPs in the NEM (compared to 13 DNSPs), with relatively large differences in their size. Western Power's network size, throughput and maximum demand place it among the smaller TNSPs compared to the biggest, TransGrid and Powerlink. In terms of climatic and terrain factors, Western Power has a reasonably large bushfire risk exposure (although probably somewhat less than TNSPs in NSW, Victoria and SA).

Given the small number of TNSPs in the NEM and their heterogeneous network characteristics, it makes little sense to identify a peer group to which Western Power belongs. For these reasons, limited reliance should be placed on any productivity benchmarking applied to the TNSPs. Consequently, we have applied only the multilateral and partial total factor productivity techniques (MTFP and MPFP respectively) to the TNSPs.

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1 We note steel Stobje poles installed in the SA distribution network have a very different (materially lower) opex structure to wood poles, an issue that has been of significance to Western Power historically,

MTFP results

We have developed separate MTFP models for electricity distribution and transmission. The multilateral nature of the models allows us to compare MTFP levels across networks rather than just own-performance over time.

Electricity distribution

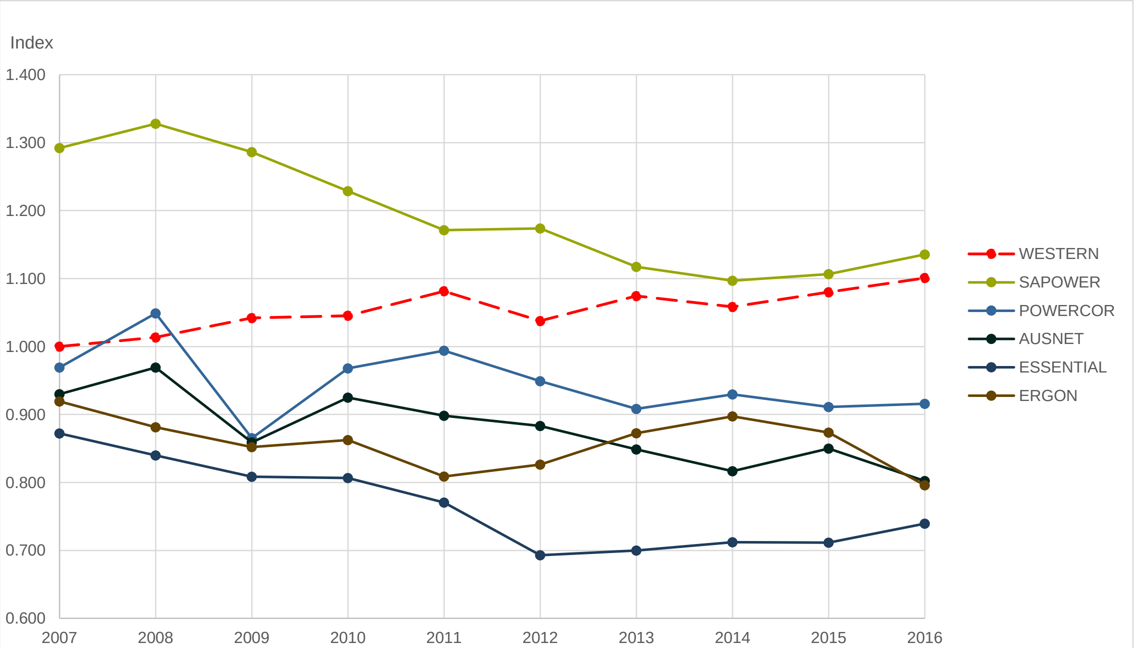
We have adopted Economic Insights' preferred MTFP model formulation as of July 2014. It is a nine-parameter model comprising:

- energy distributed, ratcheted maximum demand, customer numbers, circuit length and supply interruption as outputs; and
- operating costs, overhead lines, underground cables and transformers as inputs.

Western Power's 2006 TFP score is the reference point for the MTFP measures and therefore has a value of 1.00. All other MTFP scores are relative to that number.

The figure below presents our MTFP results for Western Power and what we consider to be its closest NEM peers between 2006-07 and 2015-16. Western Power's performance is represented in the red dashed line.

MTFP results for Western Power's closest NEM DNSP peers – 2006-07 to 2015-16



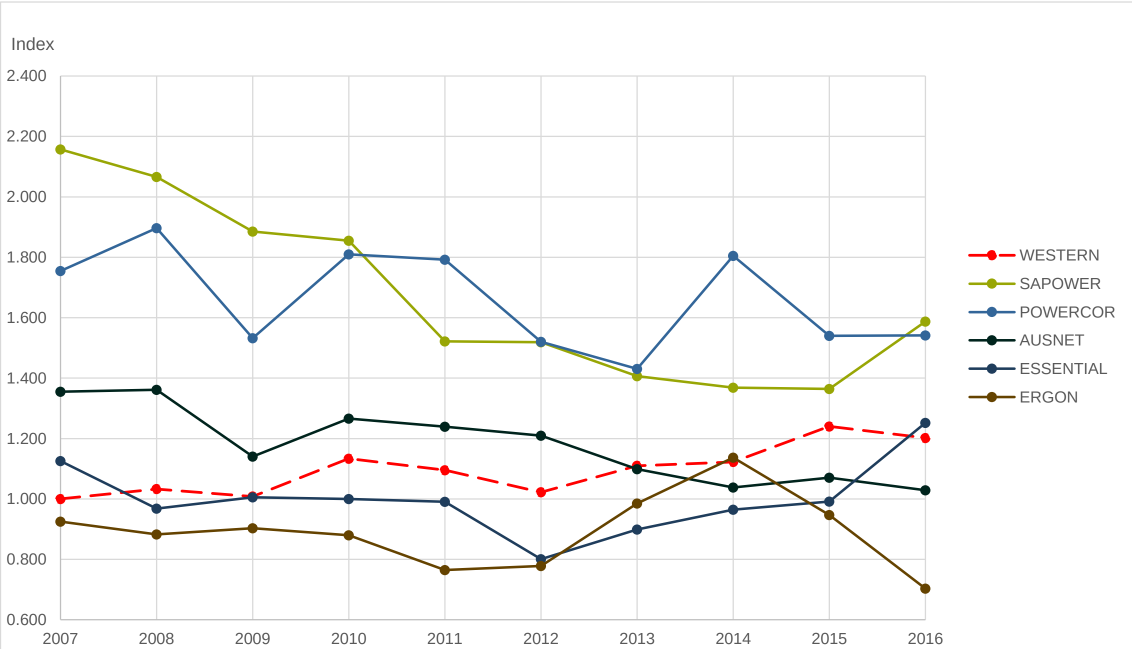
Source: Synergies' DNSP MTFP model

Western Power's own MTFP performance has increased by around 10% over the whole of the assessment period. While Western Power's relative MTFP performance ranking remains unchanged as 2nd best of its closest peers, it has materially widened the gap to those less highly ranked.

The MTFP level gap between SA Power Networks and Western Power, who we consider to be the latter's best performing peer, has narrowed significantly over the period from around 29% to 3%. In other words, in 2015-16, SA Power Networks required around 3% fewer inputs to deliver its outputs than Western Power (based on the assumed inputs and outputs in the AER's MTFP model formulation).

The figure below indicates that the improvement in Western Power's opex productivity over the period has resulted in a move from 5th to 4th ranked DNSP. Its opex productivity performance is now around 30% lower than its best performing peer, SA Power Networks, compared to over 100% lower at the start of the period. However, we note that this relatively large gap had substantially closed in 2014-15 (to around 10%) before widening in 2015-16. This reflects SA Power Networks reducing its reported opex by around 15% in 2015-16 compared to Western Power's reported opex increasing by around 8%.

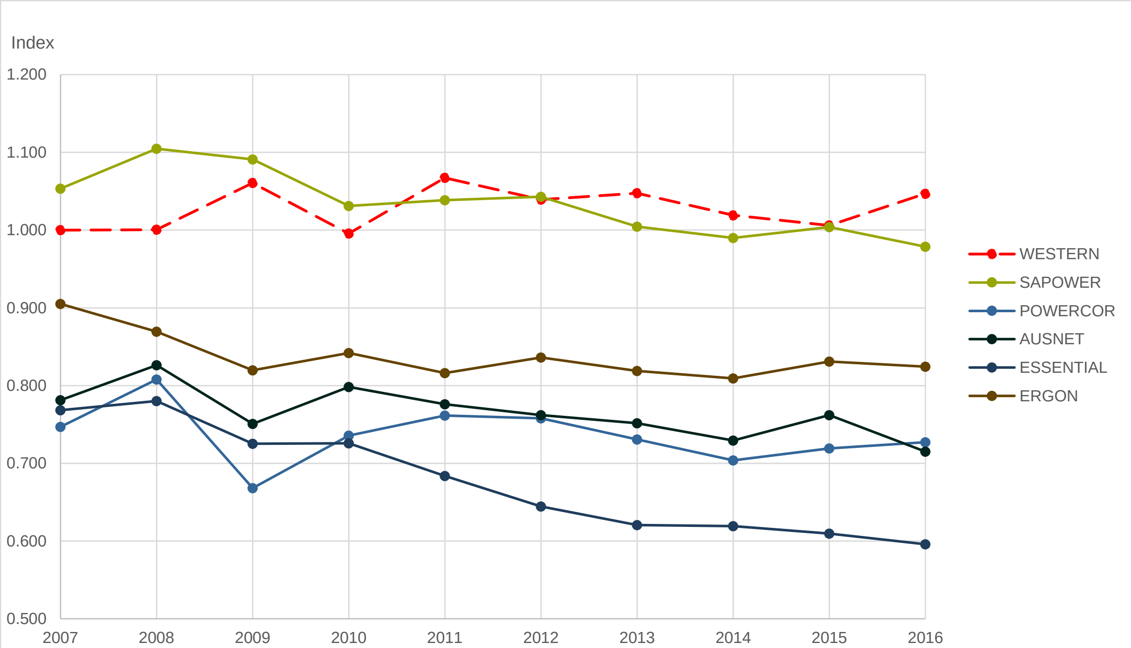
Opex PFP results for Western Power's closest NEM DNSP peers – 2006-07 to 2015-16



Source: Synergies' DNSP MTFP model

The figure below indicates that Western Power's capex productivity has increased by around 5% over the assessment period, its ranking amongst its closest DNSP peers has improved from 2nd to 1st. Further, its capex productivity performance 'gap' against its lower ranked peers in 2015-16 (SA Power Networks excepted), has increased materially since the start of the period given Western Power is the only DNSP in the sample that has improved its capex productivity over the assessment period.

Capex PFP results for Western Power's closest NEM DNSP peers – 2006-07 to 2015-16



Source: Synergies' DNSP MTFP model

Electricity transmission

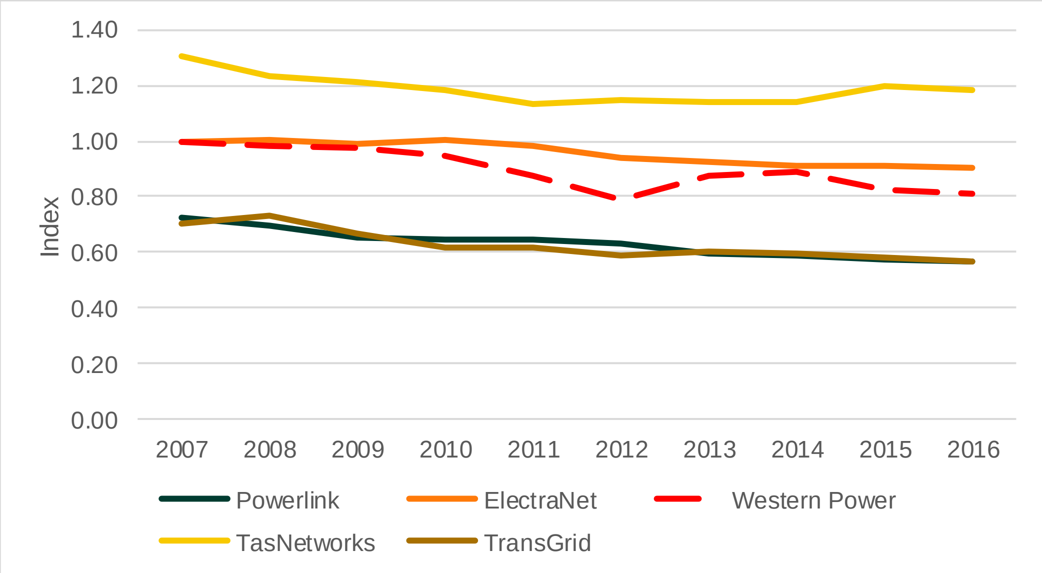
We have also adopted Economic Insights' preferred MTFP model formulation as of July 2014 for TNSPs as follows:

- system capacity (kVA x kms), entry and exit points, energy throughput (GWh) and aggregate unplanned outage duration as outputs; and
- as with the DNSP model, operating costs, overhead lines, underground cables and transformers as inputs.

The figure below shows the MTFP results for five Australian TNSPs, Powerlink, Electranet, Western Power, TasNetworks and Transgrid.[2] As for the DNSP MTFP results, Western Power's 2007-08 TFP score is the reference point for the MTFP measures and therefore has a value of 1.00. All other MTFP scores are relative to that number.

[2] It is has not been possible to include AusNet in the analysis because of data gaps in its Benchmarking RIN, including throughput data (a key TFP output).

MTFP results for Western Power's NEM TNSP peers – 2006-07 to 2015-16



Source: Synergies' TNSP MTFP model

Western Power's MTFP performance for its transmission network has declined over the assessment period along with most of the other NEM TNSPs.

The marked dip in Western Power's transmission network productivity performance between 2008-09 and 2011-12 was driven primarily by adverse movements in the opex input and reliability output parameters contained in the model – reliability is a negative output (i.e. an increase in the outage minutes-related reliability measure represents a decrease in output), which was combined with a sharp concurrent increase in opex.

Summary of our productivity findings

At this stage, Synergies is reluctant to make any strong conclusions in respect of the relative trends and levels regarding the MTFP of the DNSPs and TNSPs as presented in this report. This is because it is unclear to what extent the differences reflect anomalies in the data gathering and reporting (in the AER's Benchmarking Regulatory Information Notices (RIN)), or because they favour certain network formations over others.

In addition, Western Power does not currently report its financial and physical data in accordance with the AER definitions used in the RIN templates. Consequently, Western Power has been required to re-cut its data to satisfy the AER definitions, which was a significant task. However, this re-cut data is unaudited and may be subject to different definitional interpretations than those adopted by its NEM peers and as accepted by the AER. Moreover, we note that Western Power's network is planned, operated and invested in as an integrated transmission-distribution network rather than two separate networks.

However, we consider that the results we have presented in this report are likely to be broadly consistent with those that the AER would report if it were charged with measuring the productivity performance of Western Power.

Subject to these caveats, we consider that Western Power's productivity performance relative to its distribution network NEM peers has been relatively good over the assessment period, particularly its opex partial MTFP performance, which has driven a strong improvement in its MTFP of around 10% compared to declines recorded by its closest peers.

Productivity implications of Western Power's proposed expenditure forecasts for AA4 regulatory period

It is possible to form an indicative view about Western Power's likely future productivity performance based on Western Power's expenditure forecasts for the AA4 regulatory period.

This is a more straightforward matter for opex productivity than capex productivity because there is only one input variable in the MTFP model formulation (opex itself) compared to five capital input variables. However, we emphasise we cannot apply any precision in our calculations because we do not have detailed expenditure forecasts for any DNSPs.

Recognising these limitations, assuming an efficient Western Power base opex of $250m for the AA4 opex forecasts, and assuming constant outputs (and no change in opex productivity levels for any other DNSPs), we estimate this would result in an opex PFP improvement for Western Power of around 34%. Such an improvement will ensure Western Power remains one of the top ranking DNSPs (both amongst its closest peers and more generally) and would demonstrate impressive own opex PFP performance.

We understand Western Power is currently incurring some up-front restructuring costs in making opex efficiencies, which suggests that its opex productivity will improve further once these one-off costs drop out of its reported opex.

In terms of the impact of Western Power's AA4 capex forecasts on its future capex productivity performance, in simple terms, in the absence of any major upward step changes in Western Power's capex program, including augmentation and/or replacement capex, it can reasonably be concluded that its capex productivity is likely to remain good compared to its closest NEM peers given current relative capex productivity performance levels.

Contents

Figures and Tables

1 Introduction

The purpose of this report is to develop an independent report that assesses the efficiency of Western Power's forecast capital and operating expenditure (opex and capex respectively) to be incorporated in its Access Arrangement 4 (AA4) using benchmarking techniques adopted by the Australian Energy Regulator (AER) under the national electricity regulatory framework.

Specifically, we have analysed Western Power's productivity performance compared to distribution network service providers (DNSPs) and transmission network service providers (TNSPs) in the National Electricity Market (NEM) using the latest available data, which is 2015-16.

The 'top down' measures of productivity performance that the AER has applied in either its annual benchmarking reports or last set of revenue determinations are as follows:

(a) total multifactor productivity (MTFP) index number scores, as well as the associated capex and opex partial TFP scores;

(b) stochastic frontier analysis (SFA) model used to assess DNSPs' base year opex for forecasting purposes complemented by the following econometric benchmarking techniques:

  (i) Cobb-Douglas SFA

  (ii) Translog least squares econometric (LSE)

  (iii) Cobb-Douglas LSE.

In addition, we have undertaken an assessment of Western Power's distribution opex productivity applying the data envelope analysis (DEA) benchmarking technique. The DEA results provide a useful cross-check of our SFA results and opex partial TFP results, recognising that no economic benchmarking technique is overwhelmingly better than any other and that each has its strengths and weaknesses.

The remainder of our report is structured as follows:

- Chapter 2 briefly discusses important contextual information regarding the AER's application of economic benchmarking techniques;
- Chapter 3 presents relevant network characteristics for Western Power and its NEM peers;
- Chapter 4 identifies operating environment factors (OEFs) that we consider are important in interpreting our economic benchmarking results;
- Chapter 5 presents our MTFP performance scores;

- Chapter 6 provides our view on the efficiency of Western Power's opex and capex forecasts in AA4 for the 2017-18 to 2021-22 regulatory period;
- Chapter 7 provides an indicative view on the future productive implications of Western Power's expenditure forecasts for the AA4 regulatory period;
- Attachment A presents our SFA performance scores;
- Attachment B presents our DEA performance scores;
- Attachment C presents several charts incorporating partial productivity indicators relevant to our economic benchmarking results.
- Attachment D presents Western Power's MTFF performance compared to government-owned NEM DNSPs.

2 AER's economic benchmarking context

The two main ways in which economic benchmarking techniques have been applied by the AER in recent years is in its Annual Benchmarking Reports and electricity distribution determinations.

2.1 AER's Annual Benchmarking Reports

In accordance with Parts O and L of Chapters 6 and 6A of the NER respectively, the AER is required to release Annual Benchmarking Reports for DNSPs and TNSPs, which incorporate a range of benchmarking techniques including:

- the MTFP and opex and capex partial MTFP measures;
- a range of partial productivity indicators; and
- the Cobb-Douglas opex SFA and other econometric measures of DNSPs' opex productivity performance.[3]

We have used the same Benchmarking Regulatory Information Notice (RIN) data as the AER collects to undertake the analysis in this report, except for Western Power, which does not report its financial and physical network data on this basis. Consequently, for this report, Western Power has re-cut its reported data in accordance with its interpretation of the RIN definitions, which may result in some discrepancies with its NEM peers.

2.2 National energy merits review decisions

To date, the AER has relied heavily on a stochastic frontier analysis (SFA) model developed by Economic Insights (the EI Model) for its assessment of DNSPs' base year opex. This model, or any comparable alternative benchmarking model, has not yet been applied to assess the efficiency of TNSP's opex, primarily because of a small sample size and heterogeneity of Australian transmission networks.

In undertaking this project, we consider it is important having regard to the Australian Competition Tribunal's (the Tribunal's) decision on 26 February 2016 in relation to the AER's revenue determinations for Ausgrid, Endeavour Energy, Essential Energy and ActewAGL.[4] The AER subsequently applied to the Federal Court for a judicial review of the Tribunal's decision, which assessed the lawfulness of the Tribunal's decision-making

[3] The AER also presents DNSPs' opex efficiency results applying LSE and Cobb-Douglas LSE opex models developed by Economic Insights.

[4] The Tribunal's decision also covered the gas distribution business, Jemena Gas Networks.

process. The Federal Court published its decision in May 2017, upholding the Tribunal's findings in relation to the AER's assessment of the NSW/ACT DNSPs' opex under the NER. The matter has been remitted back to the AER for it to remake its revenue determinations.

Of most significance in a productivity and benchmarking context was the Tribunal's strong criticisms of the AER's opex SFA model, such that we consider the model in its current form to be compromised in terms of it being applied in future revenue determination processes. In particular, the use of the Ontario and New Zealand data was heavily criticised by the Tribunal, including because of the lack of comparability of networks in those jurisdictions with those in Australia.

Further, the Tribunal concluded that the RIN data, at this point of its evolution, should not have been relied on by the AER to the extent that it did in determining the benchmark opex that would be incurred by an efficient DNSP or to corroborate the use of the SFA opex model. This included known inconsistencies due to back-casting issues and differences in accounting (capitalisation) policies.

Given the outcome of the legal reviews, we consider it is most likely that the AER will need to apply a more balanced combination of top-down and bottom-up techniques when assessing opex expenditure forecasts in its next set of revenue determinations, as required by the opex assessment criteria of Chapters 6 of the NER. However, benchmarking is still likely to play a key role.

2.3 Synergies' approach

Given the current uncertainty regarding the AER's use of the SFA benchmarking technique, including its need for large data sets, we prefer the results generated from multilateral total factor productivity MTFP and multilateral partial factor productivity (MPFP) benchmarking techniques. This is because MTFP does not require international data to provide reasonably robust results and can still provide an assessment of the relative productivity of Australian DNSPs.

Nevertheless, for thoroughness, we have developed SFA results applying the AER's opex SFA model formulation. In addition, we see merit in presenting results from the Data Envelope Analysis (DEA) technique in our benchmarking report as a cross-check for the MTFP results. In contrast to SFA, DEA is somewhat less reliant on deep data sets and can also provide useful insights regarding the impact of economies of scale on measured efficiency. However, it still is reliant on NZ and Canadian DNSP data and consequently our results should be treated with appropriate care. Our SFA and DEA performance results are presented in Appendices 1 and 2 of our report respectively.

In applying any economic benchmarking techniques, it is important to recognise relevant exogenous operating environment factors (OEFs) that are beyond an electricity network's control. This includes identifying OEFs that are specific to Western Power and understanding the sensitivity of these factors on our MTFP, SFA and DEA results.

Underlying our approach is the position that there are potentially a wide range of functional forms and input and output variables to choose from in applying economic benchmarking techniques, many of which are valid but will produce different productivity or efficiency estimates. Moreover, appropriate identification of controllable and uncontrollable drivers of Western Power's costs relative to its Australian network peers is the key to robust benchmarking outcomes. Consequently, we consider economic benchmarking should not be applied in a deterministic manner, but rather requires a more nuanced application and interpretation of the various techniques.

We consider such an approach is consistent with that applied by OFGEM in its economic regulation of electricity networks in the UK. OFGEM applies economic benchmarking techniques to networks' actual and forecast total expenditure (totex), rather than actual opex or capex separately, and uses a combination of 'top down' and 'bottom up' modelling approaches to assess comparative efficiency as it explains:[5]

> Our use of three [benchmarking] models [two top-down and one bottom-up] acknowledges that there is no definitive answer for assessing comparative efficiency and we expect the models to give different results. There are advantages and disadvantages to each approach. Totex models internalize operational expenditure (opex) and capital expenditure (capex) trade-offs and are relatively immune to cost categorisation issues. They give an aggregate view of efficiency. The bottom-up, activity-level analysis has activity drivers that can more closely match the costs being considered.

And;[6]

> We benchmark the efficient level of totex for each DNO [distribution network operator] using the upper quartile (UQ) of the combined outputs from the three models. This addresses the risk that the combination of three separate UQ benchmarks might result in a benchmark that is tougher than any of the DNO forecasts.

5 Ofgem (2014), RIIO-ED1: Final determinations for the slow-track electricity distribution companies: Business plan expenditure assessment, November, p 28

6 OFGEM (2014), Final determinations for the slow-track electricity distribution companies: Overview, November, p 24

3 Characteristics of Australian distribution and transmission networks

Australian electricity distribution and transmission networks are characterised by widely differing network sizes, customer numbers and disposition, landscape and environment, energy consumption per customer, maximum demand and climatic conditions. This chapter identifies what we consider to be the most important network characteristics in a benchmarking context.

3.1 Introduction

In undertaking any form of economic benchmarking analysis, it is very important to understand differing network characteristics because they will have an effect on measured productivity performance. Failure to do so can result in legitimate cost differences between networks being mistaken for inefficiencies.

There are a number of approaches that can assist in differentiating between such controllable and uncontrollable costs. Some are inherent in the specification of the functional form of the benchmarking measure. For example, including customer number and circuit km as outputs in a TFP index goes some way to internalising the effect of customer density on productivity. DEA, provided there is a sufficient dataset, tends to compare firms that have made similar decisions over their production technology and output mix.

However, given the known limitations of the data so far available, we consider that this is best done by paying closer regard to Western Power's most closely comparable (peer) electricity network service providers (NSPs) rather than the full set of NSPs. We consider this preferable at this stage to seeking to compare the efficiency of businesses that operate networks with fundamentally different characteristics, by means of statistical or econometric approaches. Nevertheless, it is important to remain mindful that 'uncontrollable' differences between comparator businesses that are difficult to observe are no doubt present.

There are a number of identifiable factors that provide a strong indication of the nature of an electricity distribution network and what factors are truly exogenous to an NSP's provision of services. In other words, the NSP has no control over these factors and must build and maintain its network accordingly.

This section of our report presents a summary of the key network characteristics of Australian NSPs, including how Western Power's distribution and transmission networks compare to other NSPs in the NEM.

3.2 Distribution network size (in circuit kilometres)

Network size encompasses three distinct components:

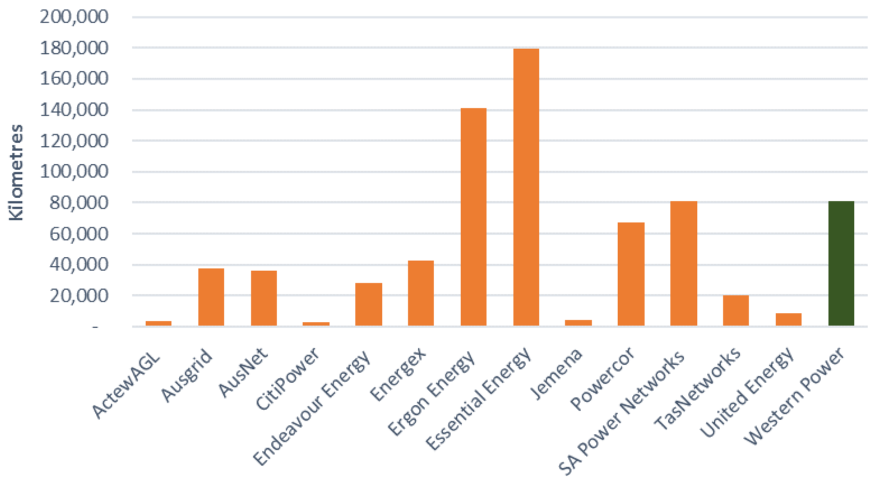
- the geographical extent of the network
- the number of customers connected to the network
- the distribution of conurbations within the network (i.e. number, size and density of cities, towns and townships).

The aggregate length in kilometres of lines provides one component measure of the size of the network. Other measures are set out below.

A DNSP's network size (measured in terms of route line length km) will have a large impact on its capital and operating cost base. More geographically dispersed networks could be expected to have relatively larger asset bases and operating and maintenance costs given the greater network coverage and distances required to inspect and maintain the assets. Route line length is a reasonable, although imperfect, measure of network size. Spatial density (customer per km^2) may be a better measure of customer density than linear density (customers per km) when assessing productivity performance although this data is not currently collected.

Figure 1 indicates that there is a substantial degree of variability between Australian distribution networks in terms of their respective network sizes.

Figure 1 Distribution network size (route line length km)



Note: This data is based on a 5 year average

Data source: Various DNSP Benchmarking RINs

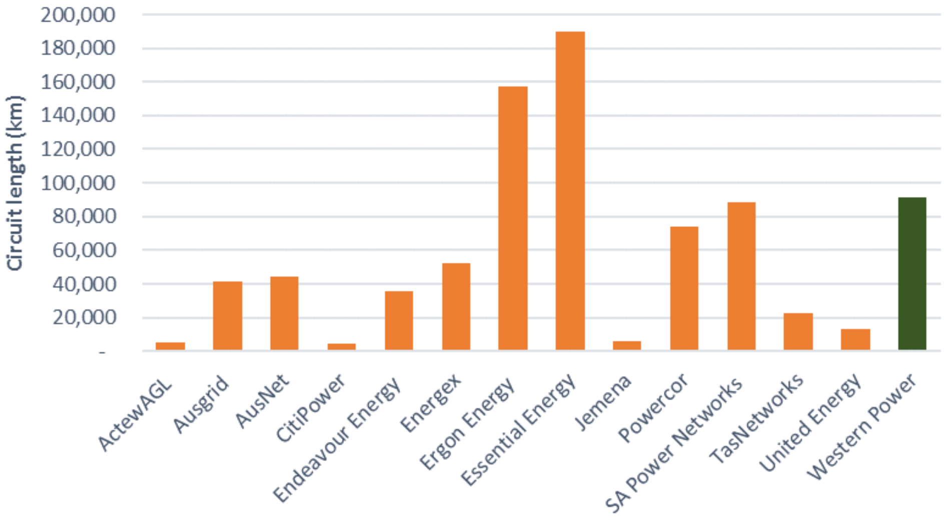
Notwithstanding the large variations, it is possible to identify several networks of a similar size.

Western Power can be characterised in the group of DNSPs with a relatively large network size. Western Power's network of around 80,000 km is comparable with SA Power Networks (around 81,000 km) and Powercor (around 67,000 km). Only Essential Energy (around 180,000 km) and Ergon Energy (around 140,000 km) have larger distribution areas than Western Power. All of these large dispersed networks are characterised by substantial semi-rural and/or rural network components and can be contrasted with a number of primarily urban (including CBD) networks, such as Citipower, Jemena and United Energy (all in Victoria) and ActewAGL in Canberra.

Network size is a critical driver of capital and operating costs on distribution networks and must be taken into account in any partial productivity or MTFP analysis. On average, across the whole RIN samples used in our analysis, circuit kilometres represent around 36% of the distribution input cost base.[7]

DNSPs can also be compared on the basis of circuit length. Circuit length measures the length of lines (overhead and underground) in service, which means that a double circuit line counts as twice the length. However, Figure 2 shows that circuit length follows a similar pattern when compared to route line length. At just under 92,000km, Western Power has the third-longest circuit length, after Essential Energy (around 190,000km) and Ergon Energy (around 157,000km) reflecting the large rural component of their respective networks.

Figure 2 Total circuit length (km)



Note: This data is based on a 5 year average

Data source: Various DNSP Benchmarking RINs

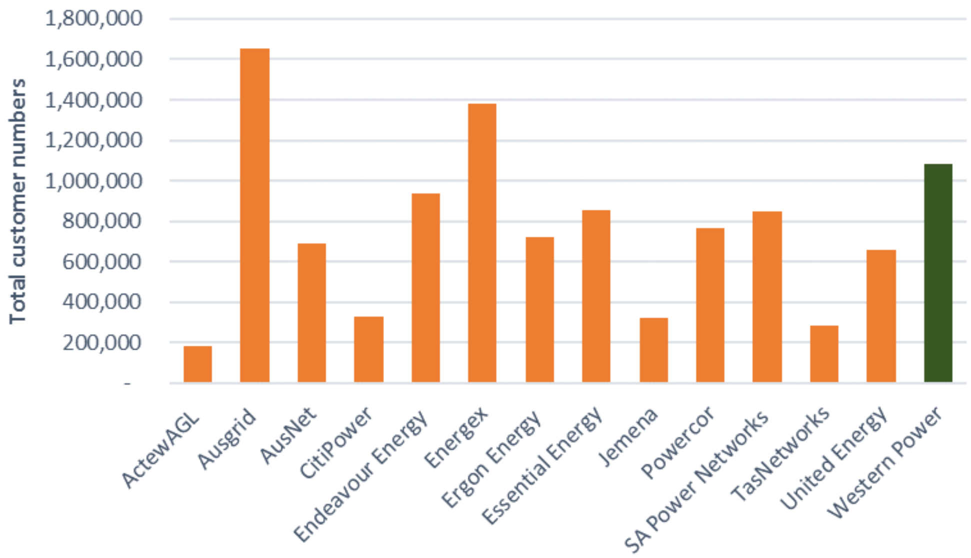
[7] Based on the annual user cost of capital associated with overhead and underground lines.

3.3 Number of distribution customers

The total number of customers served by a distribution network will generally be an important driver of connection and operating costs, notwithstanding the potential for economies or diseconomies of scale to occur as customer numbers increase.

Figure 3 below indicates that Western Power's total customer base is significant, with around 1.1 million customers connected to its network. This places Western Power amongst the largest group of DNSPs in customer number terms, with only Ausgrid (around 1.6 million) and Energex (around 1.4 million) larger.

Figure 3 Total customer numbers



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

Figure 3 also indicates that there is a relatively large cohort of networks with customer numbers in excess of 800,000, including SA Power Networks, Essential Energy and Endeavour Energy.

This can be contrasted with a number of much smaller distribution networks with customer numbers below 400,000, including ActewAGL (around 180,000), TasNetworks (around 280,000), Jemena (around 320,000) and Citipower (around 326,000).

We consider customer numbers to be a critical driver of distribution network costs and must be taken into account in any partial productivity or MTFP analysis. The output cost share attributable to customer numbers in our MTFP analysis is around 40%, meaning that 40% of costs is driven by customer numbers. By way of example, this contrasts with a 12% output cost share for energy distributed.

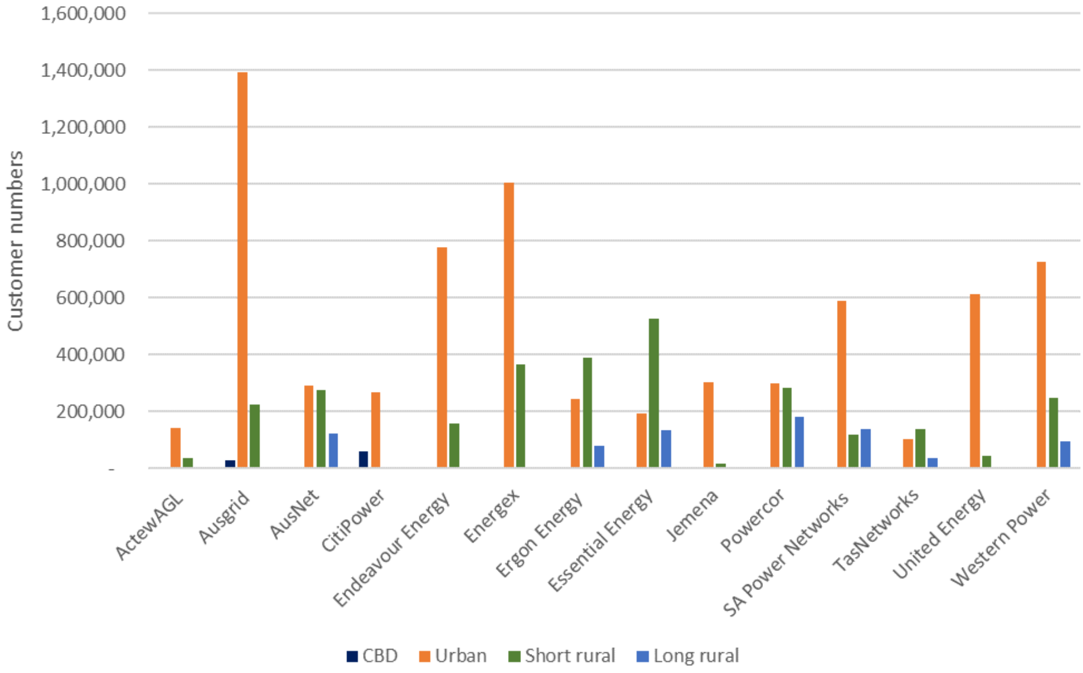
3.4 Location of distribution network customers

Australian distribution networks are often broken down into the following sub-components for performance reporting purposes:

- CBD
- Urban
- Short rural
- Long rural

Figure 4 indicates that customer number data broken down on this basis reveals some large differences across Australian DNSPs.

Figure 4 Customer numbers by distribution network location



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

Western Power is one of the few Australian distribution networks with customers spread across all four network components. The only other networks with this customer profile are SA Power Networks and Ausgrid.

Western Power's CBD sub-network serves around 7,000 customers, comparable to SA Power Network's CBD sub-network, which serves around 5,000 customers.

The only other networks with CBD sub-networks are Ausgrid, Energex and CitiPower, each serving one of the three largest cities in eastern Australia. Notwithstanding the low customer numbers generally connected to CBD sub-networks, generally much higher reliability standards apply than for other parts of the network, due in part to greater undergrounding of the network, with associated capital and operating cost implications.

Not surprisingly, the majority of Australian distribution networks have the largest proportion of their customers connected to the urban sub-network, including most prominently the Victorian urban distributors, CitiPower, Jemena and United Energy. Each of these distributors has either only a very small non-urban customer base (Jemena, United Energy) or none at all (CitiPower).

In contrast, there are several networks, including Western Power, serving relatively large numbers of customers on the short and long rural parts of their networks. Only Essential Energy and Ergon Energy have more rural than urban customers, making them the most clearly definable rural distribution networks in the NEM. Western Power's five year historical average rural customer numbers (short plus long rural) of 345,516 are broadly comparable with Powercor (468,300), AusNet Services (396,607) and SA Power Networks (257,740). Customer location is a key identifier of network type (e.g. urban, rural) and driver of capital and operating costs in an aggregate sense. As a result, it should be taken into account in the MTFP analysis, including to exclude from any comparative analysis those DNSPs whose customer profiles are fundamentally different.

Customer location is closely related to the network characteristic known as customer density, which is discussed in the next section of our report.

3.5 Distribution customer density

In general, electricity networks with relatively large distribution areas are likely to have lower customer density than networks with relatively small distribution areas. Customer density can be measured as the number of customers per route kilometre of line.

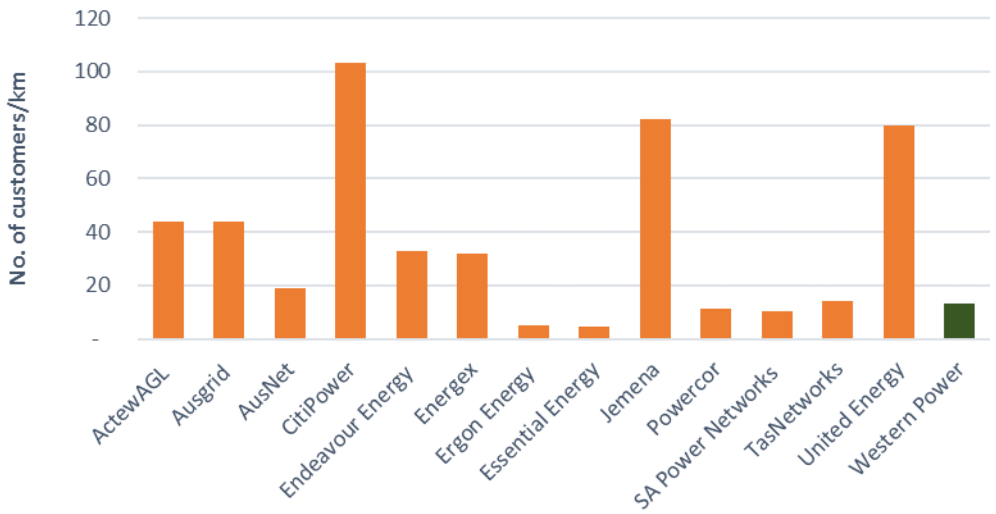
A DNSP with lower customer density will generally need more poles and wires to reach its customers compared to a DNSP with higher customer density. The additional costs associated with meeting this requirement could make the DNSP with the lower customer density appear less efficient if this factor is not recognised in MTFP analysis.

We recognise that spatial density (customer per km^2) may be a better measure of customer density than linear density (customers per km) when assessing productivity performance.

Relatively sparsely populated networks also provide significant challenges for achieving reliability and service quality targets.

Figure 5 below indicates that there is a substantial degree of variability between Australian distribution networks in terms of their respective customer densities, with an average of around 37 customers per kilometre.

Figure 5 Customers per route length km



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

Notwithstanding the variations indicated in Figure 5, broad groupings of distribution networks based on customer density can be identified:

- Western Power is in the group of DNSPs with relatively low customer densities. It has an average customer density of 13.20 customers per kilometre, which is comparable to TasNetworks (13.29 customers per kilometre), Powercor (10.90 customers per kilometre), SA Power Networks (10.13 customers per kilometre) and AusNet Services (19.17 customers per kilometre);
- Essential Energy (4.61 customers per kilometre) and Ergon Energy (4.83 customers per kilometre) are the only other DNSPs with lower customer densities than Western Power. These low customer densities reflect the very large short and long rural proportions of these networks; and
- the relatively low customer density networks can be contrasted with the primarily urban networks of CitiPower, Jemena and United Energy, all in Victoria.

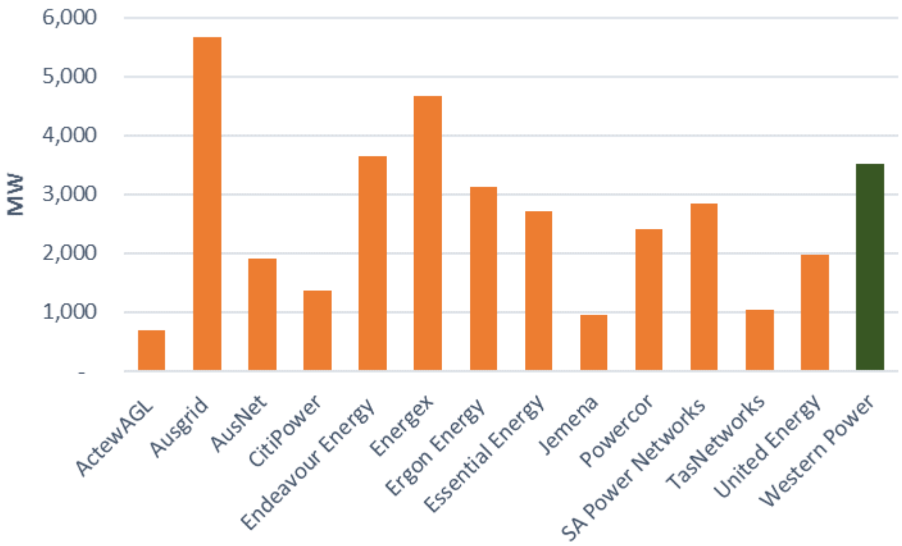
We consider customer density to be a critical driver of capital and operating costs for distribution networks and must be considered in any TFP analysis.

3.6 Energy thoughput and demand

Maximum demand is a measure of the overall peak in demand experienced by the network.

To be consistent with the AER annual benchmarking report, the measure displayed in Figure 6 is non-coincident summated raw system annual maximum demand at the transmission connection point.

Figure 6 Maximum demand (MW)



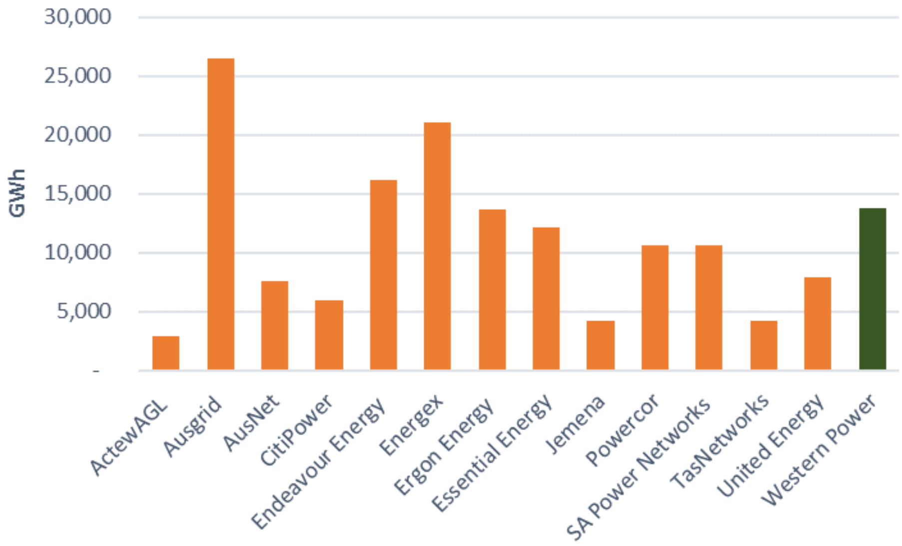
Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

Average maximum demand for Western Power (around 3,500 MW) is considerably lower than for Ausgrid (around 5,700 MW) or Energex (4,700 MW), but similar to Endeavour Energy (around 3,700 MW) and Ergon Energy (around 3,100 MW).

Energy throughput measures the amount of electricity that DNSPs deliver to their customers.

Figure 7 (over page) shows energy throughput averaged over five years for each DNSP. The average amount of energy delivered by Western Power between 2012 and 2016 was almost identical to the amount delivered by Ergon Energy. Essential Energy's throughput was only slightly lower, at around 12,000 GWh.

Figure 7 Energy throughput (total energy delivered)



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

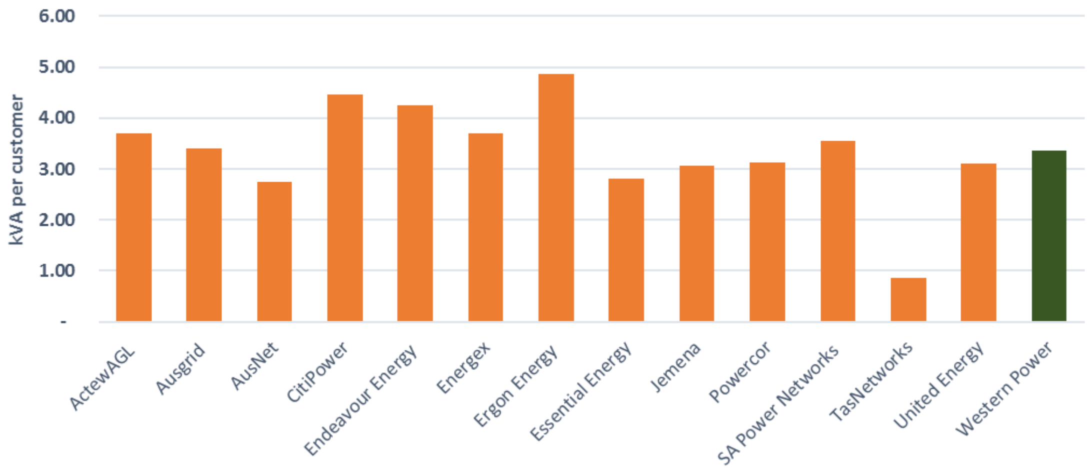
3.7 Distribution demand density

Demand density (kVA non–coincident peak demand per customer) provides a broad measure of the peakiness of demand (as opposed to average consumption), with peak demand a key driver of network capital costs.

Figure 8 indicates that there is a significant variability across Australian distribution networks in terms of their respective demand densities. Demand density across the networks falls within the range from 0.86 (TasNetworks) to 4.86 per customer (Ergon Energy), with an average of around 3.36 kVA per customer.

On average, the customers of networks at the high end of the range have relatively peakier demand than the other networks, which potentially has network planning and cost implications in terms of the need for additional capacity to meet maximum demand at zone sub-stations across the distribution network.

Figure 8 Network demand density (kVA per customer)



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINS

Western Power's demand density is again around the middle of the distribution of values in line with the average, at 3.36 kVA per customer. Its closest peers are Ausgrid (3.40 kVA per customer), SA Power Networks (3.55 kVA per customer) and Powercor (3.12 kVA per customer).

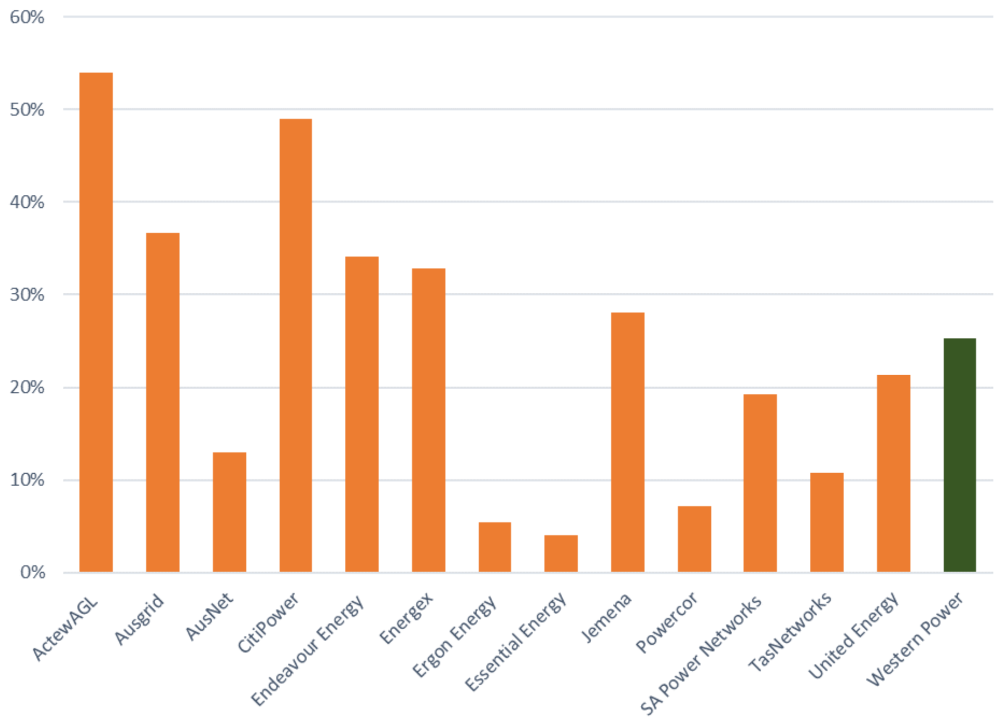
3.8 Proportion of underground and overhead distribution network

Network reliability is also partially affected by whether a distribution network has a large proportion of overhead wires, which are more susceptible to severe weather events, such as storms and bushfires, than underground cables.

Underground cables are more expensive to construct, thereby resulting in a higher capital cost per circuit km, but generally can be expected to have lower maintenance costs over their life. As noted above, underground cables are also likely to contribute to higher network reliability. They are also more prevalent in urban networks.

Figure 9 (over page) indicates that the underground proportion of Western Power's network is broadly in the middle of the range of DNSPs at around 25 per cent, comparable with Jemena (28 per cent), United Energy (21 per cent) and SA Power Networks (19 per cent). This reflects the fact that it has a large rural and metropolitan network, as well as servicing the Perth CBD.

Figure 9 Percentage of underground network



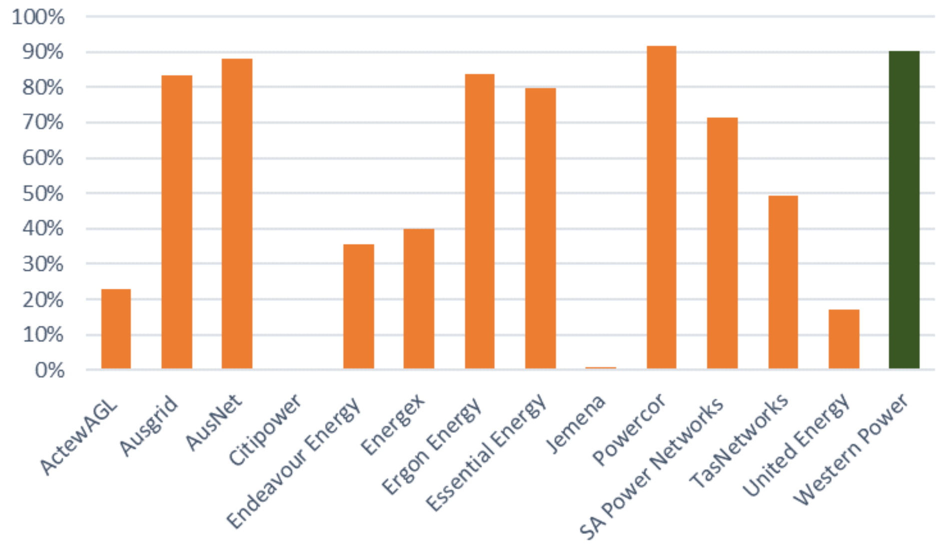
Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

3.9 Rural proportion of network

The rural proportion of a DNSP's network is defined as the distribution line route length classified as short rural or long rural in kilometres per total network line length.

Figure 10 indicates that Western Power has a relatively large rural proportion of its total network at around 90 per cent, which compares to the average rural proportion of 53 per cent. Similar rural profiles are held by Powercor (92 per cent), Ausgrid (93 per cent) and AusNet Services (88 per cent).

Figure 10 Rural network proportion



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

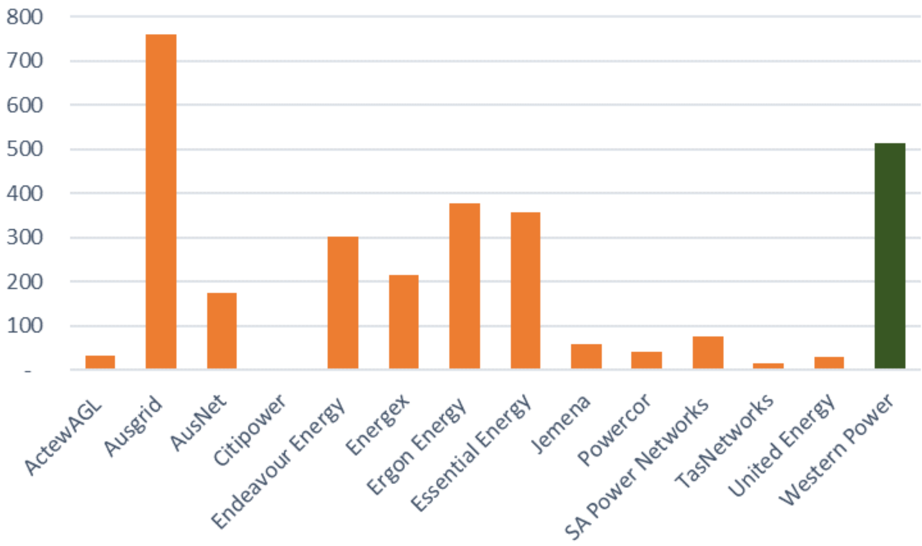
3.10 Vegetation management

Vegetation management is one of the largest opex programs of DNSPs. For the purpose of the AER's benchmarking, RIN vegetation management is defined as the total count of spans in the network that are subject to vegetation management practices in the relevant year. If DNSP report poles rather than spans, the number of spans is the number of poles less one.

Figure 11 below indicates that there is substantial variation amongst DNSPs in the size of their vegetation management task.

Western Power has one of the largest vegetation management tasks amongst DNSPs with 515,182 vegetation maintenance spans. Its closest peers are Ergon Energy (378,160), Endeavour Energy (301,973) and Essential Energy (321,879). Vegetation management is generally one of the largest maintenance programs for DNSPs.

Figure 11 Vegetation management — spans subject to bushfire maintenance ('000')



Note: This data is based on a 5 year average
Data source: Various DNSP Benchmarking RINs

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3.12 Summary of findings for distribution networks

The above comparison of the distribution networks of Western Power and DNSPs in the NEM indicate that it is most like the following distribution networks:

- SA Power Networks
- Powercor
- Ausnet Services
- Essential Energy
- Ergon Energy.

The similarities include most importantly, their large rural network components, measured by route line length and proportion of customers in rural areas.

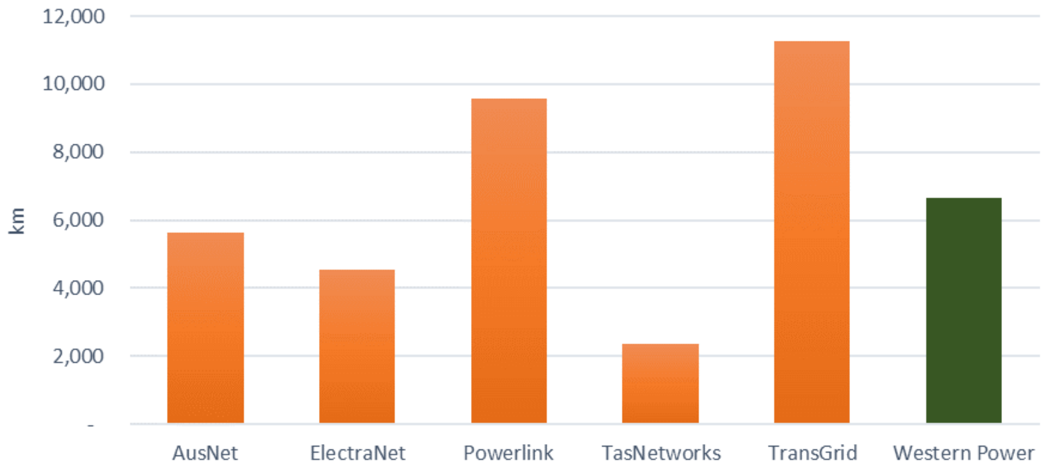
Operating environment factors for DNSPs, as judged by the AER, are discussed in the next chapter of our report.

In contrast to the DNSPs, there are only six TNSPs operating in the NEM, with generally only one per State. In contrast to TNSPs, transmission networks have only a small number of direct customers ie those customers that are connected to the transmission network. This means that measures of customer numbers and customer density are not relevant in a benchmarking context. Key Australian transmission network characteristics are discussed in the following sections for completness.

3.13 Transmission route line length

As for distribution networks, the size of a transmission network will be a major driver of opex and capex and potentially TFP outcomes. Figure 15 indicates that there is a substantial degree of variability between Australian transmission networks in terms of their respective network sizes.

Figure 15 Transmission network size (route line km)



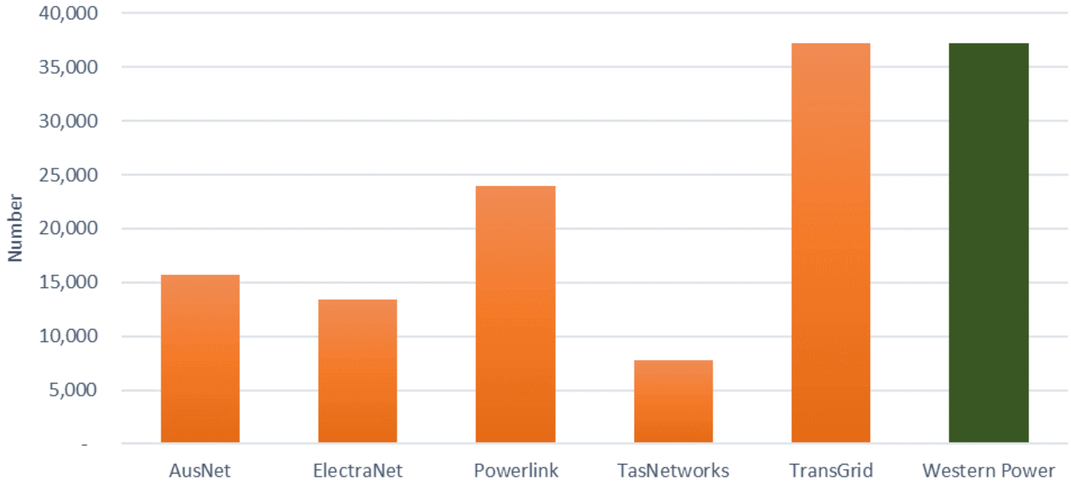
Note: This data is based on a 5 year average. Western Power data was available only until 2013.
Data source: Various TNSP Benchmarking RINs

Western Power has a mid-range transmission network size of 6,649 kilometres route length. This is similar to AusNet Service's network size of 5,639 kilometres. The ElectraNet network size of 4,541 kilometres is broadly comparable.

3.14 Total number of transmission network spans

Figure 16 (over page) indicates that Western Power has the largest number of spans of all the TNSPs at 37,157. TransGrid, at 36,046 spans, is the only other TNSP that has a similar level of spans as Western Power, with both having significantly more spans than the remaining TNSPs.

Figure 16 Total number of spans



Note: This data is based on a 5 year average. Western Power data was available only until 2013.
Data source: Various TNSP Benchmarking RINs

The relatively different picture presented for total number of spans across TNSPs is likely to reflect the varying proportions of overhead lines at different voltage levels, with standard span lengths varying by voltage level.

There is a high correlation between circuit km and number of spans for all the other TNSPs but not Western Power. This suggests that Western Power's spans are much shorter than the other TNSPs, which could be due to the 66kV lines that form part of its transmission asset base but not the NEM TNSPs.

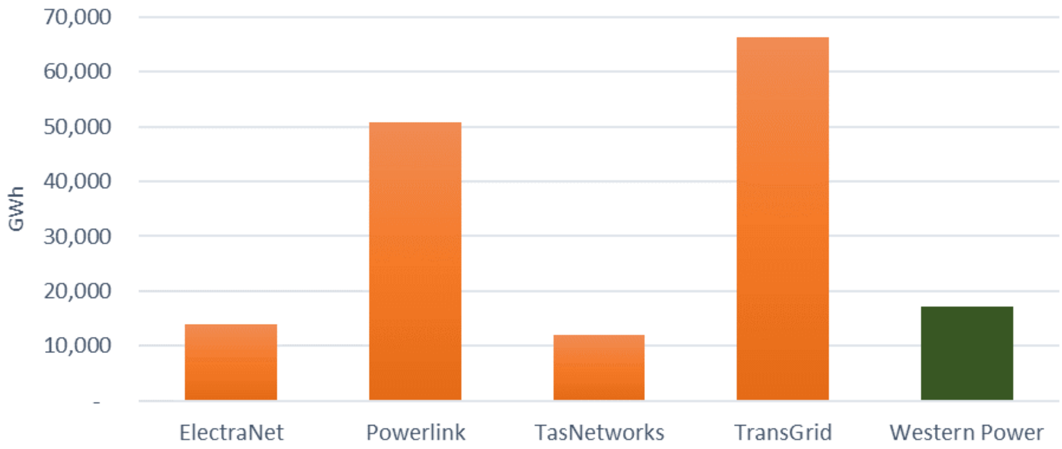
3.15 Transmission electricity throughput

The amount of energy throughput on a transmission network provides a good indication of network size and is a potential network output.

Figure 17 (over page) indicates that Western Power's transmission network and energy output is comparable to those in the smaller Australian states but is much smaller than the NSW and Queensland transmission networks.[8]

[8] No energy throughput data was provided in AusNet's RIN.

Figure 17 Total energy transported (GWh)



Note: This data is based on a 5 year average
Data source: Various TNSP Benchmarking RINs

3.16 Transmission system maximum demand

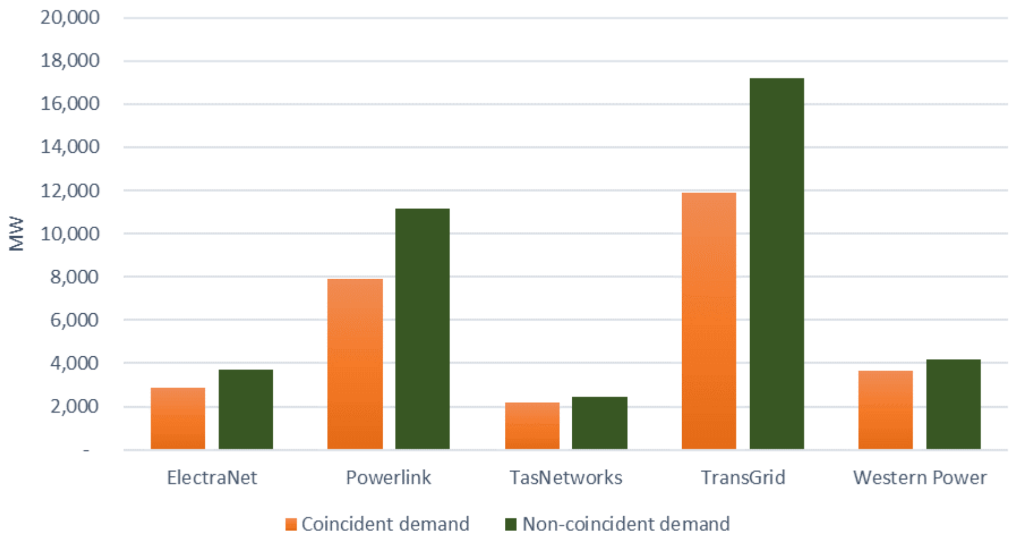
As for distribution networks, transmission networks are built with sufficient capacity to meet the maximum (peak) demand placed on the network whenever that may be. Maximum demand can be volatile over time reflecting changing climatic conditions and other factors beyond a TNSP's control. Maximum demand can be expressed in coincident and non-coincident terms.

For the AER's Benchmarking RIN, coincident maximum demand is defined as the summation of actual unadjusted (ie not weather-normalised) demands at a TNSP's downstream connection and supply locations that coincides with the maximum demand of the whole transmission system.

In contrast, non-coincident maximum demand is defined as the actual unadjusted (ie not weather-normalised) summation of actual raw demands at a TNSP's downstream connection and supply locations irrespective of whether they coincide with the transmission system peak.

Figure 18 indicates a close relationship between coincident and non-coincident maximum demand on Western Power's network, as is also the case for ElectraNet and TasNetworks.

Figure 18 Coincident and non-coincident maximum demand

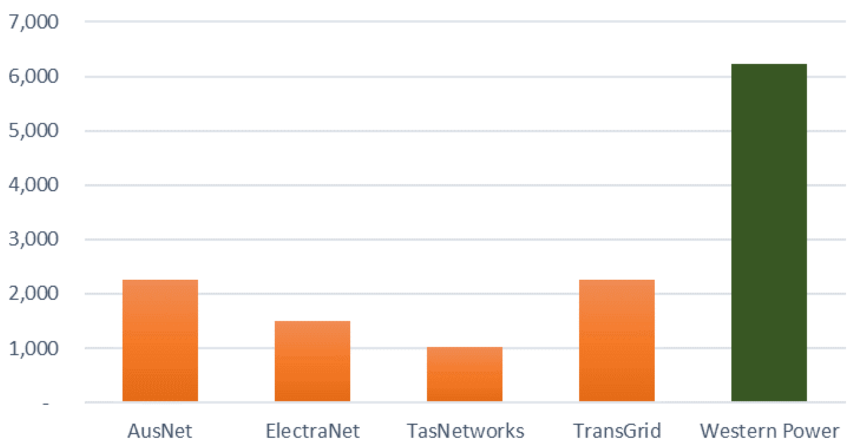


Note: This data is based on a 5 year average
Data source: Various TNSP Benchmarking RINs

3.17 Vegetation management

As for DNSPs, vegetation management is one of the TNSPs largest opex programs. Figure 19 indicates that Western Power has a vegetation management task many times greater than that of other TNSPs.[9] This is likely to be a function of Western Power's relatively higher proportion of 66kV, 33kV and 22kV assets operated by its transmission network compared to its NEM peers.

Figure 19 Number of vegetation maintenance spans



Note: This data is based on the 2013 data as previous years' data for the providers was not complete.
Data source: Various TNSP Benchmarking RINs

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3.19 Summary of findings for transmission networks

The above comparison of the transmission network of Western Power and TNSPs in the NEM indicate relatively large differences in network characteristics and operating conditions. Western Power's network size, throughput and maximum demand place it among the smaller TNSPs compared to TransGrid and Powerlink.

Given the very small number of NEM TNSPs, heterogeneous network characteristics and small incomplete RIN data sets, economic benchmarking techniques, such as SFA and DEA, are highly unlikely to generate robust results and hence should not be used.

While the MTFP benchmarking technique is less reliant on large data sets, the small number of heterogeneous TNSPs is similarly problematic.

To this end, we have only applied the MTFP benchmarking technique to assess the productivity performance of the TNSPs (refer Chapter 5). We also consider that the MTFP results for TNSPs that we have generated should be treated with caution.

4 Operating environment factors

In an electricity network benchmarking context, the 'operating environment' refers to those factors associated with providing network services that are generally beyond the control of managers but which materially affect the quantities of inputs needed to provide those services.

Operating environment factors (OEFs) can have a large impact on network costs and measured efficiency. As a result, to ensure true like-with-like comparisons, some adjustment to the MTFP results to account for the most important factors is desirable if the relevant underlying data is available.

4.1 AER's recognition of OEFs

The AER Expenditure Forecast Assessment Guideline incorporates benchmarking in the assessment of expenditure forecasts, and seeks to "*… measure the efficiency of a* [DNSP's/TNSP's] *use of inputs to produce outputs, having regard to operating environment factors.*"[10]

The AER economic benchmarking assessment of operational expenditure (opex) proposals involves a number of key steps in relation to the selected base year opex.

These include:

- establishing the efficiency of opex for the selected base year using economic benchmarking (stochastic frontier analysis (SFA));
- examining individual opex categories in order to test the economic benchmarking evidence; and
- adjusting the raw benchmarking result to account for any modelling uncertainty and data error, and to account for the impact of individual operating environment factors that are not captured directly by the modelling.

4.1.1 Information requirements

In assessing a service provider opex forecast, the National Electricity Rules (NER) require[11] the AER to consider benchmark operating expenditure that would be incurred by an efficient network service provider during a regulatory period.

[10] AER, *Expenditure Forecast Assessment Guideline*, November 2013, section 2.4.1, p. 13

[11] *NER*, version 94, July 2017, clause 6.5.6(e)(4) for distribution network service provider, clause 6A.6.4(e)(4) for transmission network service provider

In recent 2014-19 determinations for Distribution Network Service Providers (DNSPs) in NSW and the ACT, the AER relied upon economic benchmarking from Economic Insights to establish a benchmark efficiency target, and against which adjustments were made for operating environment factors that were specific to NSW and the ACT.

Whilst aspects of this approach were successfully challenged in the Australian Competition Tribunal (refer section 4.1.4), the AER will continue to use economic benchmarking with adjustments for factors specific to the network service provider as part of the assessment process for opex forecasts.

4.1.2 Operating environment data

In its ruling on economic regulation[12] of Network Service Providers (NSPs), the Australian Energy Market Commission (AEMC) stated that "*… when undertaking a benchmarking exercise, circumstances exogenous to a NSP should generally be taken into account, and endogenous circumstances should generally not be considered. In respect of each NSP, the AER must exercise its judgement as to the circumstances which should or should not be included.*"[13]

These external factors were categorised as:

- geographic factors: topography, climate, bushfire risk
- customer factors: density of customer base (urban/rural split), load profile, mix of customers between industrial and domestic
- network factors: asset age profile, mix of underground and overhead lines, proportion of sub-transmission in network
- jurisdictional factors: reliability and service standards, environmental and safety regulations, licence conditions

4.1.3 Assessment criteria

In acknowledging that network service providers operate under different conditions, and that adjustments can be justified to account for OEFs, the AER has incorporated OEFs into their modelling where possible. For those factors whose impact has not been accounted for in discrete models, high-level assessment criteria have been established to decide if any further adjustments are justified.

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12 AEMC, *Rule Determination: National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012*, 29 November 2012

13 Ibid., section 8.5.2, p. 113

In the draft decision for the 2014-19 Ausgrid distribution determination, the AER applied *"… three criteria to help … decide whether or not an operating environment factor should be accounted for:*

> **Is it outside of the service provider's control?** The first criterion is that an operating environment factor should be outside the control of service provider's management. Where the effect of an operating environment factor is within the control of service provider's management we would not generally provide an adjustment for the operating environment factor. Adjusting for that factor may mask inefficient investment or expenditure.
>
> **Is it material?** The second criterion is that an operating environment factor should create material differences in service providers' opex. Where the effect of an operating environment factor is not material, we would generally not provide an adjustment for the factor. Many factors may influence a service provider's ability to convert inputs into outputs
>
> **Is it accounted for elsewhere?** The third criterion is that the operating environment factor should not have been accounted for elsewhere. Where the effect of an operating environment factor is accounted for elsewhere, we have not provided an adjustment for that factor. To do so would be to double count the effect of the operating environment factor."[14]

The Explanatory Statement for the AER Expenditure Forecast Assessment Guideline provides little guidance on how materiality is determined, other than relying upon a qualitative assessment based on knowledge of NSP operations and feedback received from submissions and workshops.

Where the AER is satisfied that an operating environment factor is considered to have a material effect on the efficiency of an NSP, the impact is quantitatively assessed for any adjustment to the opex.

To determine if any adjustments are likely to be applicable to the Western Power operational expenditure estimates, it is necessary to:

- identify any operating environment factors unique to the Western Power electricity network;
- decide whether these are material to justify adjustment to the estimates; and
- quantify the adjustments.

[14] AER, *Draft decision Ausgrid distribution determination - Attachment 7 - Operating expenditure*, November 2014, section A.5.1, p. 7-105

4.1.4 Australian Competition Tribunal ruling

On 26 February 2016, the Australian Competition Tribunal (the Tribunal) published a decision on the merits review mechanism appeal raised by NSW and ACT electricity distribution utilities, and Jemena Gas Networks in regards to the 2014-19 revenue determinations made by the AER.

The Tribunal concluded that whilst the merits review mechanism remains an integral component in the regulatory framework, the AER had erred in its approach to several key factors in the determinations; one of which was the primary reliance on economic benchmarking for adjustments to the base year opex allowances without regards to other opex assessment factors, such as operating environment factors.

The key reason for the upholding of the appeals raised by the NSW and ACT utilities was the AER use of an SFA analysis model as a determinative adjustment factor on the opex forecasts, without also considering the limitations of the SFA modelling and its supporting dataset. The Tribunal also ruled that the adjustments made to opex forecasts for operating environment factors was arbitrary.

In our view, the implications of this ruling for Western Power are that:

- any assessment of opex forecasts will be a balanced combination of top-down and bottom-up approaches, with economic benchmarking used as part of the assessment process rather than as a primary evaluation of efficiency
- the impact of operating environment factors should be based on an individual utility basis, with specific factors assessed.

4.2 Western Power operating environment factors

It is important to emphasise that the AER identified and applied its OEFs in the context of setting an efficient base year opex level for each NEM DNSP using its SFA economic benchmarking technique. For reasons explained earlier, this is not the purpose of our report, which is focussed on assessing Western Power's own and relative productivity performance over the 2007-08 to 2015-16 period.

Hence, our reason for identifying OEFs relevant to Western Power is to determine whether we should be making any adjustments to the underlying data used to develop our MTFP estimates so that relatively clean 'like-with-like' performance comparisons can be made.

4.2.1 AER's approved OEFs

Over the course of its last set of revenue determinations, Table 1 shows the AER-approved OEFs applied as part of its SFA opex benchmarking.

Table 1 AER's approved OEFs

OEF	Description	Potential application to Western Power
Cost allocation and capitalisation policies		Yes, potentially. Western Power's current cost allocation methodology is not subject to AER scrutiny, nor does Western Power complete RIN templates in an ongoing sense, as is the case for the NEM DNSPs, As previously noted, Western Power has re-cut its currently reported financial and physical data in accordance with its understanding of the RIN template definitions. As a result, there may be some differences in interpretation compared to NEM DNSPs, which will affect our MTFP estimates, but we cannot be certain if this effect is likely to be material.
Bushfires	The geographic characteristics and settlement patterns of a network area are beyond the control of service providers. Regulatory obligations associated with bushfire risk can have a material impact on service providers' opex	No, bushfire risk in WA is considered to be lower than other Australian states. Our assessment is that bushfire regulations imposed on Western Power are not unduly onerous compared to NEM DNSPs in general, with Victoria having the most onerous of such regulations.
Cyclones	Cyclones are beyond service providers' control and can have a material effect on opex.	No, cyclones are not a recurring weather event adversely affecting Western Power's network.
Extreme weather	The weather is beyond service providers' control and the effect of extreme weather events on opex can be material.	Yes, potentially, Western Power's network is affected frequently by extreme weather events as reflected in its major event day network reliability data. However, we do not consider that Western Power is an outlier compared to NEM DNSPs, such that it is incurring materially higher opex due to this factor.
Licence conditions	Increased transformer capacity to meet the 2005 QLD change in network planning requirements may lead to a material increase in maintenance expenditure.	Yes, potentially, Western Power is subject to licence conditions that differ from NEM DNSPs. However, we are not aware that the costs imposed by any such differences is material, including in regards to reliability standard obligations.
Network Access	The amount of a service provider's network with non-standard vehicle access is determined by land use that is beyond service providers' control. Differences in network access can lead to material differences in opex.	No, we are not aware that Western Power's distribution network is subject to adverse network access issues such that they have materially increased its ongoing base level opex.
OH & S regulations	OH&S regulations are not set by service providers and may materially affect service provider's opex.	Yes, potentially. Safe Work Australia has developed a single set of Workplace Health and Safety laws, which have been applied across most jurisdictions

OEF	Description	Potential application to Western Power
		but not WA. Based on AER analysis, it would appear that imposition of the new laws on electricity distributors would increase their opex by around 0.5% per annum. In the absence of an adjustment to the underlying opex data, this suggests Western Power is slightly favoured compared to its NEM peers in a benchmarking sense by not being required to comply with this new national Workplace Health and Safety laws.
Taxes and levies	Taxes and levies are not set by service providers and may account for a material part of opex.	Yes, Western Power is subject to the WA Government's Tariff Equalisation Contribution (TEC) scheme. This is a subsidy scheme which funds uniform tariffs across WA by imposing a levy on Western Power, which is passed through to its customers via network tariffs. The TEC is reported as an opex expense in Western Power's accounts and is around $200m per annum. This cost is beyond Western Power's control and should be removed from its opex when applying economic benchmarking techniques.
Termite exposure	The prevalence of termites in a geographic area is beyond service providers' control and may create a cost disadvantage for some networks.	No, Western Power's network is not subject to termite risk given climatic conditions.
Sub-transmission	The boundary between distribution and transmission is not determined by service providers. Data from Ausgrid's regulatory accounts suggest that sub-transmission assets are up to twice as costly to operate as distribution assets.	Yes, the definitions of distribution and transmission network under the Access Code and NEM are quite different. In addition, there are legacy definitional issues applying across NEM jurisdictions which affect where the line between distribution and transmission networks is drawn. Most importantly, the definitional differences mean that Western Power's distribution network has a relatively low proportion of sub-transmission assets compared to NEM DNSPs in general. In the absence of an adjustment to the underlying opex data, this suggests Western Power is slightly favoured compared to its NEM distribution peers in a benchmarking sense by having a smaller proportion of more expensive to maintain sub-transmission assets. This issue is discussed in more detail later in the next section of this chapter.
Vegetation management	The division of responsibility for vegetation management and other stakeholders is not determined by service providers, Information from Energy Safe Victoria, the Victorian service providers, the Queensland service providers, the category analysis	Yes potentially. Western Power has a relatively large dispersed distribution network with significant vegetation management task. In the absence of an adjustment to the underlying opex data, this suggests Western Power is disfavoured compared to its NEM distribution peers

OEF	Description	Potential application to Western Power
	RINs, and Economic Benchmarking RINs, suggests that differences in responsibilities for vegetation management could lead to material differences in opex.	in a benchmarking sense by having a materially higher vegetation management task compared to nearly all of its NEM peers.
Immaterial factors	There are various exogenous, individually immaterial factors not accounted for in Economic Insights' SFA model that may affect service providers' costs relative to the comparison firms. While individually these costs may not lead to material differences in opex, collectively they may.	Yes, there are always likely to be immaterial exogenous factors that affect economic benchmarking estimates, However, given our report, is focussed on long-term productivity performance not setting efficient opex base levels, we have focussed on only material factors.

Source: AER (2015), Preliminary Decision, Energex determination 2015−16 to 2019−20, Attachment 7 – Operating expenditure, April, pp 31-33.

4.2.2 Sub-transmission assets

The AEMC ruling on economic regulation nominated network factors as an exogenous consideration that should be taken into account for a benchmarking adjustment. This includes network configurations, such as the mix of underground and overhead, and the proportion of sub-transmission assets in an electricity system.

The Electricity Network Access Code 2004 (the Code) defines the distribution system as assets operating at voltages below 66 kV and the transmission system as assets operating at 66 kV or higher. There is no definition for sub-transmission assets in the Code. The NER categorises[15] a transmission network as operating at 220 kV or above, plus any part of a network operating at a voltage between 66 kV and 220 kV that operates in parallel to and provides support to the higher voltage transmission network, or is deemed by the AER to be part of the transmission network.

Similarly, sub-transmission is defined in the NER as assets which operate between the transmission system and the distribution network.[16]

In its draft decision for Ausgrid, the AER noted that "*… the boundary between transmission and distribution networks is the result of historical decisions made by state governments when dividing electricity networks*" and that "*… differences in sub-transmission configuration are likely to lead to material differences in the cost of providing network services.*"[17] For Western Power, there are four 33 kV overhead lines that have been designed to 66 kV design standards, and are considered to support the transmission system, and therefore satisfy the NER definition as sub-transmission.

[15] *NER*, version 94, July 2017, Chapter 10 Glossary, p. 1244

[16] Ibid., clause 5.10.2, p. 464

The AER noted in its 2013 Ausgrid decision that sub-transmission assets are "*… twice as costly to operate*" as distribution network assets. Hence, the AER considers that DNSPs with a higher proportion of sub-transmission lines are likely to have additional opex requirements relative to other DNSPs.

The AER indicated that sub-transmission lines account for an average of 5.3% of the total network line length for NSW DNSPs. In contrast, the proportion of Western Power's distribution network attributable to sub-transmission lines (as defined by the NER) was approximately 0.1% over the 2011-12 to 2015-16 period

The approach adopted by the AER in the NSW and ACT determinations was to calculate the adjustment as the difference between the proportion of sub-transmission lines for the utility being assessed and the 5.3% benchmark level.

Western Power is an integrated transmission/distribution electricity utility, and is therefore not subject to the same operating environment as the NSW and ACT DNSPs, which have an operational interface with TransGrid and therefore consideration of distribution network assets supporting the transmission system is relevant.

In contrast, Western Power's distribution network has a relatively small proportion of assets that could be classified as sub-transmission under the NER provisions. Hence, the type of adjustment required for Western Power would entail increasing its distribution opex based on an assumption of the volume of 66kV assets that would be notionally transferred from its transmission network to align its distribution network asset composition more closely with its NEM peers.

In making such an adjustment in the context of developing MTFP estimates, a broader issue is raised about whether a notional transfer of 66kV assets from the transmission to distribution network should also be made, which will impact on the capex partial MTFP estimates (as well as the total MTFP estimates).

In practice, this adjustment will be a relatively time consuming task for Western Power to effect given it is not currently reporting data on this basis. It will also effectively create two notional networks that do not represent what Western Power invests in, operates and maintains. In other words, a network, whether distribution, transmission, or vertically integrated, has to operate and maintain what it has, not what it should have under a benchmarking model. As a consequence, the network owner may be efficiently maintaining the wrong assets, which will come out as inefficiently maintaining ideal assets. Finally, this is a materiality issue in terms of its impact on our MTFP results.

On balance, we have decided not to make any adjustment for the sub-transmission OEF. The impact of not making the adjustment to Western Power's opex and capex productivity performance is hard to assess but is likely to be to its benefit in terms of its relative distribution benchmarking performance.

4.3 Summary of potential adjustments

We have reviewed the potential OEFs that the AER would consider are relevant to Western Power.

For our report, we consider that any adjustments we make to reflect OEFs relevant to Western Power should be focussed only on those that could materially distort our MTFP estimates, as opposed to whether the AER would likely make the adjustment when applying its SFA benchmarking technique.

On this basis, we have removed the TEC expense that is included in Western Power's reported opex in developing our MTFP estimates given its materiality.

We have not made any adjustments to Western Power's opex data to reflect the effects of different OH&S laws in WA compared to NEM jurisdictions or for Western Power's potentially relatively large vegetation management task given we do not have robust data to make any such adjustments. We note the OH&S factor likely benefits Western Power and the vegetation management factor adversely affects it.

The more complex OEF relates to the sub-transmission proportion of Western Power's distribution network, which has relatively fewer 66kV assets than the NEM DNSPs given the different transmission/distribution definitions in the Electricity Access Code compared to those in the NER. On balance, we have decided not to make an adjustment for this OEF, which likely benefit Western Power's distribution network in our benchmarking results.

5 Western Power's MTFP performance

Estimation of MTFP and MPFP will enable movements in the total, labour and capital productivity of Western Power to be assessed relative to its peers since the mid-2000s. In other words, how well Western Power uses its labour and capital inputs to deliver its outputs, including maximum demand and service performance.

This provides a 'top down' perspective on Western Power's relative cost and productivity performance and can be contrasted with a more detailed 'bottom up' assessment of disaggregated costs we expect to be undertaken by ERA.

5.1 Distribution network MTFP scores

5.1.1 MTFP specification

The output specification used in the AER's MTFP analysis comprises energy delivered, customer numbers, circuit length, ratcheted maximum demand and reliability. Reliability is measured as the number of customer minutes off supply. (Reliability is a negative output because a decrease in supply interruptions is equivalent to an increase in output.)

The input specification comprises the observed opex spent on 'network services'. Network services are defined by the AER to be a DNSP's core network services.[18] This series has a lower value than the total opex category, which includes costs associated with street lighting, connection services and metering services. It is not our intention to choose a lower value series to boost Western Power's measured MTFP performance. Rather, this series has been chosen because, in our view, it is most likely to allow 'cleaner' comparisons of opex productivity to be made across NEM DNSPs.

In addition, capital inputs are split into overhead distribution (low and medium voltage) lines, overhead sub-transmission (high voltage) lines, underground distribution cables, underground sub-transmission cables and transformers and other capital.

Several opex categories are collected in the RIN statements. In addition to selecting 'network services' we have selected an opex sub-category using DNSPs' historical cost

18 AER (2013), Economic benchmarking RIN for distribution network service providers, November, p 44 'Network Services relate to services provided over the shared network used to service all network users connected to it. Such services may include the construction, maintenance, operation, planning and design of the shared network. Network Services are delivered through the provision and operation of apparatus, equipment, plant and/or buildings (excluding connection assets) used to convey, and control the conveyance of, electricity to customers. Network Services also include the provision of emergency response and administrative support for other Network Services. Network Services are a subset of Standard Control Services that excludes Connection Services, Metering services, Fee Based and Quoted Services and Public Lighting Services.'

allocation approaches.[19] We consider that this data series provides benchmarking results that are independent of changes in cost allocation methodologies and classification of services that other opex data series might be subject to. For example, the opex category *Current opex categories and cost allocations* would be based on DNSPs' current cost allocation methodology and therefore the current year's data may not be comparable with data submitted by the DNSP in previous years.

Further, selecting opex for network services means that any changes in service classification from standard control services (SCS) to alternative control services (ACS) should not affect the data year on year.[20]

However, this does mean that opex for metering, connection services, public lighting, amounts payable for easement levies and transmission connection point planning are excluded from our benchmarking analysis. Ensuring efficient levels of expenditure for these opex categories is just as important as for network services. Our reason for selecting a data series solely related to network services for this benchmarking exercise was simply to ensure the results were more comparable year on year and across DNSPs.

MTFP results have been calculated for Western Power and all NEM DNSPs, which includes what we consider to be a relatively diverse group of distribution networks (eg primarily CBD/urban vs primarily rural networks) as shown in Table 2. The breakdown of distribution networks in Table 2 reflect the assessment of network characteristics in Chapter 3 of our report, including the rural proportion of total network and customers in rural areas.

Table 2 Type of distribution network

Primarily CBD/Urban networks	Primarily rural networks
CitiPower	SA Power Network
United Energy	Powercor
Jemena	Ausnet Services
Energex	Ergon Energy
Ausgrid	Essential Energy
Endeavour Energy	TasNetworks
ActewAGL	Western Power

Source: Synergies

[19] AER, Economic Benchmarking Regulatory Information Notice, Tab 3.2 Operating Expenditure, Table 3.2.2.2 *Opex for network services, Opex consistency – historical cost allocation approaches (DOPEX0201A)*

[20] We note that the terms *standard control services* and *alternative control services* are defined terms under the national electricity regulatory framework but not used under the Access Code. However, the benchmarking data that Western Power has provided to us is in accordance with these defined terms.

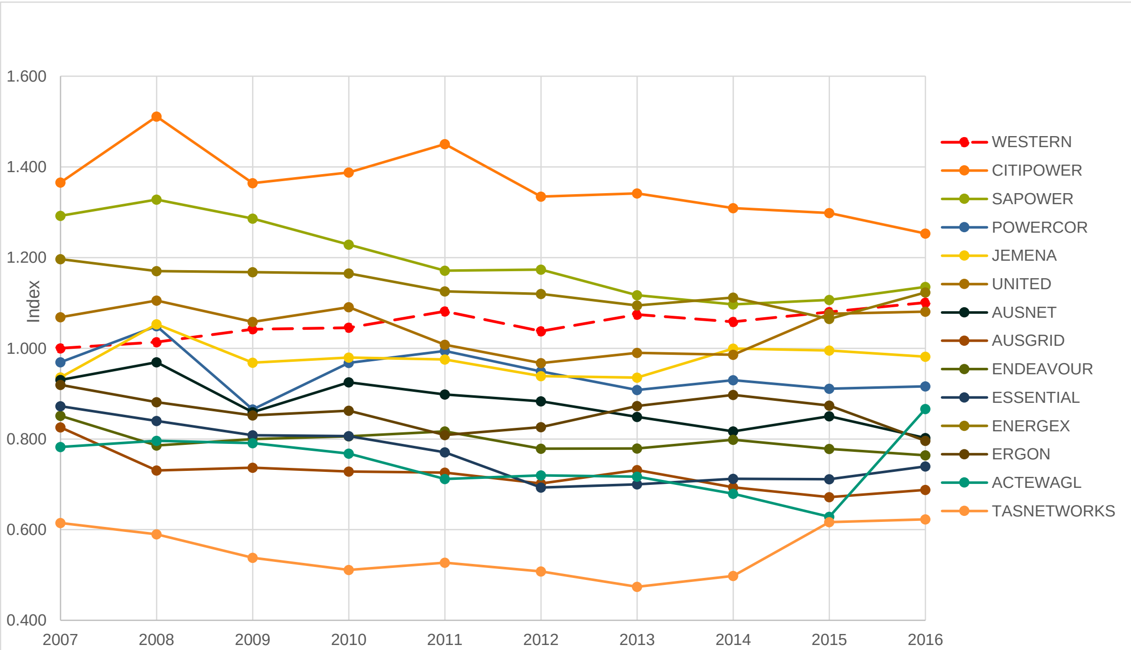
In applying MTFP analysis to all NEM DNSPs, we also note that ActewAGL, CitiPower and TasNetworks are atypically small distribution networks.

5.1.2 Trends in the distribution MTFP scores

In our MTFP analysis, Western Power is the index base network, such that all NEM DNSPs' MTFP performance is presented relative to Western Power.

Figure 21 presents our MTFP results for the period from 2006-07 to 2015-16 and is based on the publicly available AER Benchmarking RIN data sets, supplemented by Western Power's own data prepared on a comparable basis. Western Power's performance is shown in the red dashed line.

Figure 21 DNSP MTFP performance



Source: Synergies MTFP model

Figure 21 indicates that Western Power's own productivity performance between 2006-07 and 2015-16 has increased by around 10% over the period, reflecting growth in both its opex and capex productivity, particularly the former.[21] This is better than some previous better performing DNSPs such that Western Power is now ranked 4th amongst the full set of DNSPs rather than 5th at the start of the period.

[21] Western Power's 2006 score is the reference point for the MTFP measures and therefore has a starting value of 1.00 in the charts presented. All other MTFP scores are relative to the Western Power scores

We consider SA Power Network provides the best peer benchmark for Western Power given they share similar network characteristics. In 2015-16, Western Power was around 3% less productive than SA Power Network compared to around 29% less productive at the start of the period.

5.1.3 Trends in the distribution partial MTFP scores

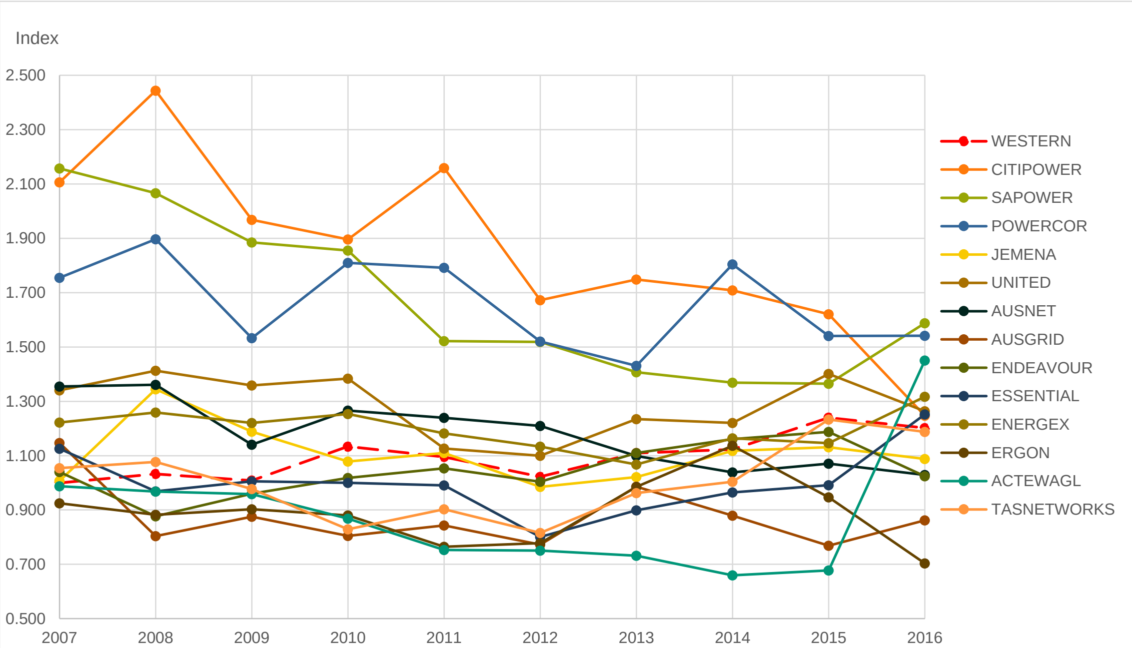
The partial MTFP measures use the same output specification (energy delivered, customer numbers, circuit length, ratcheted maximum demand and reliability) but examine the productivity of either opex or capex in isolation.

The partial MTFP scores can provide an indication as to which of opex or capex is the stronger cause of improved or declining total factor productivity performance.

Opex partial MTFP scores

Figure 22 shows the opex partial MTFP scores from 2006-07 to 2015-16. It is evident that the opex partial MTFP scores are more closely clustered than the total MTFP scores, although Citipower, SA Power Network and Powercor have generally been the best performers before converging to the pack in recent years as part of a broader convergence amongst the NEM DNSPs.

Figure 22 DNSP opex partial MTFP performance



Data source: Synergies MTFP model

Figure 22 reveals some important trends in NEM DNSPs' reported opex in recent years. Specifically, several of the government-owned DNSPs, plus ActewAGL, have undergone significant rationalisation/transformation programs that has resulted in large nominal opex reductions, which has been reflected particularly in the opex PFP results for FY2016. SAPN also reduced its opex expenditure in 2015-16.

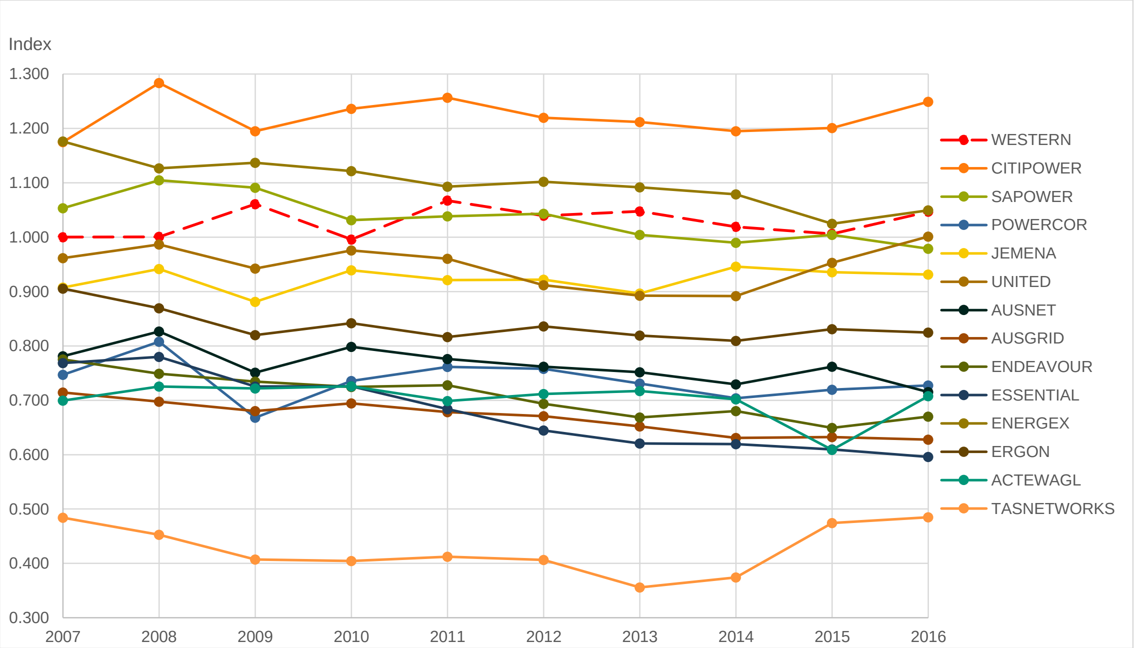
Figure 22 also indicates that the improvement in Western Power's opex productivity over the period has resulted in a move from 12th to 7th ranked DNSP. Its opex productivity performance is now around 32% lower than the best of its closest performing peers, SA Power Networks, compared to over 100% lower at the start of the period. We note this 'gap' to SA Power Networks increased materially in 2015-16 after closing substantially to around 10% in 2014-15. The reason for this widening was Western Power's increase in reported opex of around 8% in 2015-16 compared to SA Power Network's reported 15% reduction in its opex.

We consider these opex partial MTFP scores to be a more reliable guide to Western Power's improved opex productivity than the Stochastic Frontier Analysis opex scores presented in Appendix A of our report.

Capex partial MTFP scores

Figure 23 shows the capex partial MTFP scores from 2006-07 to 2015-16. It is evident that the capex partial MTFP scores are more dispersed than the opex partial MTFP scores.

Figure 23 DNSP capex partial MTFP performance



Data source: Synergies MTFP model

Western Power's own capex partial MTFP performance (refer red dotted line) has increased by around 5% over the assessment period, resulting in its ranking amongst its DNSP peers improving from 4th to 3rd.

Further, its capex productivity performance 'gap' against its lower ranked peers in 2015-16 (SA Power Networks excepted), has increased materially since the start of the period given Western Power is one of the small number of DNSPs that has improved its capex productivity over the assessment period.

5.2 Transmission network MTFP scores

It is important to note that in its transmission revenue determinations, the AER has not heavily relied on its MTFP scores in assessing the relative efficiency of TNSPs' expenditure. Rather, it has placed greater weight on each TNSP's own historical and forecast costs. Moreover, it has not applied its SFA and associated econometric benchmarking techniques to assess TNSPs' opex efficiency in its Annual Benchmarking Reports.

In regard to application of benchmarking techniques to TNSPs' expenditure, the AER commented as follows in its 2016 Annual Benchmarking Report:[22]

> 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.

We concur with the AER's assessment.

5.2.1 MTFP specification

The output specification used in the AER's MTFP analysis for TNSPs comprises energy delivered, circuit line length, ratcheted maximum demand, voltage-weighted entry and exit points (comparable to the customer numbers output variable used for DNPs) and reliability. As noted for DNSPs, reliability is measured as the number of customer minutes off supply.[23]

[22] AER (2016), Annual Benchmarking Report, Transmission network service providers, November, p 13

[23] Reliability is a negative output because a decrease in supply interruptions is equivalent to an increase in output.

The input specification is the observed opex spent on prescribed transmission services, which are the core shared network services provided by TNSPs. Capital inputs are split into overhead lines, overhead transmission lines, underground transmission cables and transformers and other capital.

MTFP results have been calculated for Western Power and the following NEM peers:[24]

- TransGrid
- Powerlink
- Electranet
- TasNetworks (transmission).

5.2.2 Trends in the transmission MTFP scores

Figure 24 (over page) indicates that Western Power's transmission MTFP performance (refer red dotted line) has declined by around 20% over the period from 2007 to 2014.[25] This outcome reflects increases in all inputs, but particularly the opex input. These increases have not been fully offset by increases in outputs.

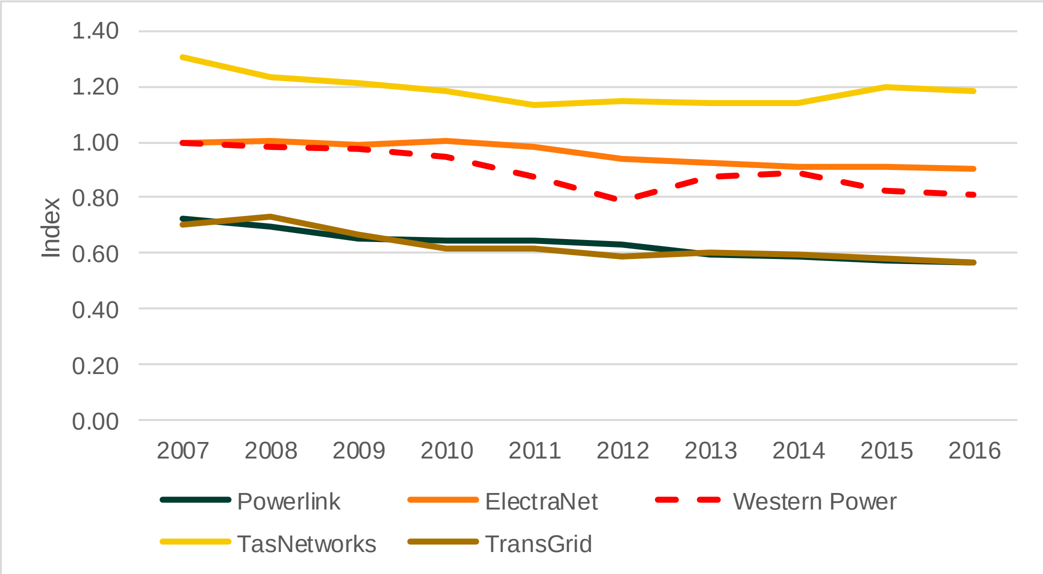
However, in level terms, it remains one of the best performing TNSPs amongst NEM peers. It is also worth noting the convergence of the MTFP scores in recent years, with TasNetworks currently being the best performer.[26]

24 We have not included Ausnet Services in our sample because of significant data gaps in its reported RIN data, including energy delivered.

25 Western Power's 2007 score is the reference point for the MTFP measures and has a starting value of 1.00 in the charts presented.

26 The fact that TasNetworks is also one of the worst performing DNSPs is somewhat puzzling.

Figure 24 TNSP MTFP performance



Source: Synergies MTFP model

It should be noted that Synergies has used only a very low weight for transmission network reliability (0.2%) given the high sensitivity of the model to this output variable, as well as the problem in accurately attributing supply outages at the transmission level to customer numbers. However, this low weighting softens the MTFP impact of Western Power's poor transmission network reliability performance.

5.2.3 Trends in the transmission partial MTFP scores

Partial MTFP specification

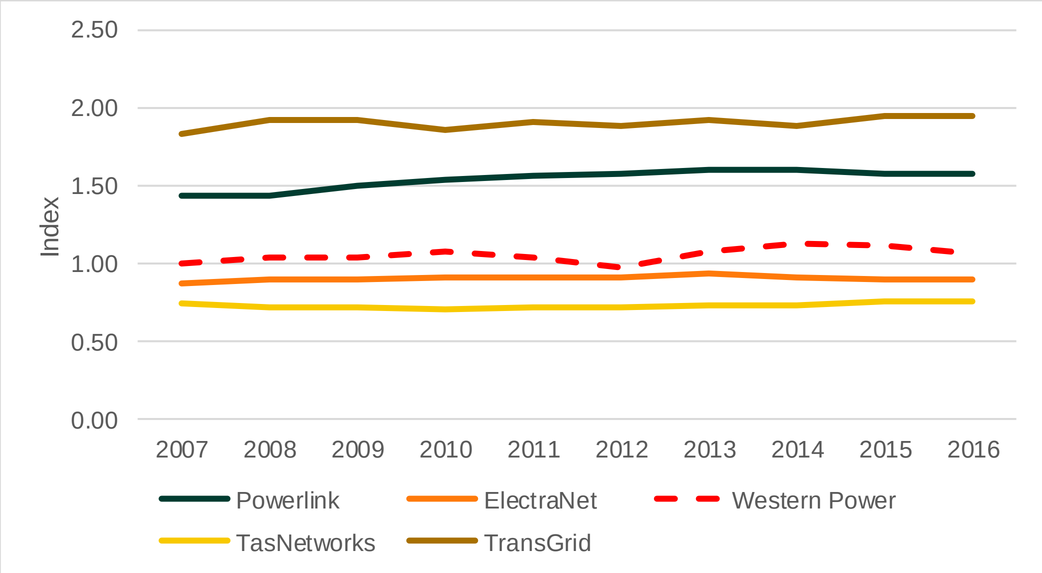
The partial MTFP measures use the same output specification (energy delivered, customer numbers, circuit length, ratcheted maximum demand, voltage weighted entry and exit points and reliability), but examine the productivity of either opex or capital in isolation.

Partial MTFP scores

Figure 25 indicates that Western Power's transmission opex partial MTFP performance has been relatively flat over the period from 2007 to 2015 and in level terms is somewhat better than that of TasNetworks and Electranet.

Figure 25 also indicates that TransGrid delivers its outputs with significantly fewer labour and materials inputs than all other TNSPs, including around three times less than Western Power.

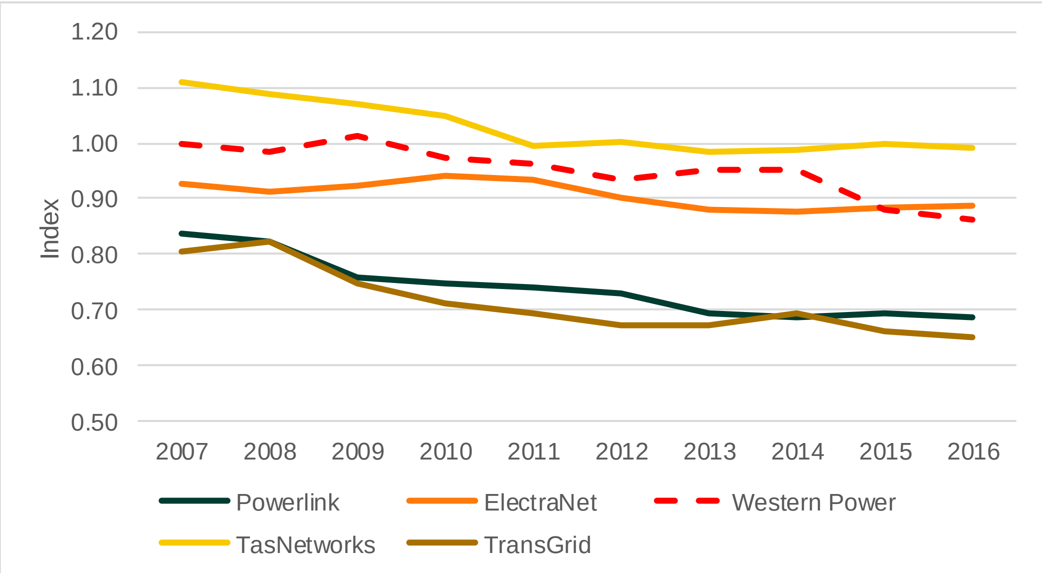
Figure 25 TNSP partial opex MTFP performance



Source: Synergies MTFP model

Figure 266 below indicates that Western Power's transmission capex partial MTFP performance (refer red dotted line) has declined by around 14% over the period from 2007 to 2015 as part of a compression of partial capex MTFP scores amongst the TNSPs. This is most likely indicative of an increasing capex profile over the period.

Figure 26 TNSP partial capex MTFP performance



Source: Synergies MTFP model

However, in level terms Western Power has remained one of the two best performers with TasNetworks, which suggests that these two networks have consistently delivered their outputs with fewer capital inputs than the other TNSPs. Western Power’s capital productivity is around 30% more efficient than TransGrid in 2015-16.

5.2.4 Summary of MTFP and partial MTFP analysis

The MTFP performance of Western Power’s distribution network has been good in absolute terms over the assessment period, increasing by around 10% underpinned by strong opex productivity growth. Its relative MTFP performance has also been good, such that Western Power is now ranked 4^{th} amongst the full set of DNSPs rather than 5^{th} at the start of the period.

Similarly, Western Power’s transmission network has been a relatively good performer compared to its NEM TNSP peers over the assessment period. Notwithstanding a fall in its MTFP performance over the assessment period, its MTFP level in 2015-16 remains amongst the best performers.

Synergies is reluctant to make strong conclusions in respect of the relative levels of the DNSPs’ measured MTFP performance, because it is unclear whether the differences reflect data anomalies or because they favour certain network configurations over others.

6 Western Power's expenditure forecasts for AA4 regulatory period and productivity implications

It is possible for us to form an indicative view about Western Power's likely future productivity performance based on our understanding of Western Power's expenditure forecasts for the AA4 regulatory period.

In practice, this is a more straightforward matter for opex productivity than capex productivity because there is only one input variable in the MTFP model formulation (opex itself) compared to five capital input variables.

However, we should emphasise that given we do not have detailed expenditure forecasts for any of the DNSPs (unlike the benchmarking approach adopted by OFGEM), our approach is a very imprecise 'rules of thumb' one intended simply to determine whether there would likely be any material divergence in Western Power's own productivity performance and its ranking amongst DNSP peers from current performance levels.

6.1 Operating expenditure

It is possible to make broad assumptions about the likely impact on Western Power's own opex productivity performance given its opex forecasts for the AA4 regulatory period using simple rules of thumb.

Table 3 presents scenario results based on flexing assumed opex (in nominal dollar terms) and output index levels for a single year (FY2016). It should be noted that these results are indicative only.

Table 3 Opex PFP sensitivity 'rule of thumb' results

Output index change assumption	1. Hold actual opex at nominal 5 year average value of $319,000	2. Hold actual opex at FY15 nominal level of $303,871	3. Reduce actual opex by $10% below FY15 nominal level to $273,484	4. Reduce actual opex by 20% below nominal 5 year average value to $255,200
Hold outputs constant at 2014/15 level	Opex PFP declines by 3.3%	Opex PFP increases by 1.5%	Opex PFP increases by 13.0%	Opex PFP increases by 20.8%
Increase output index by 5% from 2014/15 level	Opex PFP declines by 1.8%	Opex PFP increases by 3.1%	Opex PFP increases by 14.5%	Opex PF increases by 22.7%
Increase output index by 10% from 2014/15 level	Opex PFP declines by 0.3%	Opex PFP increases by 4.6%	Opex PFP increases by 16.3%	Opex PFP increases by 24.5%

Source: Synergies DX Benchmarking Model

Points to emphasise in Table 3 are as follows:

- Material cuts in Western Power's opex from current levels will deliver the biggest opex PFP performance pay-off and quickly;

  - opex reductions directly reduce the level of the input index in the MTFP and PFP aggregate indexes favourably affecting the opex PFP results (ie a high output and low input index level for a DNSP will maximise its MTFP and PFP results);

- increasing outputs over time will improve opex PFP performance provided it is accompanied by opex discipline, particularly prudent expenditure reductions;

Based on our understanding that Western Power will base its AA4 opex forecasts on an efficient base year opex value of around $250m (in nominal terms) and assuming constant outputs (and no change in opex productivity levels for any other DNSPs), this would result in an opex PFP improvement of around 34% for Western Power.

Such a ballpark improvement is consistent with the sharp improvements we are seeing in other DNSPs who have cut opex significantly in 2015-16. Up-front restructuring costs that Western Power is incurring in making the opex efficiencies, including in 2015-16, suggest that its productivity outlook will be better when such costs drop out of reported opex.

An opex productivity improvement of this magnitude will place Western Power amongst the top ranking DNSPs and represent very impressive own opex PFP performance.

6.2 Capital expenditure

In terms of the impact of Western Power's AA4 capex forecasts on Western Power's future capex productivity performance, in simple terms, in the absence of any major upward step changes in its capex program, it can reasonably be concluded that given current relative performance levels, its capex productivity is likely to remain good compared to its NEM peers.

A SFA-based opex efficiency

The AER engaged Economic Insights (EI) to develop a range of economic benchmarking methods to assess the relative opex cost efficiency of DNSPs in its most recent set of revenue determinations for DNSPs.

As noted in Chapter 1 of this report, the methods included a Cobb Douglas SFA opex cost function model, which was used for the following purposes:

- determine whether the AER should adjust a DNSP's efficient base year opex; and
- the productivity change to be applied to a DNSP's forecast opex as part of applying the AER's preferred base-step-trend opex forecasting methodology.

We have updated the Australian, Ontario and New Zealand data inputs used in EIs' SFA opex model. In doing so, we emphasise the Australian Competition Tribunal's significant criticisms of the model.

Further we contrast the AER's approach with that now taken by OFGEM of using a combination of four historical and nine forecast years in benchmarking distribution network operator (DNO) costs.

A.1 EI's Cobb Douglas SFA opex model

Originally, EI intended to undertake its SFA analysis using only data from the Australian DNSPs' RINs. However, it was found that there was insufficient variation in the data to develop stable econometric outcomes and so it was decided that data from NZ and Ontario-based DNSPs should be included to generate a more robust SFA opex model formulation.

The data sets used for the NZ DNSPs were taken from the NZ Commerce Commission's Information Disclosure Data, which is similar in content to the RIN data. The Ontario data was sourced from a data set compiled by Pacific Economic Group Research in 2013 as part of a comparable benchmarking exercise undertaken for the Ontario Energy Board.

EI's final Cobb Douglas SFA model formulation expressed real opex (the dependent variable) as a function of the following independent explanatory variables:

- energy throughput
- customer numbers
- ratcheted maximum demand
- circuit length

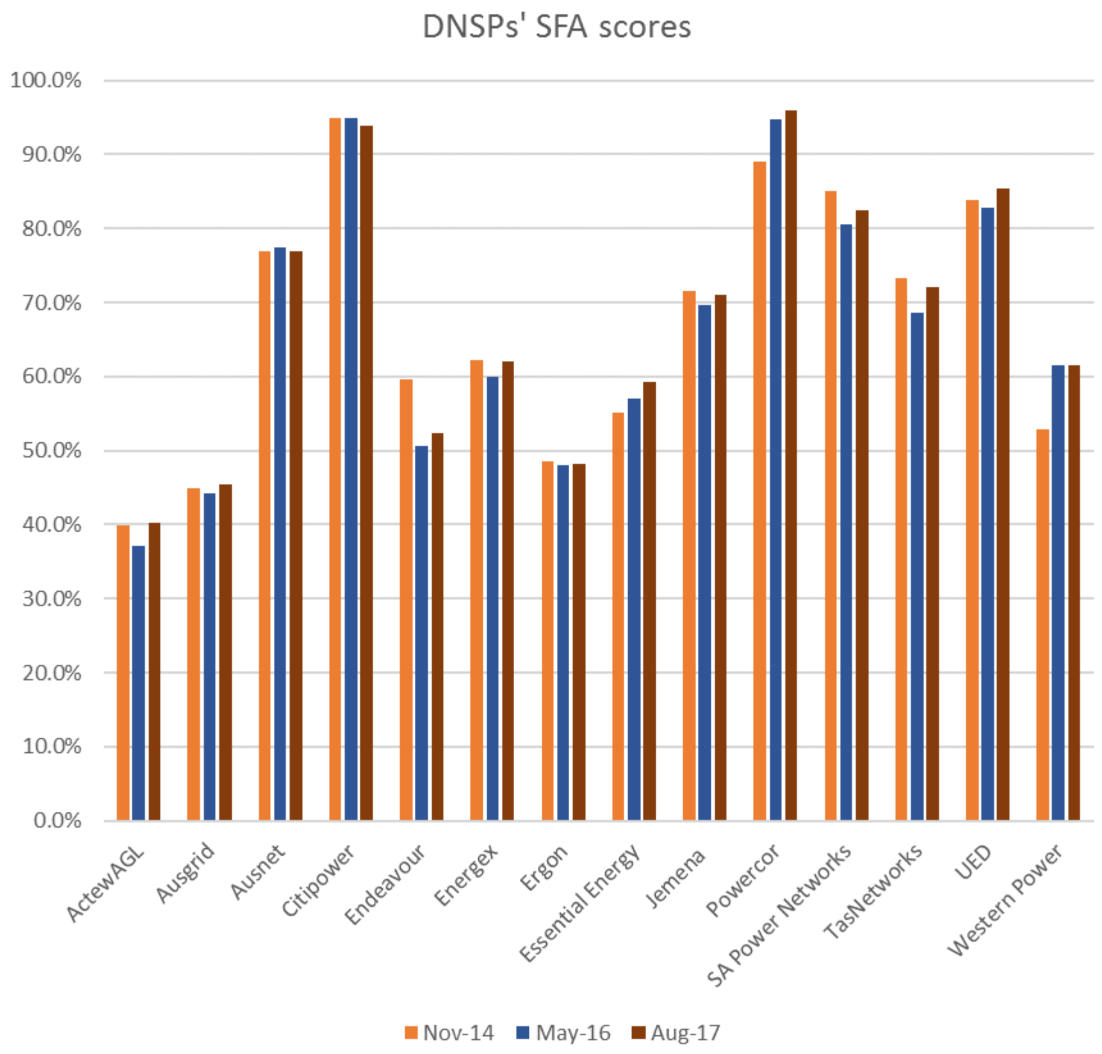
The share of underground cable is incorporated in the model as an operating environmental variable.

A.2 SFA analysis

Synergies has updated the AER's SFA data set to include the latest available observations. We have used the same network services opex RIN category for the SFA analysis as for our MTFP analysis.

Figure 27 shows the original and updated SFA scores that Synergies has estimated for Western Power using the AER's preferred Cobb Douglas SFA formulation, reflecting underlying data updates.

Figure 27 DNSP opex SFA performance



Data source: AER RIN data

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Since our last SFA analysis, Western Power's SFA score has remained at 61.5%.[27] SFA estimates of efficiency reflect not just the network's own performance, but also its performance relative to its peers. Thus, a possible interpretation is that despite Western Power's recent improvement, its DNSP peers in the NEM have also improved their efficiency.

In this regard, ActewAGL and TasNetworks were the only DNSPs to increase their efficiency scores by more than three percentage points, reflecting very significant reductions in their reported opex (i.e greater than 20%).[28] A slight decrease in relative efficiency was observed for Citipower and Ausnet. However, we note that the averaging of SFA results over the full assessment period means that ActewAGL halving its reported opex in 2015/16 over 2013/14 and Citipower increasing its opex by 30% over the same period, is reflected in these relatively modest changes in results. This can be contrasted with the MTFP and opex PFP results presented in the body of our report, which more quickly captures the materially improved or declining productivity performance of these DNSPs.

The SFA approach that the AER has adopted is a time-invariant cost model, which means that the measured inefficiency for each DNSP is assumed to be the same in each year. The consequence of this is that improvements in efficiency made in one year by, for example, an increase in output or a reduction in operating costs, will not be reflected in full in the revised SFA score. In a sense, the inefficiency score is a composite or average measure of inefficiency across all years of data for each DNSP. Hence, although it will not fully reflect a DNSP's improved or worsening performance reported in the most recent years, our approach of re-calculating the SFA scores periodically is capturing the effect of recent years' performance.

Table 4 shows the key differences in the SFA model formulation, including independent output coefficients, based on the 2014, 2016 and 2017 data sets we have used.

Table 4 Differences in the SFA model coefficients between 2014 and 2016 data bases

	2014 database	2016 database	2017 database
Observations	551	667	758
Energy delivered	Not significant	Not significant	Not included as insignificant[29]

27 It is important to note that Western Power has updated its benchmarking data since the previous analysis. Re-estimating the May 2016 analysis using the updated data returns a slightly lower efficiency score of 60.5%.

28 We note that restructuring costs for these DNSPs are also likely to be playing a substantial role in the reported opex of these entities.

29 In our previous reports, we have included energy delivered, despite evidence of multicollinearity, or high correlation, between energy delivered and ratchetted maximum demand. For the current estimations, we have followed the practice of EI and removed it from our analysis. Its exclusion does not have any material bearing upon the results.

	2014 database	2016 database	2017 database
Customer numbers	0.660	0.895	0.849
Circuit length	0.118	0.102	0.111
Ratchetted maximum demand	0.205	Not significant	Not significant
% of underground cable	-0.120	-0.119	-0.129
Year	0.018	0.018	0.021
Canada country dummy variable	0.136	0.264	0.287

Sources: EI dataset, AER RINs, Western Power

The coefficients on the cost drivers (ratchetted maximum demand, customers, circuit length and share of underground cable) are in logarithmic form and can therefore be interpreted as elasticities. That is, a 1% increase in customer numbers is expected to lead to a 0.85% increase in opex. Likewise, a 1% increase in circuit length is expected to lead to a 0.11% increase in opex. Hence, customer numbers appear to be the most significant driver of opex. The year variable measures the annual trend efficiency improvement over time, which in the most recent estimations has increased to 2.1%.

The country dummy variable for Canada[30] remains elevated relative to the original 2014 dataset. Having regard to its interpretation, the coefficient for the 2017 dataset indicates that, all other things being equal, operating costs for Ontario DNSPs are 28.7% higher than Australian costs, even after controlling for factors, such as customer numbers, demand and circuit length.

In its original SFA analysis, Economic Insights (EI) stated that the country dummies would correct for time-invariant country differences in, for example, data definitions and environmental factors. In contrast, Frontier Economics argued in its review of EI's approach that:[31]

> Simply including dummy variables is an inadequate way of controlling for specific differences between networks and between countries. The inclusion of dummy variables simply adjusts for differences in cost levels between the three jurisdictions (Australia, New Zealand and Canada) without allowing for fundamental differences between the relationship between costs and cost drivers.

The use of country dummy variables was also a source of criticism in the merits review by the Australian Competition Tribunal. The persistence of the change in the dummy variable coefficient, even in the most recent dataset, lends credence to the shortcomings of EI's SFA model and the concerns of the Tribunal.

[30] The model also included a New Zealand dummy variable, which was not statistically significant.

[31] Frontier Economics (2015), Page x.

Ratchetted peak demand is no longer a statistically significant driver of costs in the SFA model. Previously, Synergies has noted the high correlation between customer numbers and ratchetted peak demand. Another possible explanation relates to the fact that ratchetted maximum demand measures only the highest annual peak demand value up to a given point in time. Most of the DNSPs in the sample are now encountering annual peak demands below this highest level. As a result, ratchetted maximum demand is now relatively static, which limits its ability to explain variation in opex.

A.3 Conclusion

In comparing, the results from the estimations that Synergies conducted in 2014, 2016 and 2017, the main drivers of Western Power's improved SFA score are:

- the reduction in Western Power's opex by around 3% (on a real basis) between 2013 and 2016;
- the larger significance of customer numbers as an output when using the 2016 data set, which have increased somewhat over the period of analysis; and
- possibly the change in the extent to which country (i.e. being an Australian or New Zealand DNSP rather than an Ontario DNSP) impacts on operating costs, although data problems are also relevant here.

The outcome of our SFA analysis is broadly consistent with the opex partial MTFP scores presented in Chapter 5 of our report, including that Western Power's opex productivity has improved over the assessment period and is around the middle of the DNSP pack. This is likely to reflect the use of the same independent variables, except the reliability parameter that does not form part of the AER's SFA model formulation.

B Data Envelopment Analysis-based opex efficiency

The purpose of this chapter is to present our data envelopment analysis (DEA) results regarding the opex efficiency of DNSPs. We use these results to draw comparisons with the SFA opex efficiency results presented in Chapter 7 of our report.

B.1 Introduction to DEA

An alternative to the SFA benchmarking technique is DEA, a linear programming technique that offers a number of advantages compared to SFA. Importantly, DEA allows us to evaluate the role of network scale in determining efficiency scores, which cannot be undertaken as comprehensively in SFA. In addition, DEA is non-parametric, in the sense that is does not require the specification of a functional form, nor does it require any assumptions about the distribution of the inefficiencies.

One criticism of DEA is that it is susceptible to outliers. Badunenko, Henderson and Russell (2008) explain that the DEA approach, 'at best, identifies a lower bound on the true frontier; that is, it identifies a "best practice" frontier, not the true frontier.'[32] In other words, unless the sample includes all the observations that define the frontier (which in practice is unlikely), efficiency scores will tend to be overestimated, at least to some extent. On the other hand, an outlier with extremely low input use relative to its outputs may cause the efficiency scores of other firms to be understated.

There have been considerable advances in DEA efficiency modelling to address the sensitivity of the results to individual data points, to adjust the efficiency scores to take account of the bias resulting from data outliers and thin data, and to estimate confidence intervals for the efficiency measures.

To rectify the concerns raised above, we apply a bias-correction technique that employs what is referred to as 'bootstrapping'. Bootstrapping is a procedure that involves drawing with replacement from the existing sample data. This process attempts to mimic the data generating process and derive a notional distribution for the underlying population of efficiency scores. The DEA sampling bias arises from the fact that the observed sample (in the AER's case, Australian, NZ and Canadian distribution networks) is drawn from an underlying population (all electricity distribution networks in the world) that is unobservable.

Given this phenomenon, the efficiency scores that we calculate are strongly dependent on the observations of firms that comprise the frontier. Thus, by using simulations to

[32] Badunenko, O., Henderson, D.J. & Russell, R.R. (2008). Bias-corrected production frontiers: Application to productivity growth and convergence. Discussion Paper.

construct a distribution of efficiency scores, we can better understand where the "true" efficiency score is situated, thereby correcting for any bias in our sample results.

All results presented in this chapter are bias-corrected, using bootstrapping with 2000 iterations, based on the methodology of Simar and Wilson (2000).[33] We also present the raw, unadjusted scores as a means of comparison.

To maintain consistency with the basis of the AER's SFA estimates, we use the same inputs and outputs, and retain the New Zealand and Ontario DNSPs in the sample, which covers the same timeframe.[34] We have used the benchmarking package from the software 'R' for all DEA results presented here.

B.2 AER's position on DEA

In their 2014 report for the AER, Economic Insights decided not to include DEA in their benchmarking assessment. While acknowledging its benefits as a non-parametric technique, they argued that the procedure is deterministic in nature and thus sensitive to random factors and data errors.

We recognise these drawbacks, but stress that DEA is simply one component of a broader array of benchmarking techniques that each potentially provides important information. In this sense, DEA serves as a good cross-check on the other models that we have presented in our report.

In fact, Frontier Economics, in a review of the AER's benchmarking model, noted that the AER in its Expenditure Forecast Assessment Guideline had indicated that it would employ DEA, in addition to its MTFP and SFA models.[35] Additional evidence in support of DEA arises from the fact that it is a well-accepted method internationally, and has been routinely applied in other industries such as airports, hospitals and universities.

B.3 DEA methodology and scale efficiencies

DEA derives the production technology from the observed data itself rather than from some imposed functional form. However, there are a number of alternative assumptions that can be adopted in DEA which give rise to different efficiency scores. Specifically, different assumptions regarding the impact of scale on technical efficiency as follows:

33 Simar, L. & Wilson, P. (2000). A general methodology for bootstrapping in non-parametric frontier models. Journal of Applied Statistics, 27(6), pp.779–802

34 The use of the same international data set for our DEA analysis, while appropriate for comparison purposes with the AER's SFA analysis, raises the same concerns about whether NZ and Canadian distributors are sufficiently like Australian DNSPs for economic benchmarking purposes.

35 Frontier Economics (2015). Review of the AER's econometric benchmarking models and their application in the draft determinations for Networks NSW, January

- *crs* or constant returns to scale assumes that the output that is overall most efficient (in terms of the lowest use of inputs per unit of output) can be linearly scaled upwards or downwards;
- *vrs* or variable returns to scale assumes that no scaling is possible, such that the efficient production technology at each level of output is delineated by the observations in the sample with that level of output;

We explore these assumptions before comparing the results to our SFA opex efficiency scores.

B.4 DEA opex efficiencies assuming CRS

The first DEA specification calculates efficiency scores under the assumption of constant returns to scale. This assumption can be highly restrictive, particularly in situations where the selection of scale may be outside the decision-making capacities of business management.

The calculation of bias-corrected efficiency scores enables the construction of confidence intervals around our efficiency estimates. As demonstrated in Table 5, the narrow range of the upper and lower bounds around the point estimates indicates that the efficiency scores are precisely measured.

Table 5 DEA opex efficiency scores (assuming constant returns to scale)

DNSP	Bias-corrected CRS score	Confidence interval lower bound	Confidence interval upper bound	Raw CRS score	Bias
Powercor	78.7%	76.1%	80.6%	81.2%	2.5%
CitiPower	76.2%	72.8%	80.5%	81.8%	5.6%
SA Power	74.3%	70.8%	78.2%	79.7%	5.3%
Essential Energy	64.5%	59.2%	67.8%	68.4%	4.0%
United Energy	62.2%	59.1%	64.2%	64.4%	2.3%
AusNet	60.0%	58.1%	61.3%	61.6%	1.6%
TasNetworks	57.1%	55.2%	59.1%	59.8%	2.7%
Western Power	56.3%	53.6%	58.6%	59.5%	3.2%
Ergon	52.6%	48.4%	55.7%	56.4%	3.8%
Jemena	52.3%	49.8%	54.4%	54.7%	2.3%
Energex	51.5%	49.9%	52.8%	53.4%	1.9%
Endeavour	44.1%	42.9%	45.3%	46.0%	1.9%
ActewAGL	41.2%	39.9%	42.2%	42.6%	1.4%
Ausgrid	35.8%	34.5%	37.1%	37.4%	1.6%

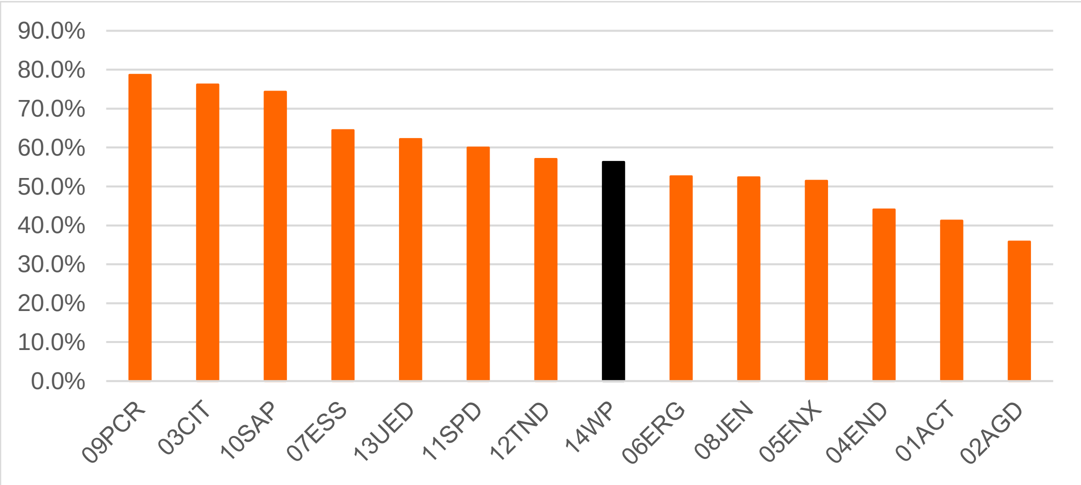
Source: Synergies

Comparable with the SFA results, Powercor and Citipower have the most efficient opex as measured by the DEA technique and the ranking of remaining DNSPs is broadly comparable.

A comparison of the raw and bias-corrected efficiency scores shows that the bias-correction in most cases is minor and has no material impact upon the results. Western Power's efficiency score (56.3%) appears consistent with its SFA score of 61.5%.

Figure 28 presents our bias-corrected DEA opex estimates

Figure 28 Bias-corrected DEA CRS opex efficiency estimates



Note: Efficiencies have been bias-corrected using bootstrapping with 2000 iterations.

Data source: AER RIN data, Synergies calculations

B.4.1 DEA opex efficiencies assuming VRS

An alternative assumption to CRS is that the networks exhibit variable returns to scale (VRS).

Table 6 shows a significant improvement in efficiency scores for a number of the DNSPs under this assumption. United Energy now has the highest efficiency score, followed by Energex and SA Power. The bias corrections tend to be larger for the VRS efficiencies, but the ranking of DNSPs would change only slightly if we were to revert to the raw VRS scores.

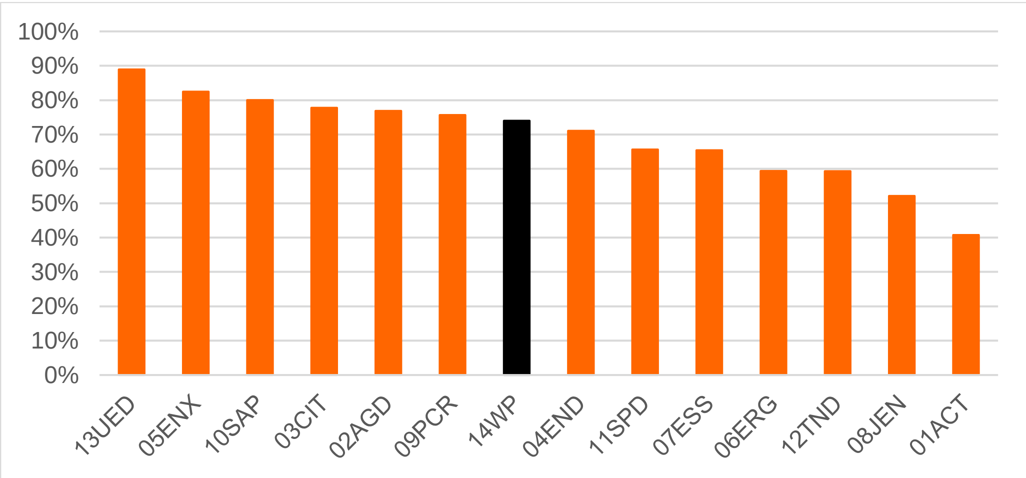
Table 6 DEA opex efficiency scores (assuming variable returns to scale)

DNSP	Bias-corrected VRS score	Confidence interval lower bound	Confidence interval upper bound	Raw VRS score	Bias
United	88.9%	84.3%	91.8%	92.4%	3.4%
Energex	82.5%	74.8%	90.2%	91.1%	8.6%
SA Power	80.0%	72.4%	87.6%	89.0%	9.0%
CitiPower	77.8%	71.5%	83.6%	84.7%	7.0%
Ausgrid	76.9%	67.0%	87.9%	89.3%	12.4%
Powercor	75.7%	69.2%	81.1%	81.8%	6.1%
Western Power	74.0%	65.0%	83.1%	84.5%	10.5%
Endeavour	71.1%	67.2%	74.1%	74.9%	3.8%
AusNet	65.6%	61.7%	68.3%	68.9%	3.3%
Essential Energy	65.4%	56.7%	75.2%	76.5%	11.1%
Ergon	59.4%	54.6%	62.9%	63.7%	4.3%
TasNetworks	59.3%	56.5%	61.9%	62.3%	3.0%
Jemena	52.1%	48.0%	55.0%	55.5%	3.3%
ActewAGL	40.8%	39.2%	42.2%	42.6%	1.9%

Source: Synergies

Figure 29 presents the bias-corrected ranking of DNSPs opex efficiency scores.

Figure 29 Bias-corrected DEA VRS efficiency estimates



Source: Synergies

Of the 14 DNSPs, Western Power experiences the fifth largest improvement in its efficiency measure when the assumption of constant returns to scale is relaxed. As indicated in Table #, Western Power's VRS efficiency score (74%) is 18 percentage points higher than its CRS score. Although Western Power's ranking increases by one place (from eighth to seventh), more significant is the convergence between Western Power and the most efficient DNSPs.

Table 7 (over page) presents a comparison of the results under the differing scale assumptions.

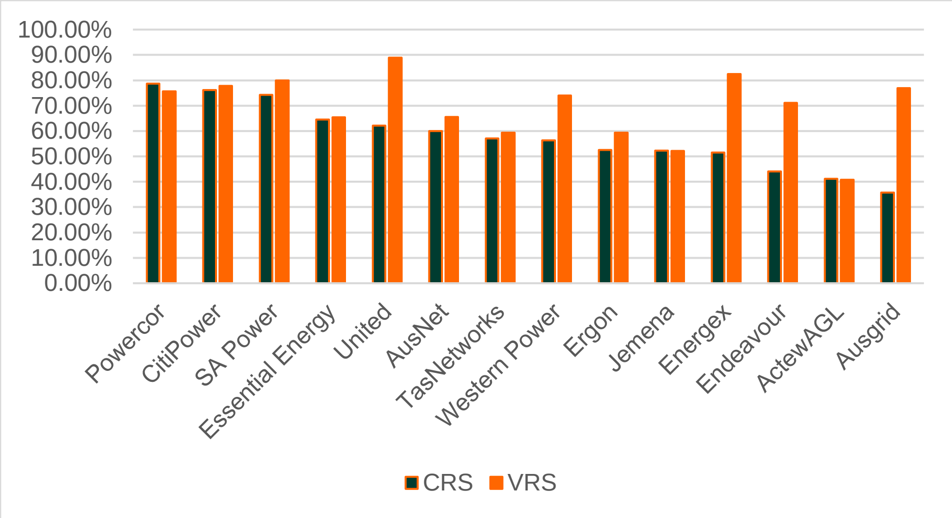
Table 7 Comparison of CRS and VRS efficiency scores

DNSP	CRS score	Ranking under CRS	Distance from most efficient Australian DNSP	VRS score	Ranking under VRS	Distance from most efficient Australian DNSP
Powercor	78.7%	**1st**	0.0%	75.7%	**6th**	13.3%
CitiPower	76.2%	**2nd**	2.5%	77.8%	**4th**	11.2%
SA Power	74.3%	**3rd**	4.3%	80.0%	**3rd**	8.9%
Essential Energy	64.5%	**4th**	14.2%	65.4%	**10th**	23.5%
United	62.2%	**5th**	16.5%	88.9%	**1st**	0.0%
AusNet	60.0%	**6th**	18.7%	65.6%	**9th**	23.3%
TasNetworks	57.1%	**7th**	21.6%	59.3%	**12th**	29.6%
Western Power	56.3%	**8th**	22.4%	74.0%	**7th**	14.9%
Ergon	52.6%	**9th**	26.1%	59.4%	**11th**	29.5%
Jemena	52.3%	**10th**	26.3%	52.1%	**13th**	36.8%
Energex	51.5%	**11th**	27.2%	82.5%	**2nd**	6.5%
Endeavour	44.1%	**12th**	34.6%	71.1%	**8th**	17.9%
ActewAGL	41.2%	**13th**	37.5%	40.8%	**14th**	48.2%
Ausgrid	35.8%	**14th**	42.8%	76.9%	**5th**	12.1%

Source: Synergies

Figure 30 (over page) presents the bias-adjusted opex efficiency scores under constant and variable returns to scale pictorially. The different scale assumptions have a relatively large effect on several DNSPs.

Figure 30 Comparison of efficiency scores with different scale assumptions



Note: Both sets of scores presented here have been corrected for bias

Source: Synergies

Under the assumption of constant returns to scale, Western Power's efficiency score was 23 percentage points lower than Powercor. Under the assumption of variable returns to scale, Powercor is now ranked as only the sixth most efficient DNSP, only two percentage points higher than Western Power. Moreover, United Energy, which is now ranked as the most efficient DNSP (89%), is only 15 percentage points more efficient, and if Western Power were to increase its efficiency by 6 percentage points, it would become the third-highest ranked DNSP in the sample.

One of the most significant improvements was observed for Ausgrid, which improved its ranking from 14th (the least efficient) to 5th. Energex also improved its ranking by nine places. Given the size of these two DNSPs, this could suggest that the treatment of scale has a significant impact on our findings. We now turn to a discussion of scale efficiency calculations.

B.4.2 Scale efficiency

Scale efficiency expresses how close a firm is to the optimal scale size. It is calculated as the ratio of the CRS efficiency score to the VRS efficiency score.[36] Table 8 (over page) presents our scale efficiency estimates.

[36] This relationship between CRS and VRS scores implies that VRS scores are always at least as large as CRS scores, such that scale efficiency is no more than 100%. However, the bias-correction tends to be slightly larger for the VRS estimates, which results in the scale efficiency scores for highly scale efficient DNSPs being slightly larger than 100%.

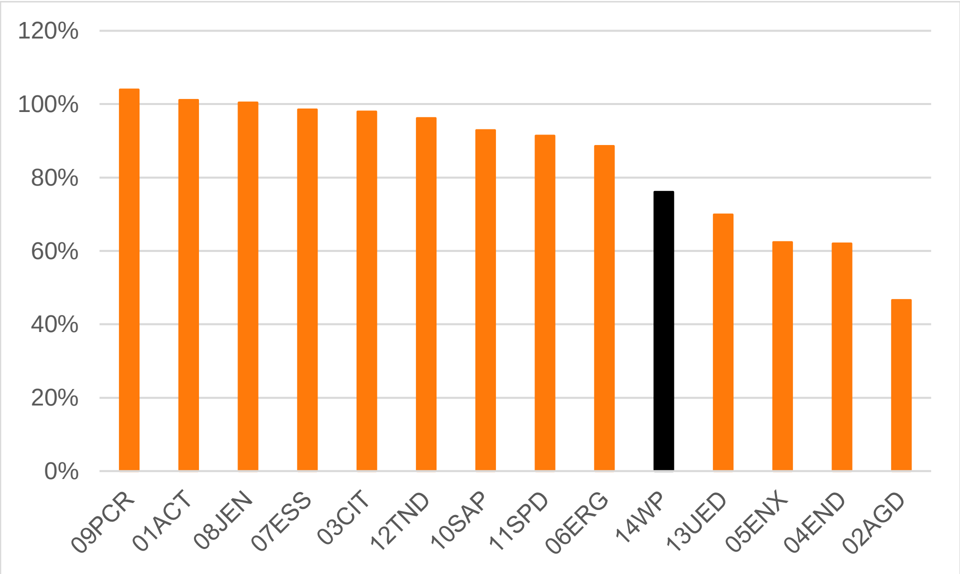
Table 8 DNSP scale efficiency

DNSP	Bias-corrected CRS score	Bias-corrected VRS score	Bias-corrected scale efficiency	Raw CRS score	Raw VRS score	Raw scale efficiency
Powercor	78.7%	75.7%	104.0%	81.2%	81.8%	99.2%
ActewAGL	41.2%	40.8%	101.1%	42.6%	42.6%	99.9%
Jemena	52.3%	52.1%	100.4%	54.7%	55.5%	98.6%
Essential Energy	64.5%	65.4%	98.5%	68.4%	76.5%	89.5%
CitiPower	76.2%	77.8%	98.0%	81.8%	84.7%	96.6%
TasNetworks	57.1%	59.3%	96.2%	59.8%	62.3%	96.0%
SA Power	74.3%	80.0%	92.9%	79.7%	89.0%	89.5%
AusNet	60.0%	65.6%	91.4%	61.6%	68.9%	89.4%
Ergon	52.6%	59.4%	88.6%	56.4%	63.7%	88.6%
Western Power	56.3%	74.0%	76.1%	59.5%	84.5%	70.3%
United	62.2%	88.9%	69.9%	64.4%	92.4%	69.7%
Energex	51.5%	82.5%	62.4%	53.4%	91.1%	58.6%
Endeavour	44.1%	71.1%	62.0%	46.0%	74.9%	61.4%
Ausgrid	35.8%	76.9%	46.6%	37.4%	89.3%	41.9%

Note: Scale efficiency is calculated as the CRS score divided by the VRS score.
Source: Synergies

Figure 31 presents bias-corrected scale efficiency of DNSPs.

Figure 31 Bias-corrected scale efficiency of DNSPs

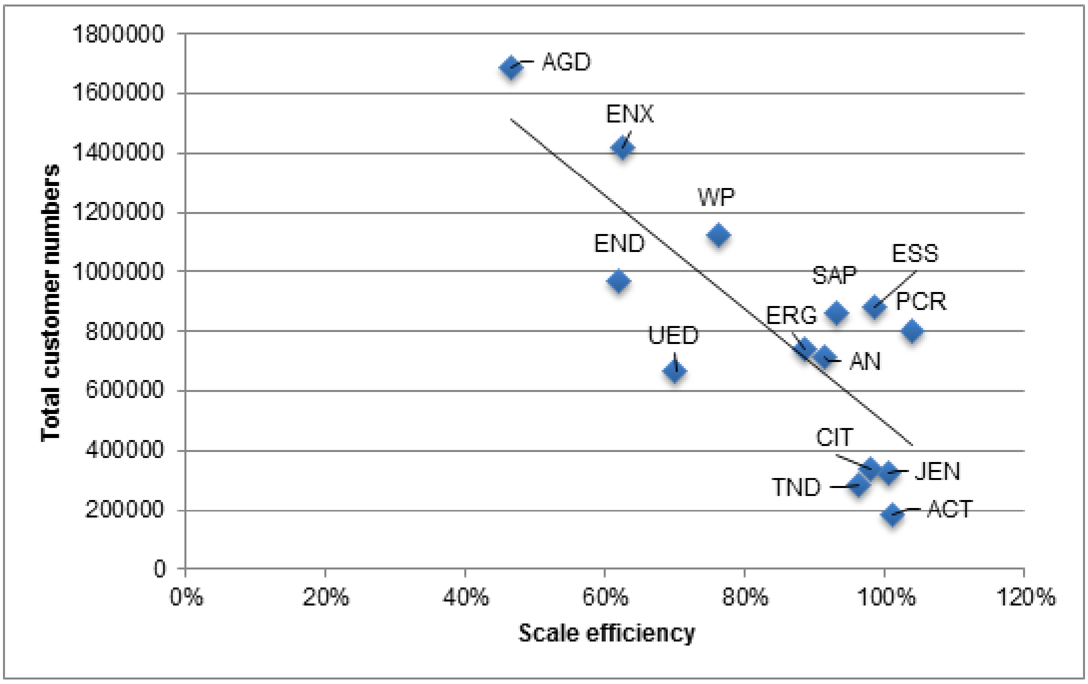


Source: Synergies

Figure 31 illustrates that 5 Australian DNSPs (Western Power, United Energy, Energex, Endeavour Energy and Ausgrid) appear to be particularly disadvantaged by scale. This explains in part why these DNSPs perform relatively poorly in the CRS estimations, yet improve measurably in the VRS estimations.

This of course leads to an important question. What is the optimal scale for an Australian DNSP? A useful, although far from comprehensive, illustration of scale in the context of Australian DNSPs is presented in Figure 32. It depicts the relationship between total customer numbers and observed scale efficiency.

Figure 32 Relationship between customer numbers and scale efficiency



Source: Synergies

It appears that customer numbers and scale efficiency appear to be inversely related. This is not to suggest that the Australian distribution networks exhibit decreasing returns to scale regardless of customer size. Rather, that the Australian distribution networks with the largest customer bases (around 1 million or more), including Western Power, exhibit decreasing returns to scale.[37]

This is merely one factor in a multi-dimensional problem, but highly relevant because based on the coefficients in the AER's estimated SFA equations, the most prominent determinant of opex efficiency is customer numbers. Therefore, it appears that Western Power's efficiency may be hindered by its relatively large customer base, as are Ausgrid, Endeavour Energy and Energex. The reason for United Energy's apparent scale efficiency is less clear.

[37] It should also be pointed out that smaller DNSPs show increasing or constant returns to scale up to the 1 million customer mark, suggesting scale efficiencies are available in some of their functions, including network control, call centres and corporate functions (Board and Executive Management).

B.4.3 Comparison of DEA and SFA results

In assessing the relevance and/or appropriateness of the competing models, it is important to note the discrepancies and similarities that they report. As previously noted, both models use the same input and output variables. However, the non-parametric nature of DEA is a key point of differentiation from the econometric specification of SFA.

Table 9 presents our DEA results under the constant and variable returns to scale assumptions compared to our SFA results.

Table 9 Comparison of DEA and SFA results

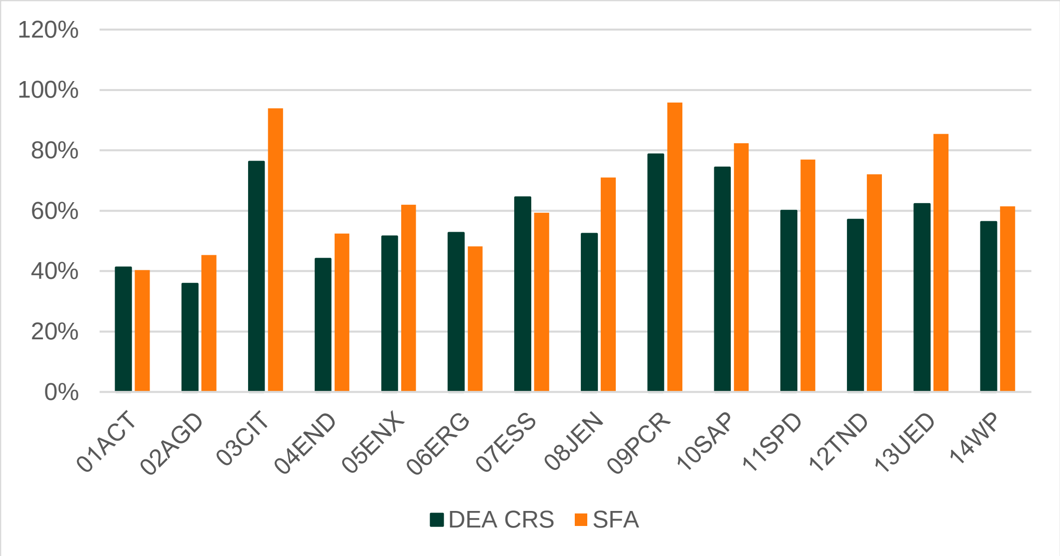
DNSP	SFA score	DEA CRS score	Difference	DEA VRS score	Difference
ActewAGL	40.3%	41.2%	**0.9%**	41%	**0.4%**
AusGrid	45.4%	35.8%	**9.6%**	77%	**31.5%**
CitiPower	93.9%	76.2%	**17.8%**	78%	**16.2%**
Endeavour	52.4%	44.1%	**8.3%**	71%	**18.7%**
Energex	62.0%	51.5%	**10.6%**	82%	**20.4%**
Ergon	48.3%	52.6%	**4.4%**	59%	**11.1%**
Essential Energy	59.3%	64.5%	**5.1%**	65%	**6.1%**
Jemena	71.1%	52.3%	**18.7%**	52%	**18.9%**
Powercor	95.9%	78.7%	**17.2%**	76%	**20.2%**
SA Power	82.4%	74.3%	**8.1%**	80%	**2.4%**
AusNet	76.9%	60.0%	**16.9%**	66%	**11.3%**
TasNetworks	72.1%	57.1%	**15.0%**	59%	**12.8%**
United Energy	85.4%	62.2%	**23.3%**	89%	**3.5%**
Western Power	61.5%	56.3%	**5.2%**	74%	**12.5%**
		Average difference:	**11.5%**	**Average difference:**	**13.3%**

Source: Synergies

The CRS efficiency scores represent a closer fit with the SFA scores for 8 of the 14 DNSPs under investigation. The average difference between the SFA and DEA-CRS scores was 13.3 percentage points, compared to 11.5 percentage points for the VRS scores. Having regard to the six instances where the VRS scores were closer, three of these VRS scores were only marginally closer to the SFA results, and in five instances, the DNSP in question was greater than 90% scale efficient.

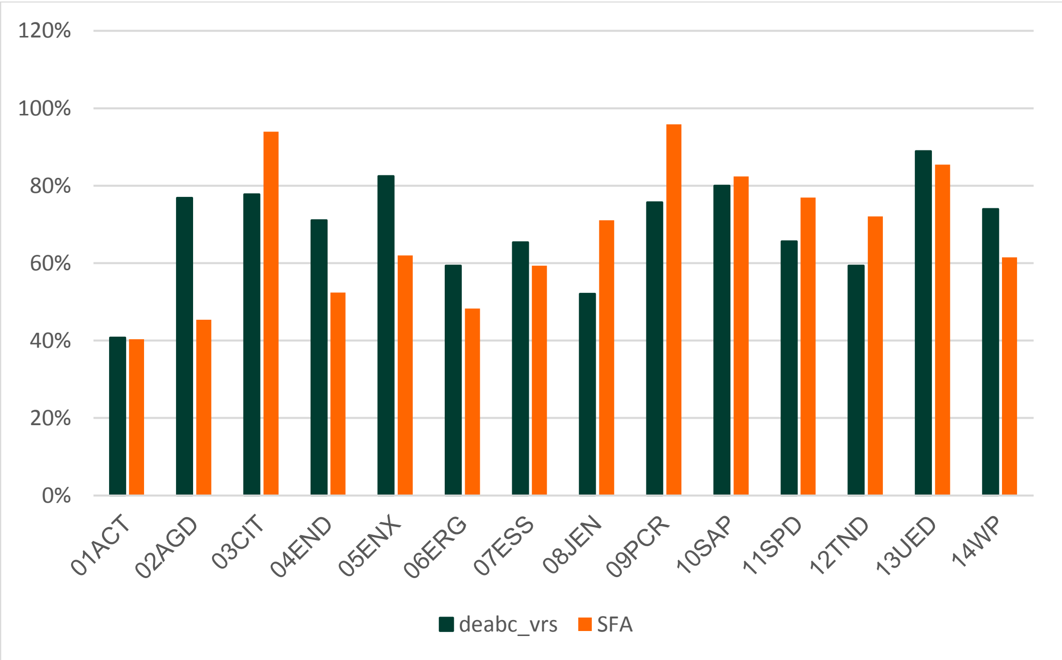
Figures 33 and 34 show the results of our analysis pictorially.

Figure 33 Comparison of SFA and DEA-CRS efficiency scores



Source: Synergies

Figure 34 Comparison of SFA and DEA-VRS efficiency scores



Source: Synergies

B.5 Summary of main findings

Overall, it appears that the AER's SFA model provides a reasonable approximation of efficiencies under a constant return to scale assumption. If this is the case, it suggests that an excessive reliance on SFA may not properly account for the true impact of network scale on efficiency outcomes for Australia DNSPs. In other words, part of measured efficiency under the AER's SFA model is a function of network scale (ie a factor beyond a DNSP management's control) not controllable inefficiency.

C Partial Productivity Indicator (PPI) analysis

This Appendix presents several partial productivity indicators (PPIs) relating to NEM distribution networks and Western Power.

C.1 Use of PPI analysis

PPI analysis is undertaken by calculating different measures of the financial, operating and service performance of comparable businesses. In terms of productivity performance, commonly adopted measures include:

- single input factor productivity measures in terms of labour, capital stock, material and/or fuel respectively; and
- unit cost measures, such as average total costs (total costs divided by a single measure of output).

In practice, outputs are delivered using a combination of inputs, and one input typically contributes to a several outputs and there is some scope to substitute between inputs, for example, substituting capital for labour. Hence, a partial indicator of productivity, relating a single output to a single input such as employees per customer or operating costs per customer, does not provide a full picture of a business's productivity. There is no meaningful way of summing the different partial measures of productivity to provide a robust measure of overall productivity.

Nevertheless, PPI analysis can help in understanding overall productivity measures by providing additional information on how aspects of business performance compare across time and across businesses. Nevertheless, the results of any such analysis should be interpreted with some care.

C.2 Cost-based PPIs

The following cost-based PPIs have been plotted against customer density:

- Opex per customer
- Asset cost per customer
- Total cost per customer

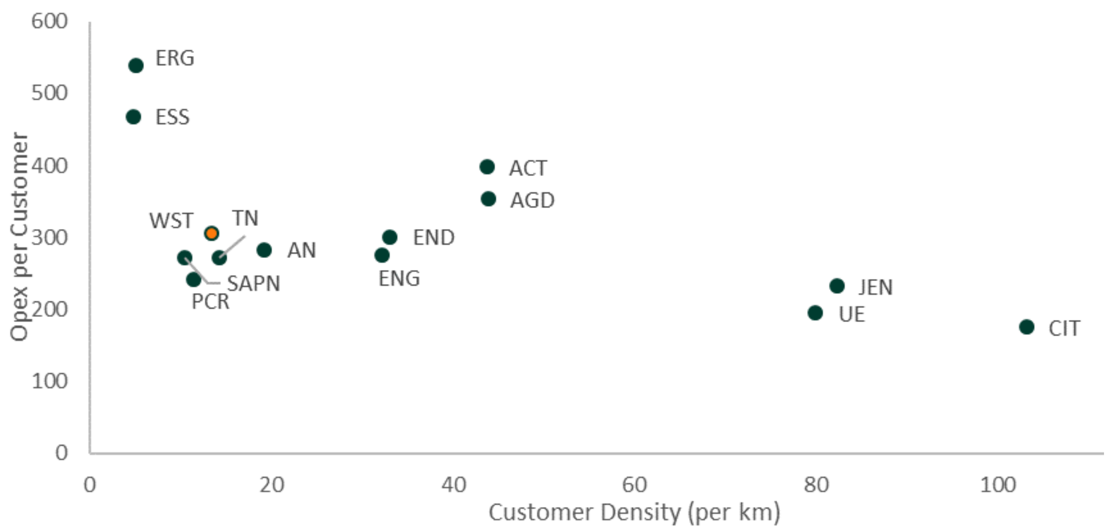
C.2.1 Opex per customer

Opex per customer is a crude measure of the productivity of opex which recognises that customers are a key driver of certain network costs. This estimate is plotted against customer density to recognise the relationship of this variable with the level of opex as indicated in Figure 35.

Western Power's average opex per customer of $305 is somewhat higher than its closest NEM peers in terms of customer density.

Western Power is 'WST' in the figure

Figure 35 Opex ($2016) per number of customers against customer density (average 2012-2016)[38]



Data source: Various DNSP Economic Benchmarking RINs.

C.2.2 Asset cost per customer

We have assumed that asset cost is defined as the return on the depreciated replacement value of the asset (at an assumed WACC) plus straight line depreciation (as presented in the RINs).

The return on asset is not presented in the DNSPs' RINs and therefore we have estimated this by applying an assumed WACC of 6 per cent to the opening RAB value for each of the years. Given that each DNSP's actual WACC that would have applied over time will

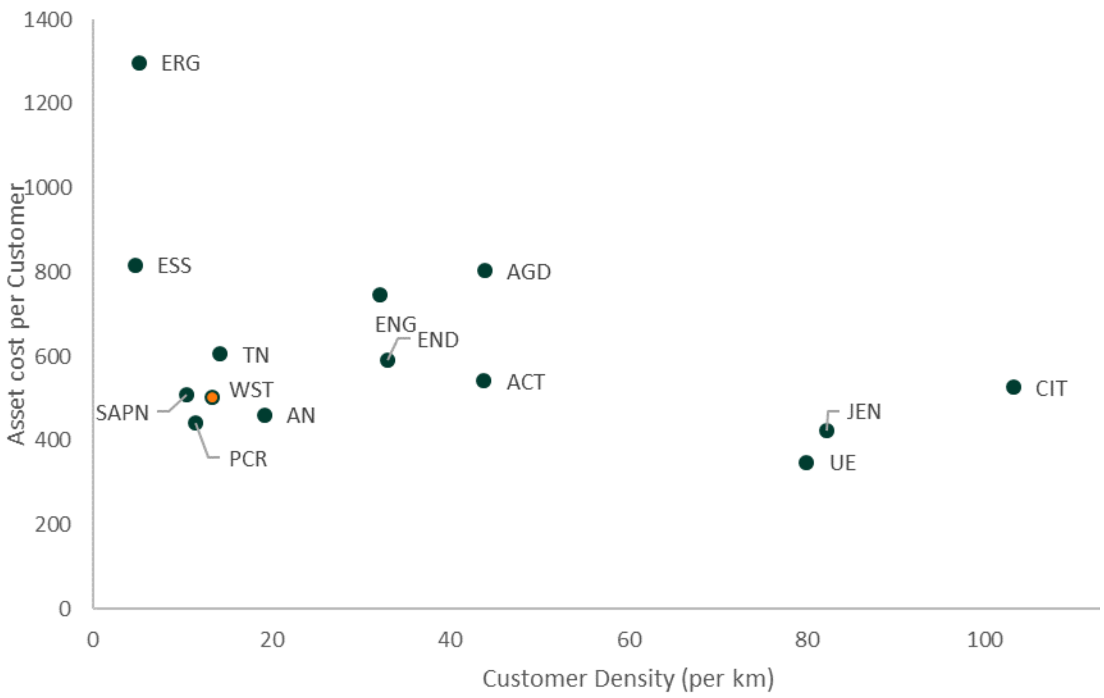
[38] Customer density equals customer numbers divided by route line length. Opex per customer equals standard control opex (network services) divided by customer numbers.

vary, we have assumed a constant level over the course of the averaging period (i.e. 2012 – 2016) for each of the DNSPs.

Western Power's average asset cost per customer of $502 compares favourably to its NEM peers.

Western Power is 'WST' in the figure

Figure 36 Asset cost ($2016) per customer compared to customer density (average 2012-2016)[39]



Data source: Various DNSP Economic Benchmarking RINs.

C.2.3 Total costs per customer

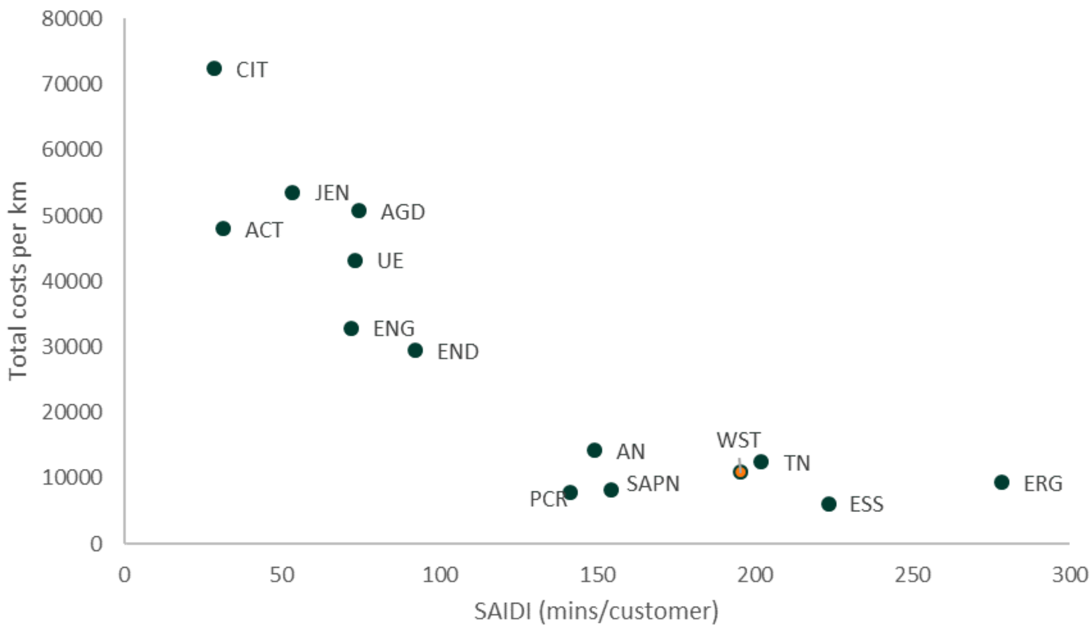
Rather than normalising total customer per customer by customer density, it is interesting to use reliability performance as the normalising factor given the latter is an important output of a DNSP.

Error! Reference source not found. indicates that Western Power's average total costs per km of $10,816 are at the low end of the range compared to its NEM peers, with its level of reliability of supply for its customers around the middle of the pack of its closest peers with large rural networks.

39 Customer density equals customer numbers divided by route line length. Asset cost per customer equals return on capital plus straight line depreciation divided by customer numbers.

Western Power is 'WST' in the figure.

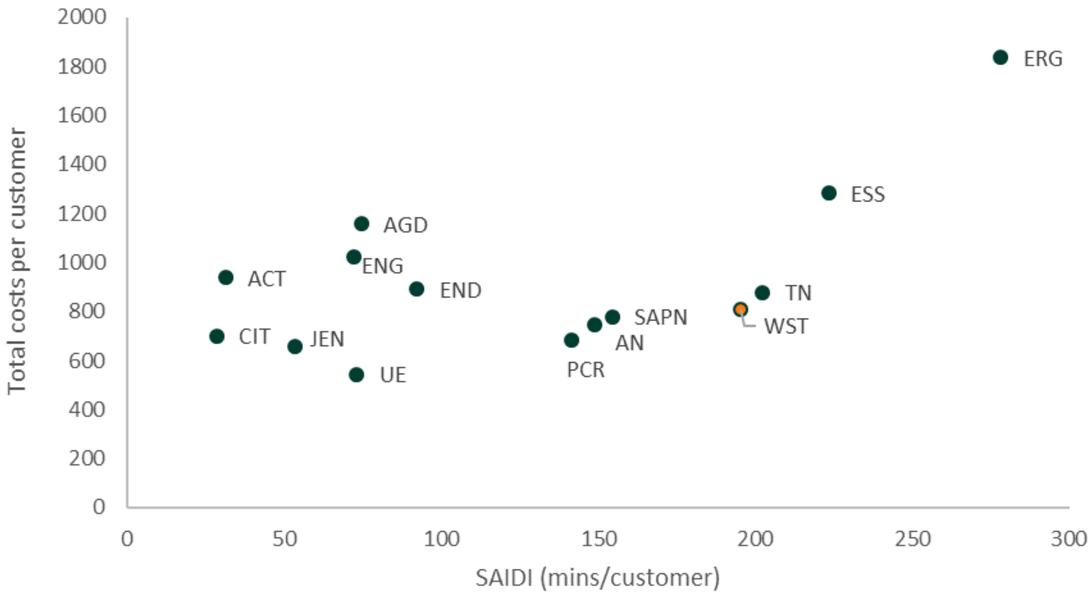
Figure 37 Total costs ($2016) per route line length by SAIDI (average 2012-2016)[40]



Data source: Various DNSP Economic Benchmarking RINs.

40 SAIDI equals whole of network unplanned SAIDI excluding major event days. Total costs per km equals SCS opex (network services) plus cost of capital (return on asset plus straight line depreciation) divided by total route line length.

Figure 38 Total costs per customer by SAIDI (average 2012-2016)[41]



Note:

Data source: Various DNSP Economic Benchmarking RINs.

41 SAIDI equals whole of network unplanned SAIDI excluding major event days. Total costs per customer equals SCS opex (network services) plus cost of capital (return on asset plus straight line depreciation) divided by customer numbers.

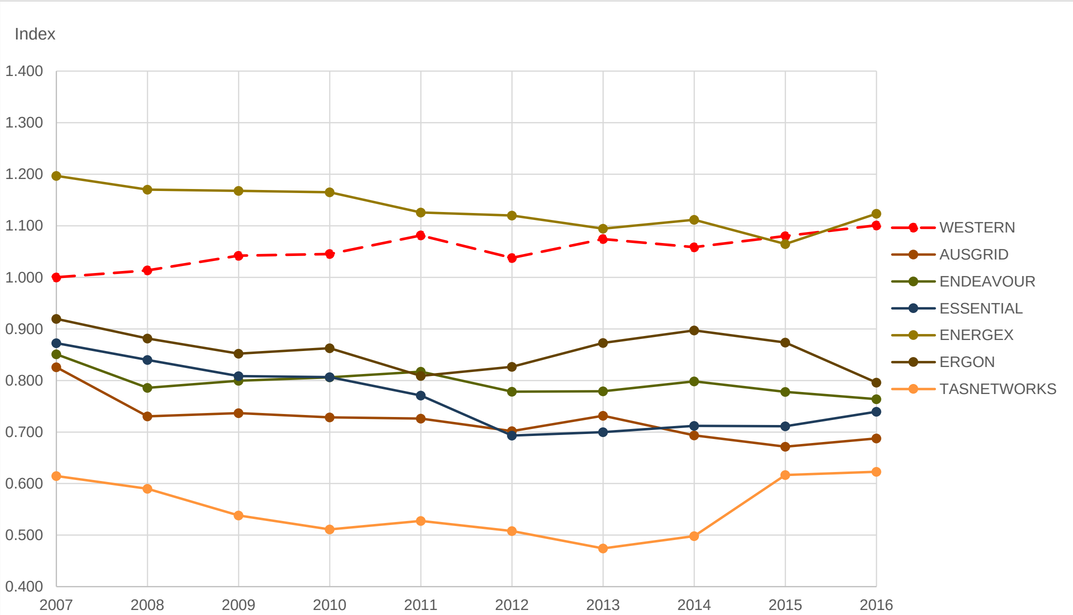
D Western Power's MTFP results compared to NEM government-owned DNSPs

This attachment presents Western Power's MTFP, opex and capex partial MTFP performance compared to other government-owned NEM DNSPS over the 2006-07 to 2015-16 period.

Two of the DNSPS in this sample, Ausgrid and Endeavour Energy, are now majority private-owned. However, they were fully government-owned entities over the assessment period.

Figure 39 presents MTFP performance. Western Power's has remained one of the best performing government-owned DNSPs over the assessment period, with its MTFP performance increasing by around 10%.

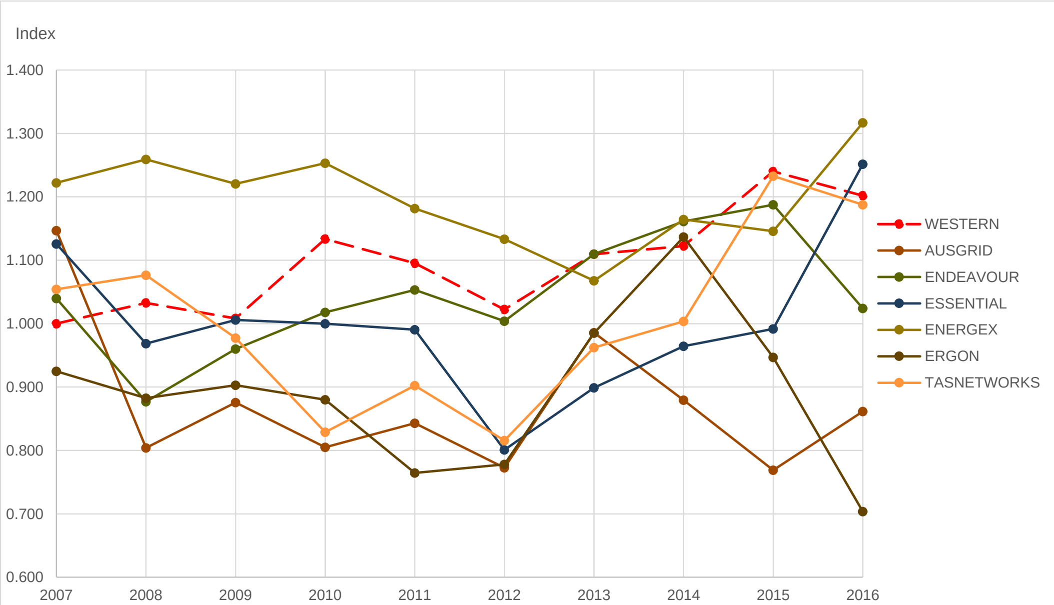
Figure 39 Government-owned DNSP MTFP performance



Source: Synergies' Distribution Benchmarking Model

Figure 40 (over page) presents opex partial MTFP performance. Western Power is one of the best performing government-owned DNSPs and has recorded one of the largest increases in performance, increasing by around 20%, over the full assessment period.

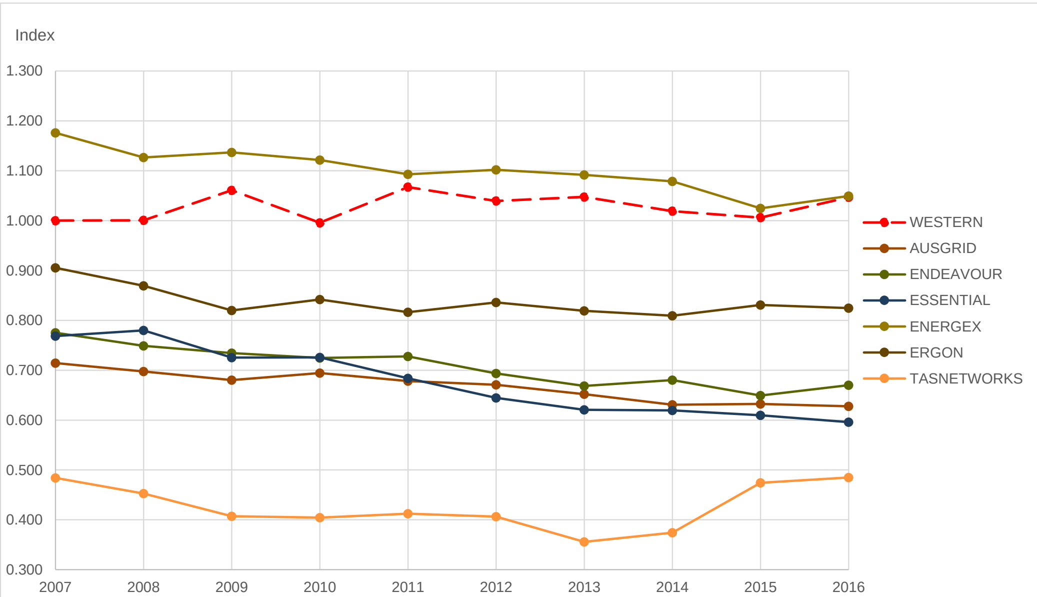
Figure 40 Government-owned DNSP opex partial MTFP performance



Source: Synergies' Distribution Benchmarking Model

Figure 41 presents capex partial MTFP performance. Western Power has been one of the better performing government-owned DNSPs over the assessment period. While most DNSPs show flat or declining capex productivity over the period, Western Power has recorded a modest increase of just under 5% over the full period.

Figure 41 Government-owned DNSP capex partial MTFP performance



Source: Synergies' Distribution Benchmarking Model