Annual Benchmarking Report

Electricity distribution network service providers

November 2019

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Summary

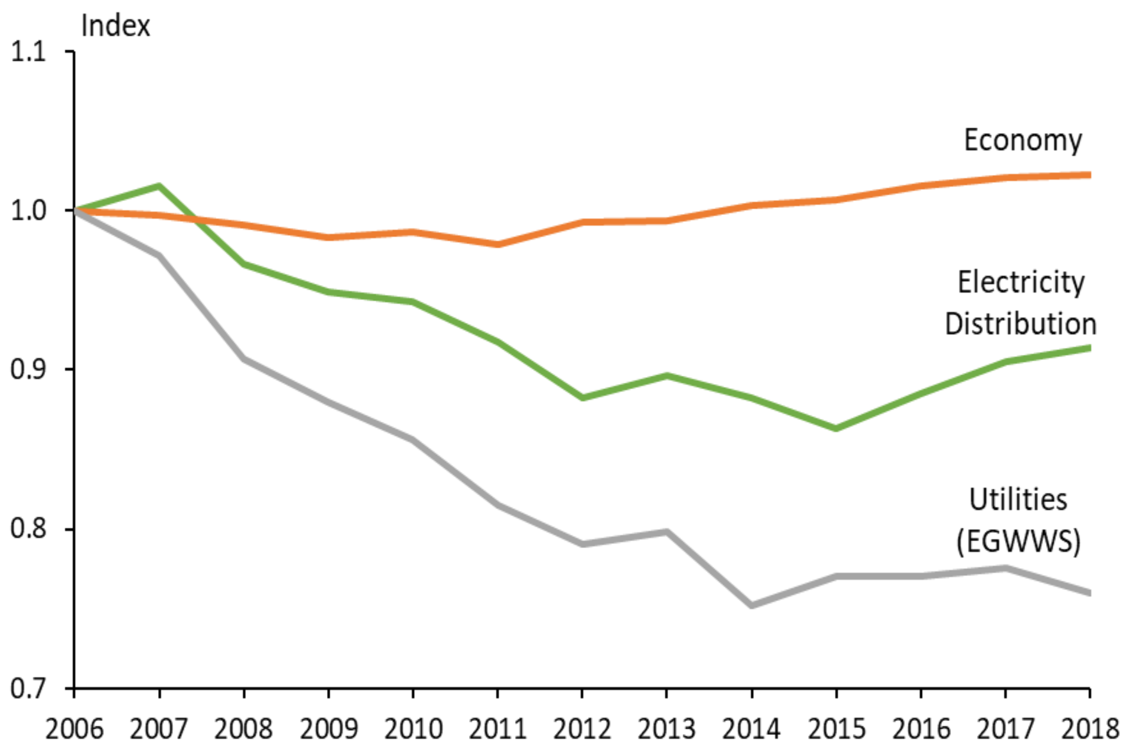
We report annually on the productivity growth and efficiency of distribution network service providers in the National Electricity Market (NEM). These service providers operate transformers, poles and wires to deliver electricity to residential and business customers. Distribution network costs typically account for between 30 and 40 per cent of what customers pay for their electricity (with the remainder covering generation costs, transmission and retailing, as well as regulatory programs).

We use economic benchmarking to measure how productively efficient these networks are at delivering electricity distribution services over time and compared with their peers. Where distribution networks become more efficient, customers should benefit through downward pressure on network charges and customer bills. We draw on this analysis when setting the maximum revenues networks can recover through consumers' bills.

The productivity of electricity distribution networks continues to grow

Electricity distribution productivity over all grew by 1 per cent over 2017–18, as measured by total factor productivity. This exceeded productivity growth for the overall economy and the utility sector (covering electricity, gas, water and waste services, or EGWWS). Electricity distribution productivity has now grown for three consecutive years, and has returned to its 2011 level. This is primarily due to reductions in operating expenditure.

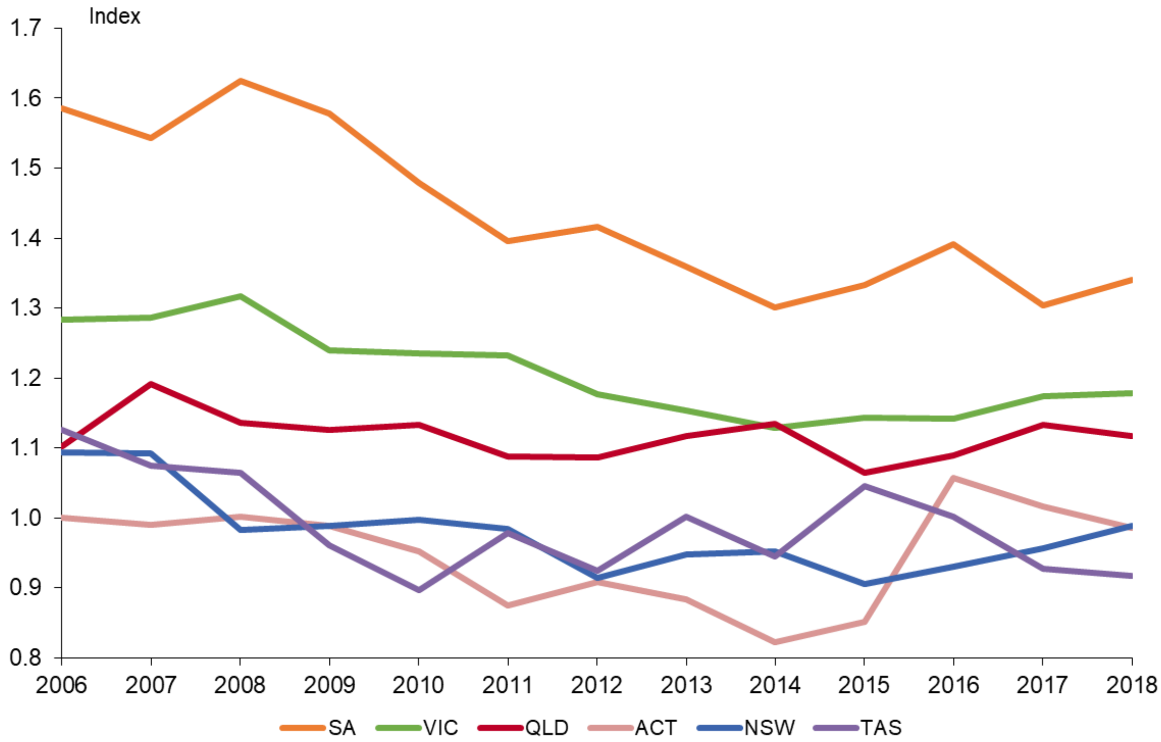
Electricity distribution, utility sector, and economy productivity, 2006–18



South Australia and Victorian distribution networks are the most efficient

The South Australia distribution network is the most productively efficient in the NEM. This is followed by the distribution networks in Victoria, Queensland, New South Wales and the ACT. Tasmania's distribution productivity level is the lowest of the included jurisdictions in 2018. However, Tasmanian distribution is disadvantaged and could be considered an outlier due its relatively unique network structure.

Electricity distribution productivity levels by state, 2006–18



Improved performance of the most efficient distribution networks

Three distribution networks in Victoria — CitiPower, Powercor, United Energy — and South Australia Power Networks have consistently been the most efficient distribution service providers in the NEM, as measured by economic benchmarking.

The productivity of these service providers declined between 2006 and 2014 due to increasing operating costs, including in response to new regulatory obligations. However, since 2015, all four service providers have increased their benchmark performance. This is a reason for overall electricity distribution productivity growth.

In 2018, CitiPower's productivity again grew by 4.4 per cent, United Energy by 7.2 per cent and SA Power Networks 2.7 per cent. This was primarily due to growth in opex productivity. On the other hand, Powercor's productivity declined by 3.7 per cent in 2018 mainly due to a decrease in reliability.

Operating expenditure reforms are benefiting customers in NSW

The electricity distribution networks in New South Wales — Ausgrid, Endeavour Energy and Essential Energy — have historically been some of the least efficient networks due to high operating expenditure and capital stocks. However, in 2018 Ausgrid's productivity grew by 6.6 per cent, Endeavour Energy by 2.3 per cent, and Essential Energy by 1.2 per cent.

These networks have been continually improving their productivity over several years. This can be linked to workforce rationalisations initiated by Networks NSW; the partial privatisation of Ausgrid and Endeavour; and that these businesses have responded to the strong incentives imposed by the regulatory regime and our use of economic benchmarking.

Endeavour Energy is now amongst the more efficient distribution networks in the NEM. Ausgrid is still a relatively inefficient network in 2017-18. However, part of this reflects the transformation costs it incurred to reduce its workforce and become more efficient.

Ongoing development of economic benchmarking

We operate an ongoing program to review and incrementally refine elements of the benchmarking methodology and data. In future benchmarking reports, we and stakeholders have identified the following key areas for development:

- The implications for cost allocation and capitalisation differences on the benchmarking results
- The future review of benchmarking output specifications
- The choice of benchmarking comparison point.

Over the next twelve months, we intend to prioritise a review of the implications of changes in cost allocation and capitalisation approaches between DNSPs (e.g. corporate overheads) on our benchmarking results.

Contents

1 Our benchmarking report

The National Electricity Rules (NER) require the AER to publish benchmarking results in an annual benchmarking report. This is our sixth benchmarking report for distribution network service providers (DNSPs). This report is informed by expert advice provided by Economic Insights.[1]

National Electricity Rules reporting requirement

6.27 Annual Benchmarking Report

(a) The AER must prepare and publish a network service provider performance report (an annual benchmarking report) the purpose of which is to describe, in reasonably plain language, the relative efficiency of each Distribution Network Service Provider in providing direct control services over a 12 month period.

Productivity benchmarking is a quantitative or data driven approach used widely by governments and businesses around the world to measure how efficient firms are at producing outputs over time and compared with their peers.

Our benchmarking report considers the productive efficiency of DNSPs. DNSPs are productively efficient when they produce their goods and services at least possible cost given their operating environments and prevailing input prices.

Our benchmarking report presents results from three types of 'top-down' benchmarking techniques:[2]

- **Productivity index numbers (PIN)**. These techniques use a mathematical index to determine the relationship between multiple outputs and inputs, enabling comparisons of productivity levels over time and between networks.
- **Econometric opex cost function models**. These model the relationship between opex (as the input) and outputs to measure opex efficiency.
- **Partial performance indicators (PPIs)**. These simple ratio methods relate one input to one output.

The primary benchmarking techniques we use in this report to measure the relative productivity of each DNSP in the NEM are multilateral total factor productivity (MTFP) and multilateral partial factor productivity (MPFP). The relative productivity of the

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1 The supplementary Economic Insights report outlines the full set of results for this year's report, the data we use and our benchmarking techniques. It can be found on the AER's benchmarking website.

2 Top down techniques measure a network's efficiency based on high-level data aggregated to reflect a small number of key outputs and key inputs. They generally take into account any synergies and trade-offs that may exist between input components. Alternative bottom up benchmarking techniques are much more resource intensive and typically examine very detailed data on a large number of input components. Bottom up techniques generally do not take into account potential efficiency trade-offs between input components of a DNSP’s operations.

DNSPs reflects their efficiency. MPFP examines the productivity of either opex or capital in isolation.

Being tops down measures, each benchmarking technique cannot readily incorporate every possible exogenous factor that may affect a DNSP's costs. Therefore, the performance measures are reflective of, but do not precisely represent, the underlying efficiency of DNSPs. For this benchmarking report, our approach is to derive raw benchmarking results and where possible, explain drivers for the performance differences and changes. These include those operating environment factors that may not have been accounted for in the benchmarking modelling.

What is multilateral total factor productivity?

Total factor productivity is a technique that measures the productivity of businesses over time by measuring the relationship between the inputs used and the outputs delivered. Where a business is able to deliver more outputs for a given level of inputs, this reflects an increase in its productivity. Multilateral total factor productivity allows us to extend this to compare productivity levels between networks.

The inputs we measure for DNSPs are:

- Five types of physical capital assets DNSPs invest in to replace, upgrade or expand their networks.
- Opex to operate and maintain the network.

The outputs we measure for DNSPs (and the relative weighting we apply to each) are:

- Customer numbers. The number of customers is a significant driver of the services a DNSP must provide. (31 per cent weight)
- Circuit line length. Line length reflects the distances over which DNSPs deliver electricity to their customers. (29 per cent weight)
- Ratcheted maximum demand. DNSPs endeavour to meet the demand for energy from their customers when that demand is greatest. RMD recognises the highest maximum demand the DNSP has had to meet up to that point in the time period examined. (28 per cent weight)
- Energy delivered (MWh). Energy throughput is a measure of the amount of electricity that DNSPs deliver to their customers. (12 per cent weight)
- Reliability (Minutes off-supply). Reliability measures the extent to which networks are able to maintain a continuous supply of electricity. (Minutes off-supply enters as a negative output and is weighted by the value of consumer reliability).

The November 2014 Economic Insights report referenced in Appendix A details the rationale for the choice of these inputs and outputs. In its November 2018 report Economic Insights updated the weights applied to each output and these are again used in this report. We discuss the outputs and inputs used further in Appendix B.

Appendix A provides reference material about the development and application of our economic benchmarking techniques. Appendix B provides more information about the specific models we use and the data required.

Updates in this benchmarking report

This benchmarking report include a number of updates in the benchmarking data, and one addition to the benchmarking methodology.

Firstly, there has been some revisions to the network services opex that we previously reported and analysed in our 2017 and 2018 benchmarking reports. Economic Insights explains:[3]

> For Australia, the AER was notified in December 2018 that three Victorian DNSPs – CIT, PCR and UED – had submitted incorrect opex data for the 2017 year in their April 2018 EBRINs. The three DNSPs had incorrectly capitalised some inspection and maintenance costs instead of expensing them as required under their EBRIN reporting. This correction has led to CIT's 2017 opex being 10 per cent higher than initially reported, PCR's 2017 opex being 15 per cent higher than initially reported and UED's 2017 opex being 4 per cent lower than initially reported. Consequently, there are material differences between the 2017 productivity performance of these three DNSP's reported here compared to Economic Insights (2018).
>
> Corrections have also been made to the opex data of a fourth Victorian DNSP, AND. The first change involves the exclusion of opex for connections services which AND had incorrectly included over 2006 to 2017. The second change reflects the exclusion of opex for transmission connection planning which AND had incorrectly included over 2006 to 2015. And the third change involves the addition of taxes and levies which AND had incorrectly omitted for 2016 and 2017. The first and second changes are relatively small but the third change leads to AND's opex increasing by around 7 per cent in 2016 and 2017.

These revisions to opex mean that the opex partial factor productivity results presented in this report for 2017 are slightly different to what was reported in the 2018 annual benchmarking report. This affects the productivity levels results as well as the change in productivity from 2016 to 2017 and 2017 to 2018.

Second, Economic Insights audited and updated the international data that it relies upon for its econometric modelling. This audit addresses some minor changes in the reporting of data by the international regulators' datasets, as well as the way DNSP amalgamations are handled including the amalgamation of several larger Ontario DNSPs which took place in 2017. Economic Insights' 2019 report sets out these changes in detail.[4]

Third, there have been some other more minor refinements to the historical Australian DNSP dataset, consistent with previous years benchmarking reports. These

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[3] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report*, 5 September 2019, p. 4

[4] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report*, 5 September 2019, pp. 4-5

refinements are set out in the consolidated benchmarking dataset published on our website.

Finally, Economic Insights has now applied the translog stochastic frontier analysis model to the benchmarking dataset over the full 2006 to 2018 period. This is explained further in section 5.1 and Economic Insights' 2019 report.[5]

Benchmarking development program

We operate an ongoing program to review and incrementally refine elements of the benchmarking methodology and data. The aim of this work is to maintain and continually improve the reliability of the benchmarking results we publish and use in our network revenue determinations.

We categorise our benchmarking development work as:

- ongoing incremental improvement in data and methods that support our annual benchmarking reporting
- specific issues that have the potential to materially affect the benchmarking results and should involve consultation with affected stakeholders
- changes and improvements in the way that we and other stakeholders use economic benchmarking in decision making.

Section 6 outlines some of our recent benchmarking developments and our priorities for future development work, including submissions from stakeholders on key issues.

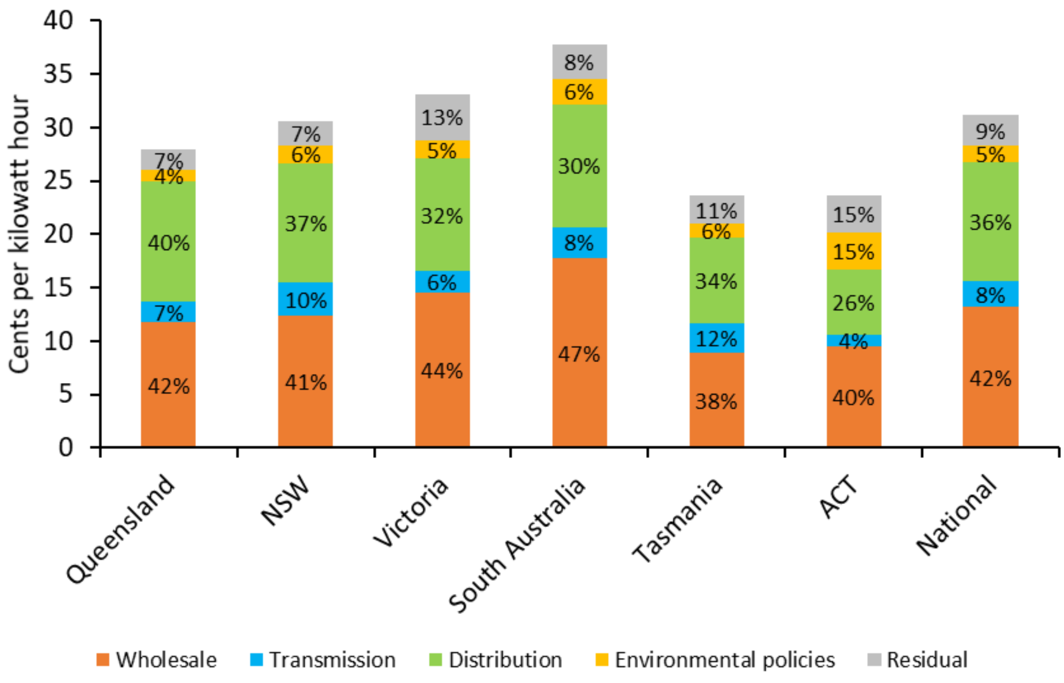
5 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report*, 5 September 2019, p. 20

2 Why we benchmark electricity networks

Electricity networks are 'natural monopolies' that do not face the typical commercial pressures experienced by firms in competitive markets. They do not need to consider how and whether or not rivals will respond to their prices. Without appropriate regulation, network operators could increase their prices above efficient levels and would face limited pressure to control their operating costs or invest efficiently.

Consumers pay for electricity network costs through their retail electricity bills. Distribution network costs typically account for between 30 and 40 per cent of what consumers pay for their electricity (with the remainder covering the costs of generating, transmitting and retailing electricity, as well as various regulatory programs). Figure 2.1 provides an overview of the typical electricity retail bill.

Figure 2.1 Network costs as a proportion of retail electricity bills, 2017



Source: AEMC, AER analysis.

Under the National Electricity Law (NEL) and the NER, the AER regulates electricity network revenues with the goal of ensuring that consumers pay no more than necessary for the safe and reliable delivery of electricity services. Because network costs account for such a high proportion of consumers electricity bills, AER revenue determinations have a significant impact on consumers.

The AER determines the revenues that an efficient and prudent network business would require at the start of each five-year regulatory period. The AER determines network revenues through a 'propose-respond' framework.[6] Network businesses propose the costs they believe they need during the regulatory control period to provide safe and reliable electricity and meet predicted demand. The AER responds to the networks' proposals by assessing, and where necessary, amending them to reflect 'efficient' costs.

The NER requires the AER to have regard to network benchmarking results when assessing and amending network capex and opex expenditures, and to publish the benchmarking results in this annual benchmarking report.[7] The AEMC added these requirements to the NER in 2012 to:

- reduce inefficient capital and operating network expenditures so that electricity consumers would not pay more than necessary for reliable energy supplies, and
- to provide consumers with useful information about the relative performance of their electricity NSP to help them participate in regulatory determinations and other interactions with their NSP.[8]

Economic benchmarking gives us an additional source of information on the efficiency of historical network opex and capex expenditures and the appropriateness of using them in forecasts. We also use benchmarking to understand the drivers of trends in network efficiency over time and changes in these trends. As we have done in this year's report, this can help us understand why network productivity is increasing or decreasing and where best to target our expenditure reviews.[9]

The benchmarking results also provide network owners and investors with useful information on the relative efficiency of the electricity networks they own and invest in. This information, in conjunction with the financial rewards available to businesses under the regulatory framework and business profit maximising incentives, can facilitate reforms to improve network efficiency that can lead to lower network costs and retail prices.

Benchmarking also provides government policy makers (who set regulatory standards and obligations for networks) with information about the impacts of regulation on

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6 The AER assesses the expenditure proposal in accordance with the Expenditure Forecast Assessment Guideline which describe the process, techniques and associated data requirements for our approach to setting efficient expenditure allowances for network businesses, including how the AER assesses a network business's revenue proposal and determines a substitute forecast when required. See: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/expenditure-forecast-assessment-guideline-2013.

7 NER cll. 6.27 (a), 6.5.6 (e),(4) and 6.5.7 (e)(4).

8 AEMC *final rule determination* 2012, p. viii.

9 AER *Explanatory Statement Expenditure Forecast Assessment Guideline* November 2013: https://www.aer.gov.au/system/files/Expenditure%20Forecast%20Assessment%20Guideline%20-%20Explanatory%20Statement%20-%20FINAL.pdf, p. 78-79.

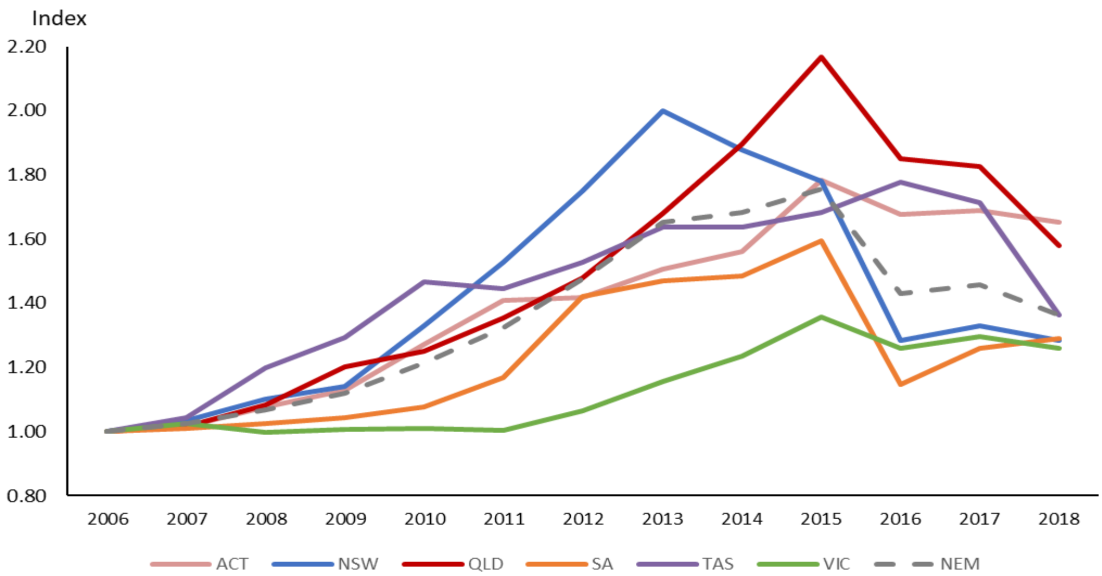
network costs, productivity and ultimately electricity prices. Additionally, benchmarking can provide information to measure the success of the regulatory regime over time.

Finally, benchmarking provides consumers with accessible information about the relative efficiency of the electricity networks they rely on. The breakdown of inputs and outputs driving network productivity in particular, allow consumers to better understand what factors are driving network efficiency and network charges that contribute to their energy bill. This helps to inform their participation in our regulatory processes and broader debates about energy policy and regulation.

Since 2014, the AER has used benchmarking in various ways to inform our assessments of network expenditure proposals. Our economic benchmarking analysis has been one contributor to the reductions in network costs and revenues for these DNSPs, and the retail prices faced by consumers.

Figure 2.2 shows that network revenues (and consequently network charges paid by consumers) have fallen in all jurisdictions in the NEM since 2015. This reversed the increase in network costs seen across the NEM over 2007 to 2013, which led to the large increases in retail electricity prices.[10] This highlights the potential impact on retail electricity charges of decreases in network revenues flowing from AER network revenue determinations, including those informed by benchmarking.

Figure 2.2 Indexes of network revenue changes by jurisdiction, 2006–18



Source: Economic Benchmarking RIN.

[10] AER *State of the Market Report* 2018, p. 135.

3 The productivity of electricity distribution

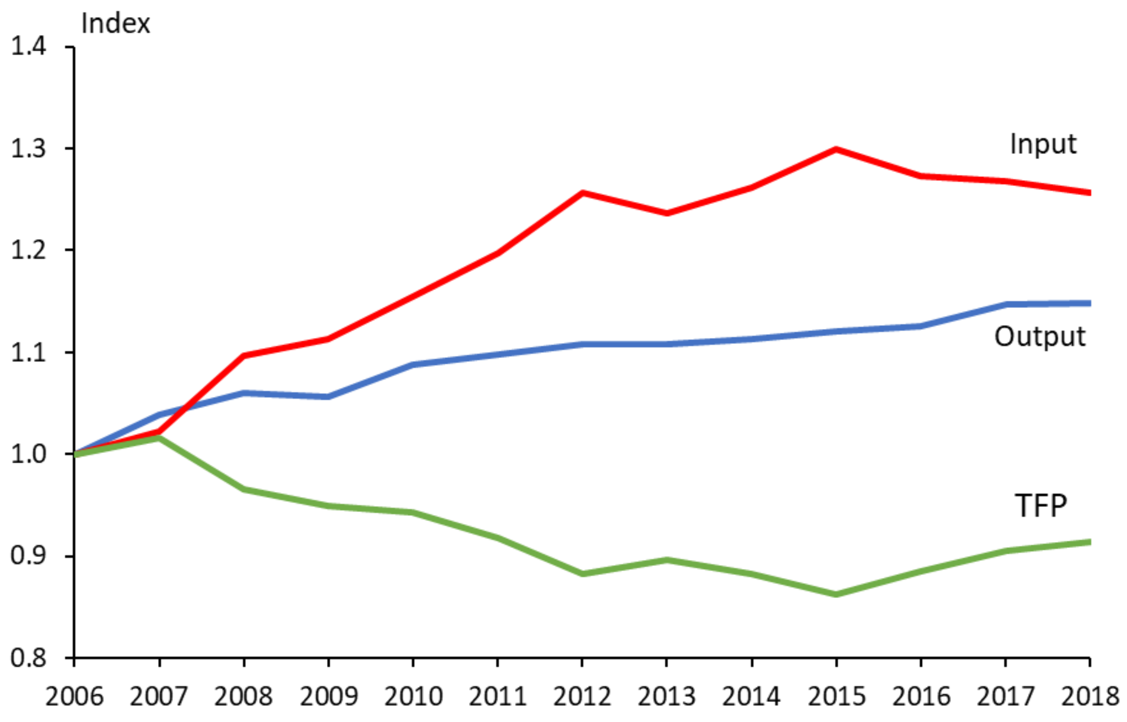
Key points

- Electricity distribution productivity, as measured by total factor productivity (TFP), increased by 1 per cent over 2017–18. Reductions in opex were the main driver of this productivity growth.
- Productivity growth in the electricity distribution industry has exceeded that in the overall Australian economy and the electricity, gas, water and waste services (EGWWS) utilities sector since 2015.

This chapter presents total factor productivity (TFP) results at the electricity distribution industry level. This is our starting point for examining the relative productivity and efficiency of individual service providers.

Figure 3.1 presents total factor productivity for the electricity distribution industry over the period 2006–18. This shows that industry-wide productivity increased by 1 per cent over 2017–18. We have now observed three consecutive years of growth in electricity distribution industry productivity.

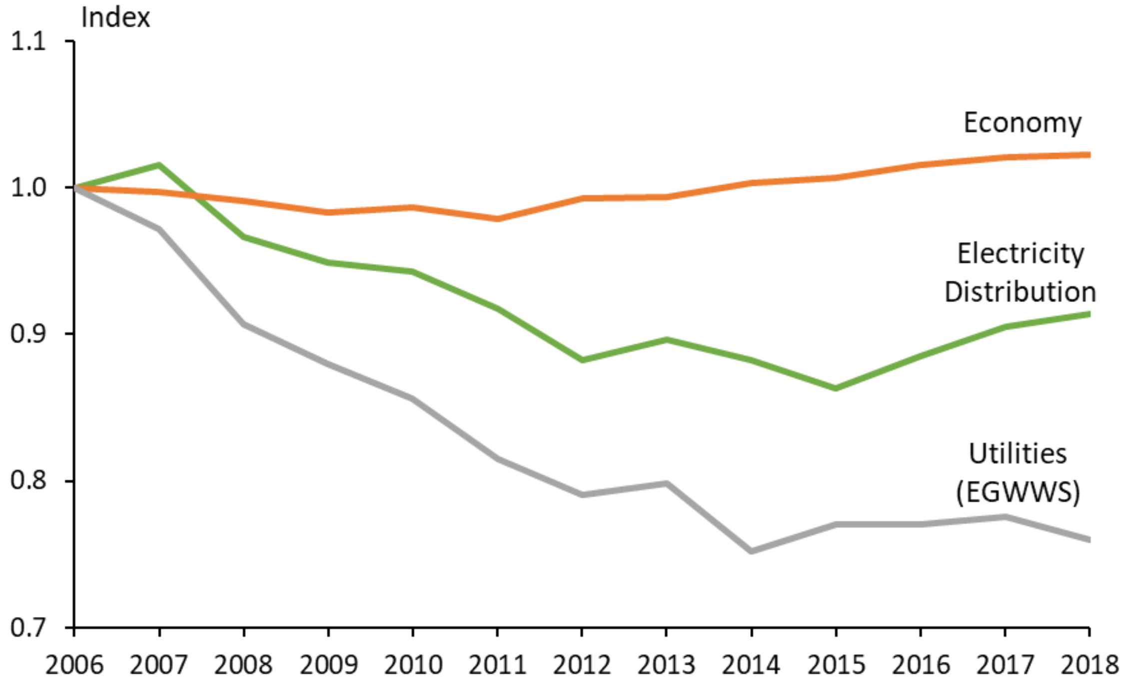
Figure 3.1 Electricity distribution total factor productivity (TFP), 2006–18



Source: Economic Insights.

Figure 3.2 compares the total factor productivity of the electricity distribution industry over time relative to estimates of the overall Australian economy and utility sector (electricity, gas, water and waste services (EGWWS)) productivity. Since 2015, productivity growth in the electricity distribution industry has exceeded that in both the overall economy and the utilities sector.

Figure 3.2 Electricity distribution and economy productivity indices, 2006–18

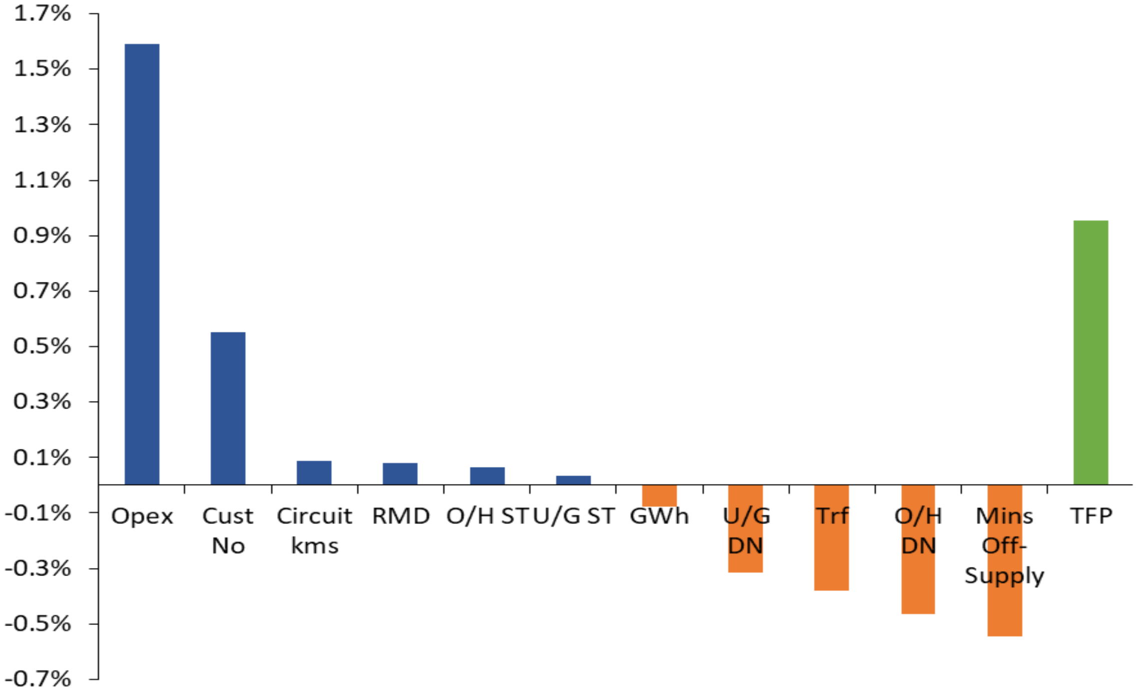


Source: Economic Insights; Australian Bureau of Statistics.

Note: The productivity of the Australian economy and the EGWWS industry is from the ABS indices within 5260.0.55.002 Estimates of Industry Multifactor Productivity, Australia, Table 1: Gross value added based multifactor productivity indexes (a). We have rebased the ABS indices to one in 2006.

Figure 3.3 helps us understand the drivers of change in electricity distribution productivity over the past 12 months by showing the contributions of each output and each input to the average annual rate of change in total factor productivity in 2017-18. This shows that reductions in opex, in addition to growth in customer numbers, drove distribution productivity growth in 2017-18. The productivity growth from reductions in opex was partially offset by increases in the quantity of distribution lines and transformers, and increases in the number of minutes off supply.

Figure 3.3 Electricity distribution output and input percentage point contributions to average annual TFP change, 2018



Source: Economic Insights.

Note: The inputs and outputs in this chart are minutes off-supply (mins off-supply), operating expenditure (opex), customer numbers (cust no), ratcheted maximum demand (RMD) , circuit line length (circuit kms), overhead distribution lines (O/H DN), energy delivered (GWh), underground sub-transmission cables (U/G ST), overhead sub-transmission lines (O/H ST), transformers (Trf), underground distribution cables (U/G DN).

4 The relative productivity of service providers

Key points

- Six DNSPs improved their productivity in 2018:
  - United Energy (7.2 per cent), Ausgrid (6.6 per cent) and CitiPower (4.4 per cent) were the most improved DNSPs in the NEM.
  - Endeavour Energy (2.3 per cent), SA Power Networks (2.7 per cent) and Essential Energy (1.2 per cent) also noticeably improved their productivity.
  - Powercor (–3.7 per cent), Ergon Energy (–3 per cent), Evoenergy (–3 per cent) and AusNet Services (-2.9 per cent) experienced noticeable decreases in productivity. Energex and Jemena also experienced small decreases in productivity.
- South Australia retained the highest distribution total productivity level, as measured by MTFP. This was followed by Victoria and Queensland distribution. New South Wales distribution improved again in 2018 and overtook ACT distribution productivity. Tasmania's distribution total productivity level remained the lowest of the included jurisdictions in 2018.
- CitiPower, SA Power Networks, Powercor and United Energy have consistently been amongst the most productive service providers in the NEM over the last eleven years. In 2018, CitiPower and United Energy further improved their productivity due to significant reductions in opex.
- Operating efficiency reforms and business restructuring have significantly improved the measured productivity of NSW distributors Ausgrid, Endeavour Energy and Essential Energy since 2012. In 2018, Ausgrid and Endeavour Energy were amongst the most improved of all DNSPs in terms of opex productivity. Essential Energy's opex productivity slightly declined in 2018 but it remains among the middle group of efficient distributors.
- Evoenergy experienced the largest decrease in opex productivity of any DNSP in 2018 due to increases in costs. However, this was partially offset by increases in capital productivity. Evoenergy states that its increase in costs were due to complying with a number of new regulatory obligations and also preparing its regulatory proposal for the 2019-24 regulatory control period. We would expect that some of these costs would decrease in 2019.
- It is desirable to take into account how differences in operating environment conditions not included in the benchmarking models can affect the benchmarking results. Our benchmarking report includes information about the most material operating environment factors (OEFs) driving apparent differences in estimated productivity and operating efficiency between the distribution networks in the NEM. These are set out in section 4.3.

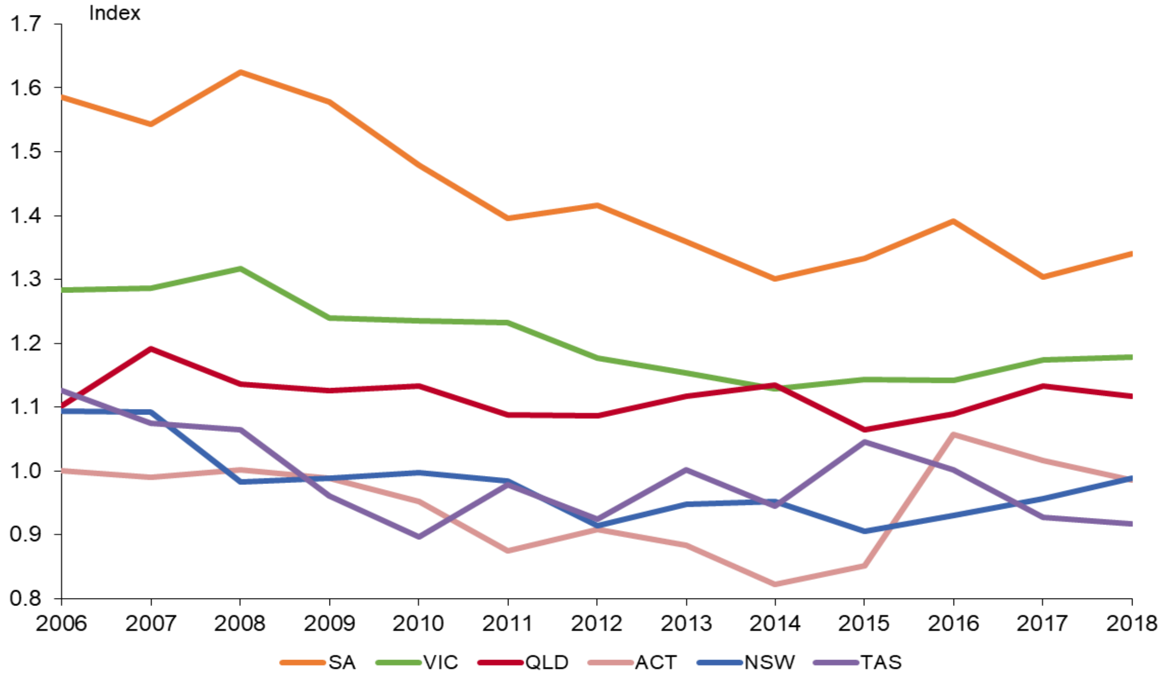
This chapter presents economic benchmarking results and provides our key observations on the reasons for changes in relative productivity of each DNSP in the NEM. Our website contains the full benchmarking results.

4.1 Economic benchmarking results

MTFP is the headline technique we use to measure and compare the relative productivity of jurisdictions and individual DNSPs. This is supported by the corresponding partial productivity measures of opex and capital inputs.

Figure 4.1 presents relative distribution productivity levels by state, as measured by MTFP over the period 2006 to 2018. This shows that South Australia distribution is the most productive state in the NEM, followed by Victoria, Queensland, New South Wales and the ACT. Tasmania's distribution total productivity level is the lowest of the included jurisdictions in 2018, the second year in a row.[11]

Figure 4.1 Electricity distribution MTFP levels by state, 2006–18



Source: Economic Insights.

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11 TasNetworks could be considered an outlier compared to its peers in terms of system structure. Compared to other DNSPs, TasNetworks operates substantially less high voltage subtransmission assets and has a comparatively high proportion of lower voltage lines. This disadvantages TasNetworks' MTFP ranking because low voltage assets generally receive the highest capital input weighting under our benchmarking models. Economic Insights advises that some caution is required in interpreting TasNetworks' MTFP score given its comparatively unusual system structure (see Economic Insights, *Memorandum – DNSP MTFP and Opex Cost Function Results*, 13 November 2015, p. 4).

The remainder of this section examines the relative productivity of individual DNSPs within these jurisdictions.

Table 4.1 presents the MTFP rankings for individual DNSPs in the NEM in 2018, the change in rankings between 2017 and 2018, and the annual growth in productivity in 2018 and between 2012 and 2018.

Table 4.1 Individual DNSP MTFP rankings and growth rates

DNSP	2018 Rank	2017 Rank	Change (2018)	Annual Change (2012 to 2018)
CitiPower (Vic)	1	1	4.4%	1.1%
United Energy (Vic)	2↑	3	7.2%	2.4%
SA Power Networks	3↓	2	2.7%	-0.9%
Powercor (Vic)	4	4	-3.7%	-0.6%
Energex (QLD)	5	5	-0.3%	0.3%
Endeavour Energy (NSW)	6↑	8	2.3%	0.2%
Jemena (Vic)	7	7	-0.5%	-0.6%
Ergon Energy (QLD)	8↓	6	-3.0%	0.7%
Evoenergy (ACT)	9	9	-3.0%	1.4%
Essential Energy (NSW)	10↑	11	1.2%	2.0%
AusNet Services (Vic)	11↓	10	-2.9%	-2.0%
Ausgrid (NSW)	12↑	13	6.6%	1.5%
TasNetworks	13↓	12	-1.1%	-0.1%

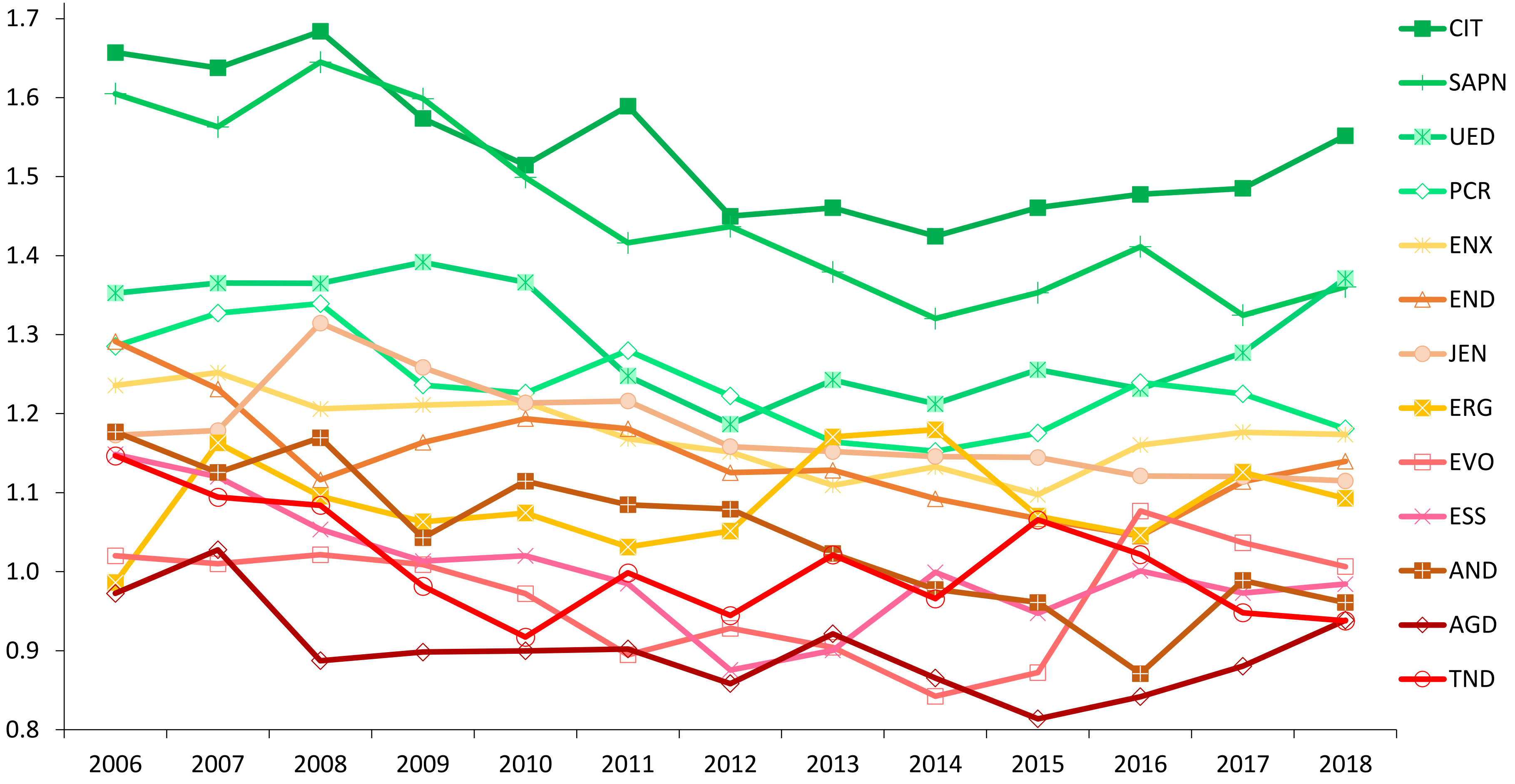
Source: Economic Insights, AER analysis.

Note: All scores are calibrated relative to the 2006 Evoenergy score which is set equal to one.

Revisions to AusNet Services, CitiPower, Powercor and United Energy's reported opex for the 2017 year led to a change in each DNSP's MTFP score in 2017, as reported in our 2018 benchmarking report. The percentage changes in this table reflect the revised MTFP scores for 2017.

Figure 4.2 presents MTFP results for each DNSP from 2006 to 2018.

Figure 4.2 MTFP indexes by individual DNSP, 2006–18



Source: Economic Insights, AER analysis.

In addition to MTFP, we also present the results of two MPFP models:

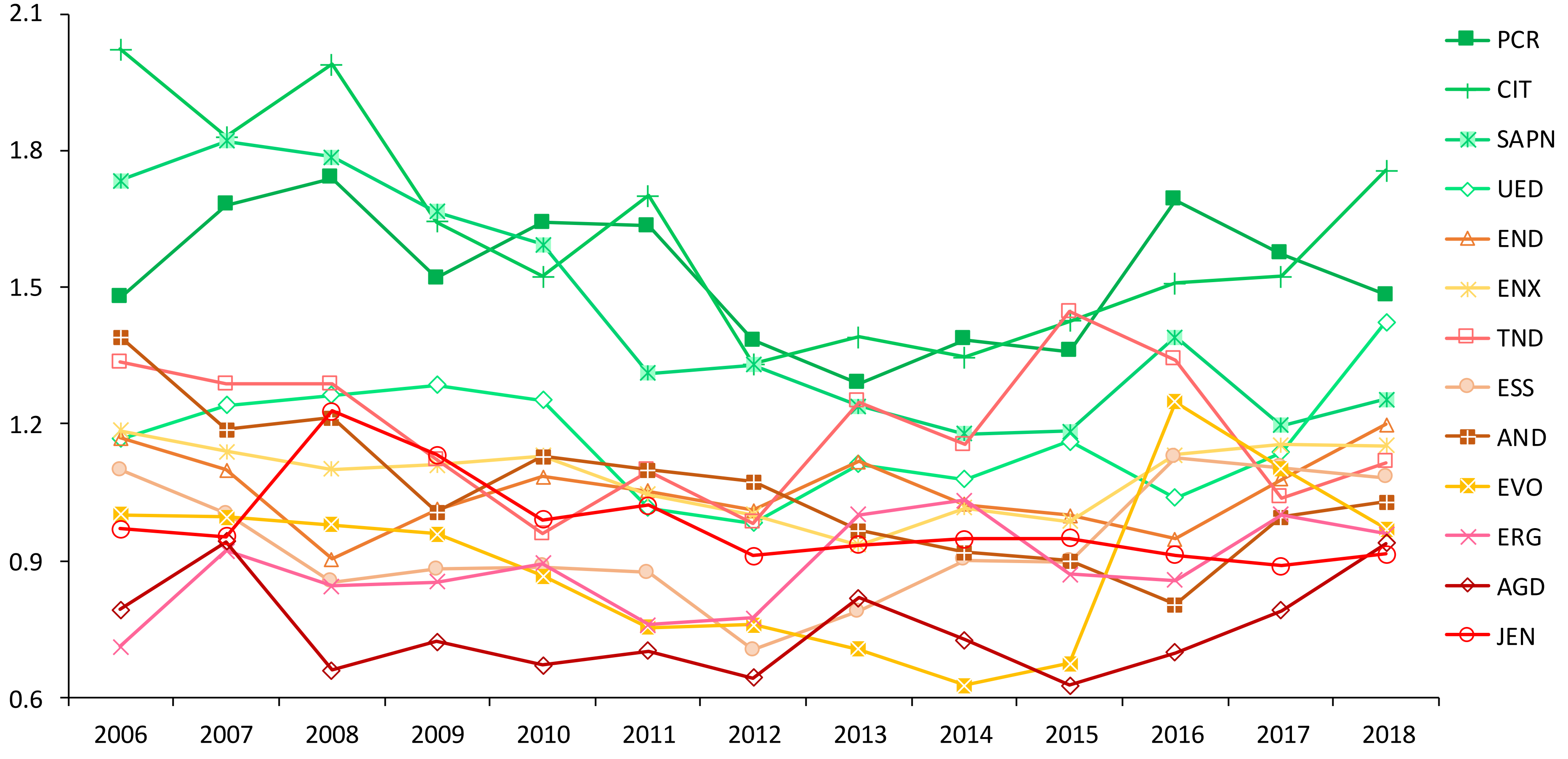
- Opex MPFP. This considers the productivity of the DNSPs’ operating expenditure.
- Capital MPFP. This considers the productivity of the DNSPs’ use of overhead lines and underground cables (each split into distribution and sub-transmission components) and transformers.

These partial approaches assist in interpreting the MTFP results by examining the contribution of capital assets and operating expenditure to overall productivity. They use the same output specification as MTFP but provide more detail on the contribution of the individual components of capital and opex to changes in productivity. However, they do not account for synergies between capital and opex like the MTFP model.

Being a tops down analysis, these results are only indicative of the DNSPs' relative performance. While the analysis accounts for some factors that are beyond a DNSP’s control, such as the impact of network density and some system structure factors, additional environmental factors can affect a DNSP's costs and benchmarking performance. Section 4.3 provides more information about some of these additional factors.

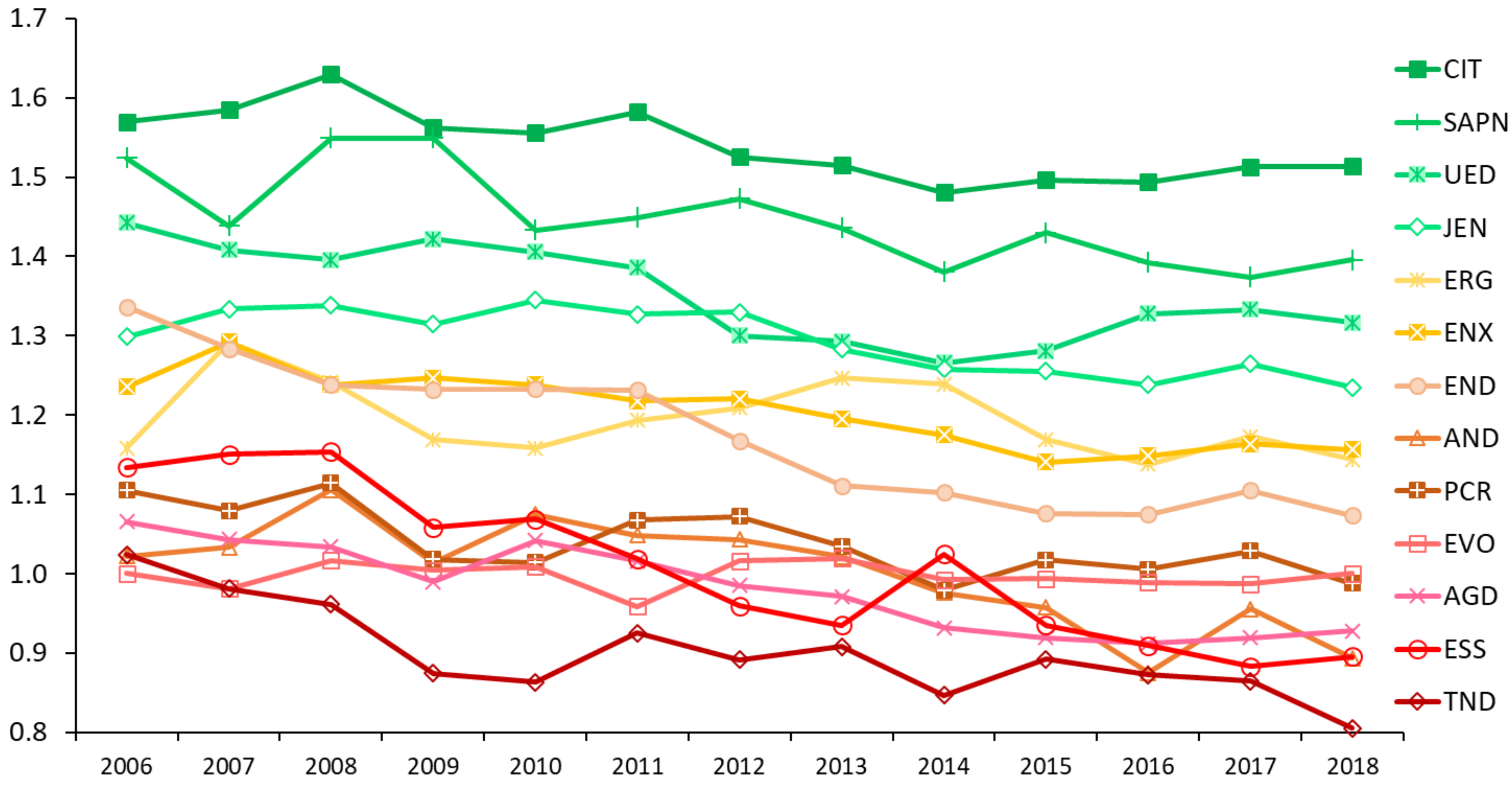
Figure 4.3 and Figure 4.4 presents opex MPFP and capital MPFP results, respectively, for all DNSPs over the 2006 to 2018 period.

Figure 4.3 DNSP opex multilateral partial factor productivity indexes, 2006–18



Source: Economic Insights, AER analysis.

Figure 4.4 DNSP capital multilateral partial factor productivity indexes, 2006–18



Source: Economic Insights, AER analysis.

4.2 Key observations about changes in productivity

This section describes some of our key observations about changes in the relative productivity of DNSPs, based on the results of our benchmarking techniques.

Improved performance of the frontier distribution service providers

CitiPower, Powercor, United Energy and SA Power Networks have consistently been the most productive distribution service providers in the NEM. These networks are among those service providers that are on the productivity frontier.

Figure 4.2 shows that these service providers experienced a gradual decline in productivity over the decade from 2006. This is primarily due to increasing operating costs as a result of new regulatory obligations, among other things. However, there has since been a turnaround in productivity for these four firms from 2014.

CitiPower, United Energy and SA Power Networks further increased their productivity in 2018. This was primarily due to growth in opex productivity (as seen in Figure 4.3).[12]

United Energy notably experienced the single highest improvement in productivity amongst the DNSPs in the NEM. United Energy provided us with some reasons to explain the reduction in opex that contributed to its jump in productivity:[13]

> United Energy's reduction in network services opex is a result of savings resulting from adoption of a common corporate back office with Victoria Power Networks (VPN). The adoption of a common corporate back office resulted in redundancies that were incurred primarily through 2017. Further, we have aligned some of United Energy's maintenance and inspection policies with those of VPN which has resulted in further savings for United Energy. Both savings are 'one off' realised through the economies of scale available through the common ownership of United Energy with VPN.

Powercor's overall productivity declined by 3.7 per cent in 2018. As shown in Economic Insights' report, a thirty per cent increase in the number of customer minutes off supply was the single largest contributor to this productivity decline.[14] The number of minutes off supply represents the reliability of distribution networks and measures the extent to which networks are able to maintain a continuous supply of electricity.

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12 As noted in section 1, CitiPower, Powercor and United Energy provided us with corrected opex for the 2017 year. These corrections have led to CitiPower's 2017 opex being 10 per cent higher than initially reported, Powercor's 2017 opex being 15 per cent higher than initially reported and United Energy's 2017 opex being 4 per cent lower than initially reported. These corrections in opex materially changed their opex productivity performance in 2017, relative to that reported in our 2018 report. The change in productivity from 2017 to 2018 observed in this benchmarking report reflects the corrected opex in 2017.

13 United Energy email to AER on 17 May 2019

14 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report*, 5 September 2019, p. 101

NSW distributors show continued improvement in productivity

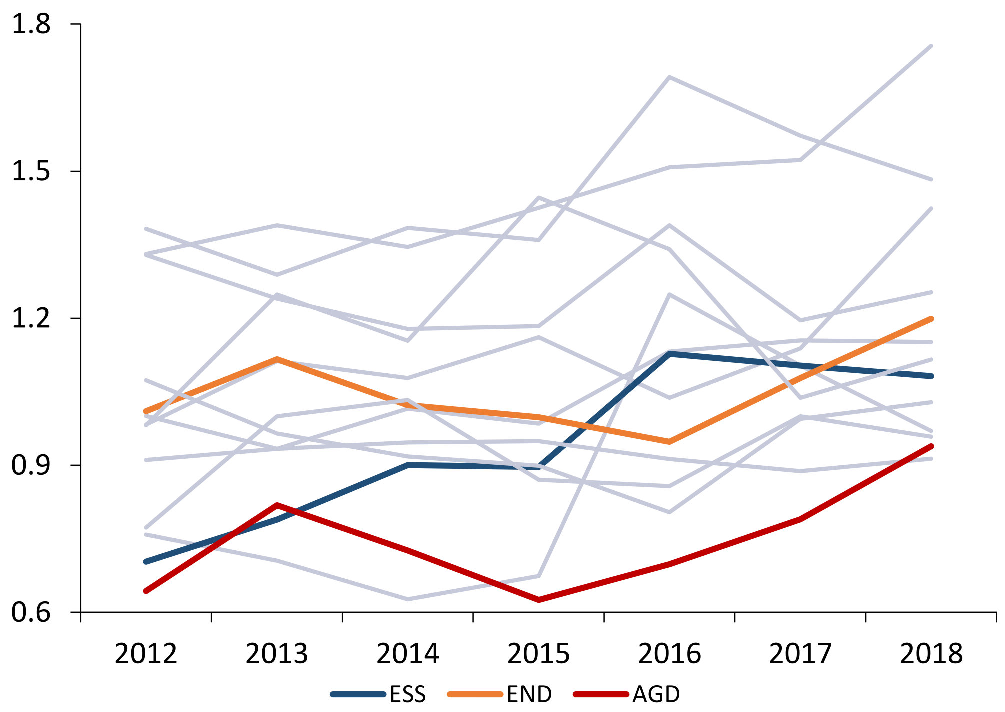
In 2018, we saw the continued improvement of productivity by NSW DNSPs. In particular:

- Ausgrid increased its opex productivity by 17.3 per cent. This follows on from the increases in opex productivity it experienced in 2016 and 2017.
- Endeavour Energy increased its opex productivity by 10.6 per cent. Its opex productivity has now increased significantly two years in a row.

Essential Energy's opex productivity declined by 2 per cent in 2018. However, its opex productivity is within the middle group of networks in 2018 in terms of efficiency.

Over the last few years, the NSW DNSPs growth in productivity can be linked to improvement in opex efficiency levels. Since 2012, the NSW DNSPs have been amongst the most improved in the NEM in terms of opex MPFP performance. This can be seen in Figure 4.5.

Figure 4.5 Opex MPFP, NSW DNSPs, 2012–18



Source: Economic Insights, AER analysis

These improvements in opex efficiency can be linked to workforce rationalisations initiated under Networks NSW; the partial privatisation of Ausgrid and Endeavour; and the AER's April 2015 revenue determinations for the 2014–19 regulatory period. In these decisions, we found that Ausgrid and Essential Energy were materially inefficient in 2012–13 and that significant opex reductions were required.

In 2019, we finalised our forecast revenue decisions for the 2019–24 regulatory period. In these decisions, we found that Endeavour and Essential's opex for the 2017-18 year was not materially inefficient and could be relied upon to forecast efficient opex for the next regulatory period. Ausgrid's opex was still relatively inefficient in 2017-18 because it was still incurring transformational costs. We agreed with Ausgrid's proposal to rely upon the 2017-18 benchmark efficient opex we set in our April 2015 decisions as the basis for forecasting opex for the next regulatory period.

These DNSPs appear to have responded to the strong incentives imposed by the regulatory regime and our use of economic benchmarking. Ausgrid is still a relatively inefficient network in 2017-18, despite its significant increases in opex productivity. However, part of this reflects the transformation costs it incurred to reduce its workforce and become more efficient. Ausgrid is forecasting significant operating expenditure reductions in 2018-19, which we expect will drive growth in its relative efficiency, particularly once transformation costs are removed.

Note that it may take longer for the MTFP scores of some of these service providers to improve significantly due to the impact of lower capital productivity and the long-lived nature of distribution capital assets and their relative immobility. Essential Energy and Ausgrid in particular are amongst the least productive in the NEM in terms of capital MPFP, and hence will likely take longer to catch-up to the networks that are most productive across both opex and capital.

Higher costs in 2018 reduced Evoenergy's productivity result and ranking

Evoenergy's opex productivity fell by 12.8 per cent in 2017-18, the largest reduction of any DNSP. Evoenergy's overall productivity fell by only 3 per cent due to an improvement in its capital productivity, which offset the decline in opex productivity.

Evoenergy has stated that its productivity declined significantly in 2017/18 as a result of an increase in operating expenditure. It explained to us that its opex increased in 2017-18 as a result of expenses incurred in complying with its regulatory obligations for that year:[15]

> Specifically, Evoenergy incurred $1.62 million in 2017/18 to comply with the new ring-fencing requirements, which required rebranding of the distribution business. In addition, Evoenergy incurred $1.95 million in 2017/18 to comply with the Power of Choice reforms, which required the design and implementation of a series of changes to business processes, work instructions and systems. The AER approved Evoenergy's applications for both of these cost pass-throughs in February 2019. The majority of Evoenergy's expenses

[15] Evoenergy submission to AER's preliminary 2019 economic benchmarking results for distribution service providers, email to AER on 22 August 2019

> associated with the preparation of its regulatory proposals for the 2019-24 regulatory period also fell in 2017/18, accounting for approximately $2 million of operating expenditure in that year. Given Evoenergy's relatively small scale compared with other electricity distributors in the NEM, these expenses significantly increased Evoenergy's operating expenditure in 2017/18.

Evoenergy also stated that the costs associated with complying with regulatory obligations should be removed from the Economic Insights analysis, otherwise, the results cannot be interpreted as representing changes in underlying productivity.[16]

We recognise Evoenergy's concern that its productivity appears worse due to materially higher costs incurred in 2018. However, we generally do not remove specific costs from the benchmarking input data, as proposed by Evoenergy.[17] This is because we benchmark total network services opex. A business' opex includes rising and falling opex items and total opex can vary from year to year. If we were to remove high cost activities from the benchmarking analysis, this may incentivise DNSPs to seek the removal of costs only when they are rising and not when they are falling. This would potentially bias the benchmarking results. We prefer to consider benchmark performance over time rather than in a single year, and where appropriate to provide commentary in our benchmarking report to explain significant changes in productivity.

4.3 The impact of differences in operating environments

This section outlines the impact of differences in operating environments not directly included in our benchmarking models. This gives stakeholders more information to interpret the benchmarking results and assess the efficiency of DNSPs.

Service providers do not all operate under exactly the same operating environments. When undertaking a benchmarking exercise, it is desirable to take into account how operating environment factors (OEFs) can affect the relative expenditures of each service provider when acting efficiently. This ensures we are comparing like-with-like to the greatest extent possible. By considering these operating conditions, it also helps us determine the extent to which differences in measured performance are affected by exogenous factors outside the control of each business.

When the AEMC added the requirement for the AER to publish annual benchmarking results, it stated that:

> The intention of a benchmarking assessment is not to normalise for every possible difference in networks. Rather, benchmarking provides a high level overview taking into account certain exogenous factors. It is then used as a

16 Evoenergy submission to AER's preliminary 2019 economic benchmarking results for distribution service providers, email to AER on 22 August 2019

17 As set in out

comparative tool to inform assessments about the relative overall efficiency of proposed expenditure. [18]

Our economic benchmarking techniques account for differences in operating environments to a significant degree. In particular:

- The benchmarking models (excluding partial performance indicators) account for differences in customer density, energy density and demand density through the combined effect of the customer numbers, network length, energy throughput and ratcheted peak demand output variables. These are material sources of differences in operating costs between networks.
- The econometric models also include a variable for the proportion of power lines that are underground. Service providers with more underground cables will face less maintenance and vegetation management costs, and fewer outages.
- Benchmarking opex is limited to the network service activities of DNSPs. This means we exclude costs related to metering, connections, street lighting and other negotiated services, which can differ across jurisdictions or are outside the scope of regulation. This helps us compare networks on a similar basis.
- The capital inputs for MTFP and capital MPFP exclude sub-transmission transformer assets that are involved in the first stage of two stage transformation from high voltage to distribution voltage, for those DNSPs that have two stages of transformation. These are mostly present in NSW, QLD and SA, and hence we remove them to enable better like-for-like comparisons with other DNSPs.

However, our benchmarking models do not directly account for differences in legislative or regulatory obligations, climate and geography. These may materially affect the operating costs in different jurisdictions and hence may have an impact on our measures of the relative efficiency of each DNSP in the NEM.

In 2017, we engaged Sapere Research Group and Merz Consulting (‘Sapere-Merz’) to provide us with advice on material OEFs driving apparent differences in estimated productivity and operating efficiency between the distribution networks in the NEM. Sapere-Merz provided us with a final report in August 2018, which is available on our website.

Based on its analysis, Sapere-Merz identified a limited number of OEFs that materially affect the relative operating expenditure of each DNSP in the NEM. Sapere-Merz consulted with the electricity distribution industry in identifying these factors. [19] It also

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[18] AEMC, *Rule Determination, National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012*, November 2012, pp 107-108.

[19] The Sapere-Merz report includes more detail about the information and data it used, our consultation with the distribution industry, and the method for identifying and quantifying these OEFs. See Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, pp. 20-21.

had regard to previous AER analysis of OEFs within our regulatory determinations for the NSW, ACT and QLD DNSPs.

The OEFs Sapere-Merz identified are:

- The higher operating costs of maintaining sub-transmission assets.
- Differences in vegetation management requirements.
- Jurisdictional taxes and levies.
- The costs of planning for, and responding to, cyclones.
- Backyard reticulation (in the ACT only).
- Termite exposure.

The following box outlines the criteria Sapere-Merz considered when identifying the relevant OEFs. These are criteria that we also considered when previously analysing OEFs in our regulatory decisions.

Criteria for identifying relevant OEFs

1. **Is it outside of the service provider's control?** Where the effect of an OEF is within the control of the service provider's management, adjusting for that factor may mask inefficient investment or expenditure.
2. **Is it material?** Where the effect of an OEF 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.
3. **Is it accounted for elsewhere?** Where the effect of an OEF is accounted for elsewhere (e.g. within the benchmarking output measures), it should not be separately included as an operating environment factor. To do so would be to double count the effect of the operating environment factor. [20]

In addition to identifying a limited number of OEFs that satisfied these conditions, the report from Sapere-Merz also provided:

- preliminary quantification of the incremental operating expenditure of each OEF on each DNSP in the NEM, or a method for quantifying these costs

[20] For example, our models capture the effect of line length on opex by using circuit length as an output variable. In this context, an operating environment adjustment for circuit length would double count the effect of route line length on opex. Another example is that we exclude metering services from our economic benchmarking data. In this case, an operating environment adjustment would remove the metering services from services providers' benchmarked opex twice.

- illustration of the effect of each OEF on our measure of the relative efficiency of each DNSP, in percentage terms, using a single year of opex.[21]

The remainder of this section provides a brief overview of each of the material factors identified by Sapere-Merz.

Sub-transmission operating costs (including licence conditions)

Sub-transmission assets relate to the varying amounts of higher voltage assets (such as transformers and cables) DNSPs are responsible for maintaining. The distinction between distribution and sub-transmission assets is primarily due to the differing historical boundaries drawn by state governments when establishing distribution and transmission businesses. In addition, DNSPs in NSW and QLD have also historically faced licence conditions that mandated particular levels of redundancy and service standards for network reliability on their sub-transmission assets. DNSPs have little control over these decisions.

Sub-transmission assets cost more to maintain than distribution assets. This is because sub-transmission transformers are more complex to maintain and maintaining higher voltage lines more often require specialised equipment and crews. [22] However, our benchmarking techniques do not directly account for these differences in costs. This is because our circuit line length and ratcheted demand output metrics do not capture the incremental costs to service sub-transmission assets compared to distribution assets. It is necessary to consider these relative costs when evaluating the relative efficiency of DNSPs using our benchmarking results.

Sapere-Merz's analysis of sub-transmission costs suggests that the NSW and QLD DNSPs require between 4 and 6 per cent more opex to maintain their sub-transmission assets, compared to a reference group of efficient DNSPs. This is because they have relatively more sub-transmission assets than the rest of the NEM. Conversely, TasNetworks requires 4 per cent less opex because they have far fewer sub-transmission assets.

More detailed information and analysis is available in the Sapere-Merz report and the supporting modelling.

Vegetation management

Vegetation management is another potentially significant factor identified by Sapere-Merz. DNSPs are obliged to ensure the integrity and safety of overhead lines by maintaining adequate clearances from any vegetation that could interfere with lines or

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21 See Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 35.

22 Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.48.

supports. Several factors drive the costs of managing vegetation that are beyond the control of DNSPs:

- Different climates and geography affect vegetation density and growth rates, which may affect vegetation management costs per overhead line kilometre and the duration of time until subsequent vegetation management is again required.
- State governments, through enacting statutes, decide whether to impose bushfire safety regulations on DNSPs and how to divide responsibility for vegetation management between DNSPs and other parties.
- Predominately rural DNSPs may be exposed to a greater proportion of lines requiring active vegetation management than urban DNSPs.

Vegetation management costs accounts for between 10 and 20 per cent of total opex for most DNSPs. Hence, differences in vegetation management costs potentially have a material impact on the relative opex efficiency of DNSPs.[23]

Our economic benchmarking models largely account for differences in vegetation management opex between DNSPs. Overhead line length is a potential driver for vegetation management costs, as vegetation management obligations relate to maintaining clearance between overhead lines and surrounding vegetation. However, Sapere-Merz's analysis of Category Analysis RIN and economic benchmarking data found that the overhead line variable does not fully explain variations in regulatory obligations, and vegetation density and growth rates across times and between different locations. [24]

Sapare-Merz's report identified a number of information sources and methodologies that could be used to quantify the effect of regulatory obligations and vegetation density. Sapere-Merz' preferred method was to calculate the total combined effect of these various factors on differences in vegetation management costs. However, under its preferred method, it could not quantify this operating environment factor based on currently available data. Its report provides some recommendations and options for quantifying this factor in the future and the additional data required for this assessment.[25]

Cyclones

Cyclones require a significant operational response including planning, mobilisation, fault rectification and demobilisation. Service providers in tropical cyclonic regions may also have higher insurance premiums and/or higher non-claimable limits. Ergon Energy

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23 Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.65.

24 Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.62.

25 Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, pp. 65-68.

is the only DNSP in the NEM that regularly faces cyclones. Sapere-Merz estimated that Ergon Energy requires up to five per cent more opex than other DNSPs in the NEM to account for the costs of cyclones.[26]

Taxes and levies

A number of jurisdictions require the payment by DNSPs of state taxes and levies such as licence fees and electrical safety levies. As they are state-based, any such taxes or levies could vary between jurisdictions and hence DNSPs. These are outside the control of DNSPs.

Sapere-Merz provided a preliminary quantification of the impact of taxes and levies on each DNSP. This was based on information provided by each DNSP in its RINs and in response to information requests. The impact of differences in taxes and levies generally do not have a significant impact on the relative costs of DNSPs (i.e. beyond 1 per cent). However, Sapere-Merz estimated that TasNetworks requires 5 per cent more opex than other DNSPs due to significant costs imposed by the Tasmanian Electrical Safety Inspection Levy.

Backyard reticulation in the ACT

Historical planning practices in the ACT mean that in some areas overhead distribution lines run along a corridor through backyards rather than the street frontage as is the practice for other DNSPs. Although landowners are theoretically responsible for vegetation management along the majority of these corridors, Evoenergy has a responsibility to ensure public safety, which includes inspecting backyard lines and issuing notices when vegetation trimming is required. Sapere-Merz estimated that Evoenergy requires 1.6 per cent more opex than other DNSPs in the NEM to manage backyard power lines in the ACT.[27]

Termite exposure

DNSPs incur opex when carrying out termite prevention, monitoring, detecting and responding to termite damage to assets. These costs depend on the number of a DNSP’s assets that are susceptible to termite damage and the prevalence of termites within the regions where the DNSP’s assets are located. Termite exposure is the smallest of the material OEFs identified by Sapere-Merz. Preliminary analysis suggests that termite exposure primarily affects Ergon Energy and Essential Energy, where they require 1 per cent more opex to manage termites.[28]

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[26] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.77.

[27] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.77.

[28] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment actors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p.74.

Next steps

Sapere-Merz acknowledged the findings and conclusions in its final report are based on the currently available information, and on a number of assumptions. Sapere-Merz suggested potential improvements to our data sources that we should consider as part of our continuous improvement of our economic benchmarking techniques and quantifying the impact of material OEFs.

The Sapere-Merz report also considered that two other OEFs have the potential to be material and we need further information to examine whether this is the case:

- Differences in DNSP terrain and topology (e.g. differences in the proportion of radial and meshed network configurations).
- Differences in the obligations and value of payments under Guaranteed Service Levels schemes in different jurisdictions.

In two recent reports from Frontier Economics, on behalf of Essential Energy and Ergon Energy, it states:[29]

> We recommend that efforts to improve the AER's benchmarking analysis and approach to OEFs should not be viewed by DNSPs or the AER as a one-off investment but, rather, as an iterative process that improves gradually the quality of information and analysis available to the regulator, the businesses and consumers as a means of promoting better regulatory outcomes.

We intend to refine and update the OEF analysis over time to ensure that the OEFs are continually improved and stay relevant. We aim to make progress in the next twelve months in collecting and analysing data to quantify OEFs related to:

- guaranteed service levels
- vegetation management

[29] Frontier Economics, *AER Benchmarking - a report prepared for Energy Queensland*, 15 January 2019, p. 34; Frontier Economics, *Operating Environment Factors (OEFs) – a report prepared for Essential Energy*, April 2018, p. 47

4.4 Power and Water Corporation

Under section 6.27A of the NER (Northern Territory), Power and Water Corporation ('Power and Water') is now a relevant service provider for our annual benchmarking report. Power and Water is the DNSP in the Northern Territory. Power and Water has recently transitioned to the NER and has not been included in our previous annual benchmarking reports.

We do not consider that the economic benchmarking of Power and Water is currently at a stage where we can use it to assess its efficiency relative to other service providers in the NEM. This is because Power and Water's benchmarking and regulatory data is relatively immature compared to other DNSPs in the NEM. Its data needs to be thoroughly examined to ensure it is fit for purpose for benchmarking.

We are also mindful of the challenges of Power and Water's potentially unique operating environment in assessing its efficiency relative to the rest of the NEM. We have not undertaken a detailed assessment of the impact of Power and Water's operating environment on its costs. However, preliminary qualitative analysis from Sapere-Merz in 2018 (as part of our review of OEFs outlined in section 4.3) identified a number of unique factors that are likely to drive materially higher electricity distribution costs in the Northern Territory relative to other jurisdictions in the NEM:

- Cyclones likely have material impact on Power and Water's opex and benchmarking performance. Part of Power and Water's network (Darwin) is situated in the tropical north of Australia and subject to cyclones during the wet season, requiring a significant emergency response operation. Service providers in cyclonic regions may also have higher insurance premiums.
- Extreme heat and humidity in the Northern Territory may have a material impact on workability. For example, how it manages overhead assets that may be subject to lightning strikes, or manages water ingress from high humidity and a wet environment may affect its measured productivity.
- Power and Water may be required to pay a cost premium to attract and retain certain types of labour, or to acquire and transport necessary materials.

We intend to review Power and Water's benchmarking data, and assess the impact of Power and Water's operating environment, for future benchmarking reports. Desirably we will include Power and Water in our benchmarking reports in advance of the start of its next regulatory control period.

5 Other supporting benchmarking techniques

5.1 Modelling of operating expenditure efficiency

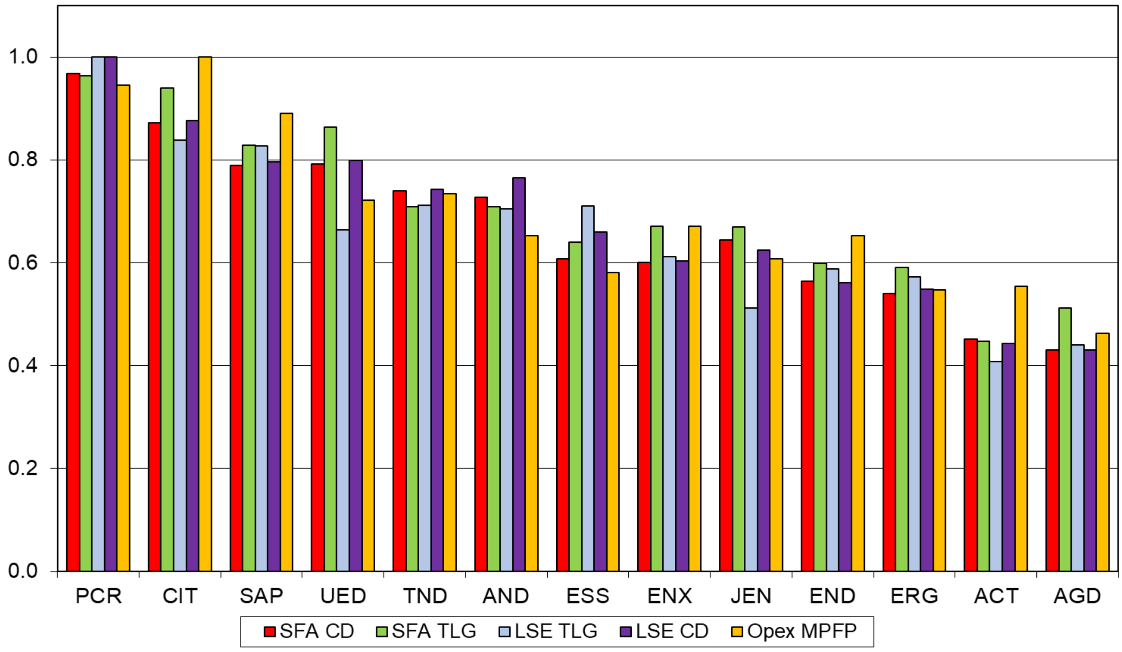
This section presents the results of four econometric models that compare the relative opex efficiency of service providers in the NEM. These results reflect an average efficiency score for each DNSP over a specified period.

The four econometric models presented in this section are:[30]

- Cobb-Douglas stochastic frontier analysis (SFA)
- Cobb-Douglas least squares econometrics (LSE)
- Translog SFA
- Translog LSE

Figure 5.1 presents average efficiency scores for these four models (plus opex MPFP) over the 2006 to 2018 benchmarking period, ranked from highest to lowest on average. Citipower and Powercor have the highest efficiency scores on the majority of metrics, followed by SA Power Networks, TasNetworks and United Energy. Ausgrid and Evoenergy have the lowest scores over this period.

Figure 5.1 Econometric modelling and opex MPFP, (2006–18 average)

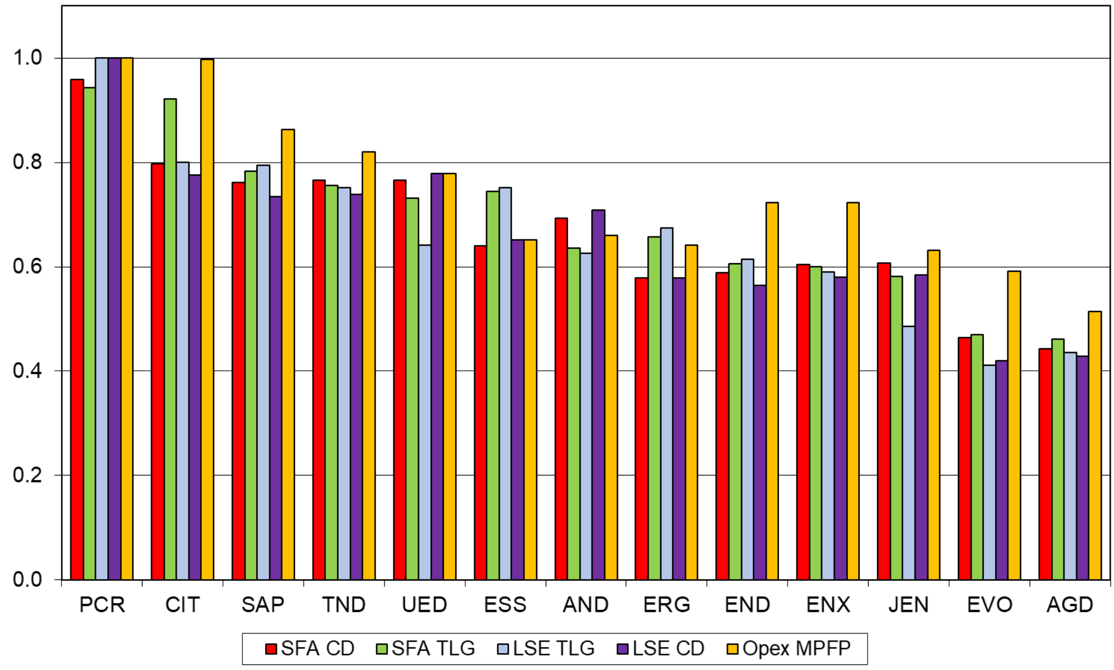


Source: Economic Insights.

[30] You can find more details about these econometric models in Economic Insights 2014 and 2018 reports.

Figure 5.2 presents the average efficiency of each DNSP over the 2012 to 2018 benchmarking period. This provides a more recent picture of relative efficiency of DNSPs in the NEM. While the efficiency results are similar between the longer-term average (2006–18) and the more recent period (2012–18), there are some notable differences. Measured relative to the efficiency frontier, Essential Energy, Ergon Energy and United Energy are more efficient over the 2012–18 period, whereas CitiPower, AusNet Services and Jemena are less efficient under some of the models.

Figure 5.2 Econometric modelling and opex MPFP, (2012–18 average)



Source: Economic Insights.

Note: This benchmarking report includes the SFA TLG model for the 2006-18 period. We did not included the results of this model in previous reports. Economic Insights 2019 report notes that the SFA TLG model performs well over the 2006-18 dataset, whereas it had violated statistical monotonicity requirements among previous datasets (see Economic Insights, Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report, 5 September 2019, p. 20).

How we use average efficiency scores to assess relative efficiency in a specific year

The econometric models produce average opex efficiency scores for the period over which the models are estimated. The results we are using in this section reflect average efficiency scores over the 2006–18 period and the 2012–18 period. Where there are rapid increases or decreases in opex, it may take some time before the average efficiency scores reflect these changes, in particular for the longer period average results. This means that in some circumstances the efficiency scores will not reflect a DNSP's relative efficiency in the most recent year.

To use the econometric results to assess the efficiency of opex in a specific year, we can estimate the efficient costs of a benchmark efficient service provider operating in the target DNSP's circumstances. We do this by first averaging the DNSP's actual opex and calculating its efficiency score over the relevant period. We then compare the DNSP's efficiency score against a benchmark comparison score adjusted for potential differences in operating environments. Where the DNSP's efficiency score is below the adjusted benchmark score, we adjust the DNSP's opex by the difference between the two efficiency scores. This results in an estimate of average opex that is not materially inefficient. We then roll forward this period-average opex to a specific base year using a rate of change that reflects changes in outputs, OEFs and technology between the average year and the specific year. We then compare the DNSP's actual opex in the base year to the rolled forward efficient opex benchmark.

An example of how we have applied this approach in practice is the AER's 2019 opex draft decision for Ergon Energy's 2020-25 regulatory control period.[31]

Appendix 6 and B provides more information about our econometric models.

[31] See AER, *Ergon Energy 2020-25, Draft Decision, Attachment 6, Operating Expenditure*, October 2019.

5.2 Partial performance indicators

PPI techniques are a simpler form of benchmarking that compare one input to one output. This contrasts with the MTFP, MPFP and econometric techniques that relate inputs to multiple outputs.

The PPIs used here support the other benchmarking techniques because they provide a general indication of comparative performance of the DNSPs in delivering a specific output. While PPIs do not take into account the interrelationships between outputs (or the interrelationship between inputs), they are informative when used in conjunction with other benchmarking techniques.

We note that on a 'per customer' metric, large rural DNSPs will perform poorly relative to DNSPs in suburban and metropolitan areas. Typically, the longer and sparser a DNSP’s network, the more assets it must operate and maintain per customer. The 'per MW' metric exhibits a similar pattern. Conversely, on 'per km' metrics, large rural DNSPs will perform better because their costs are spread over a longer network. Where possible, we have plotted PPIs against customer density, to enable readers to visualise and account for these effects when interpreting the results.

5.2.1 Total cost PPIs

This section presents total cost PPIs. These compare each DNSPs' total costs (opex and asset cost) against a number of outputs.[32] Total cost has the advantage of reflecting the opex and assets for which customers are billed on an annum basis. The three total cost PPIs shown here are:

- Total cost per customer
- Total cost per circuit length kilometre
- Total cost per mega-watt of maximum demand

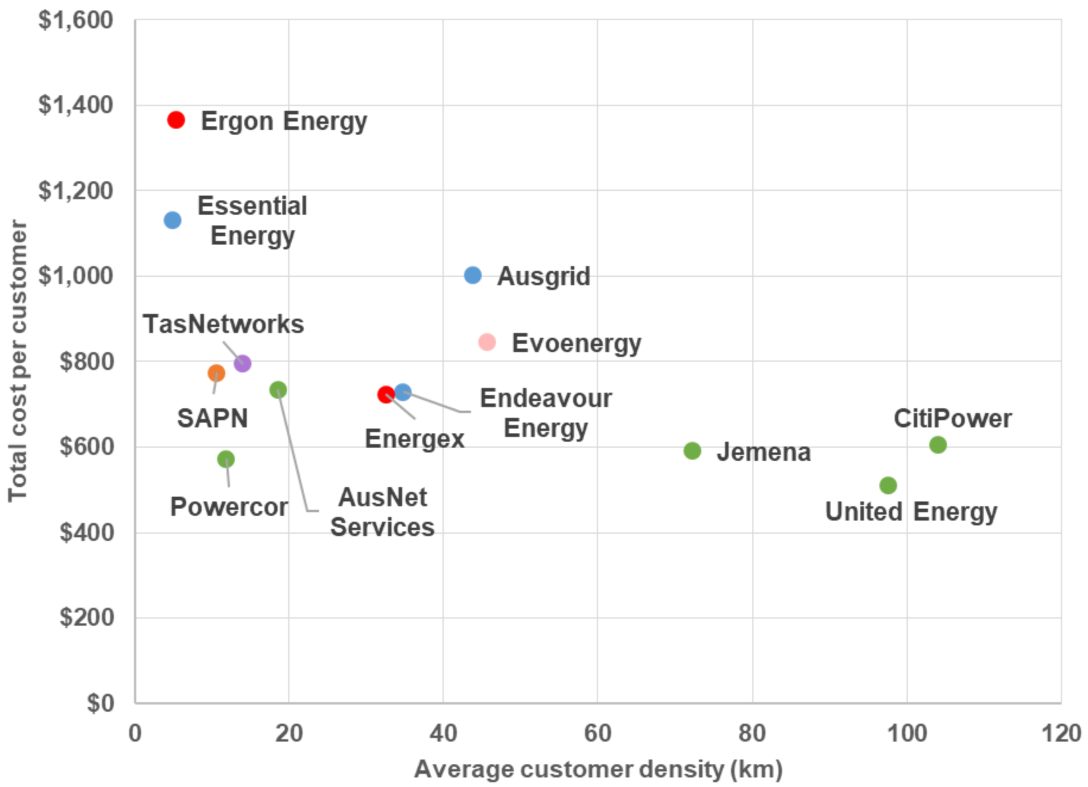
[32] Asset cost is the sum of annual depreciation and return on investmen, using the average return on capital over the period. In economic benchmarking studies, it is generally referred to as the annual user cost of capital.

Total cost per customer

Figure 5.3 shows each DNSP's total cost per customer. Customer numbers are arguably the most significant output DNSPs provide because the number of customers connected to the network drives demand and the infrastructure required to meet that demand.[33]

Broadly, this metric should favour DNSPs with higher customer density because they are able to spread their costs over a larger customer base. However, it is worth noting that there is a large spread of results across the lower customer density networks. In particular, Ergon Energy and Essential Energy have relatively higher cost per customer relative to SA Power Networks, Powercor and AusNet Services, who share similar levels of customer density.

Figure 5.3 Total cost per customer ($2018) (average 2014–18)



Source: AER analysis, Economic Benchmarking RINs.

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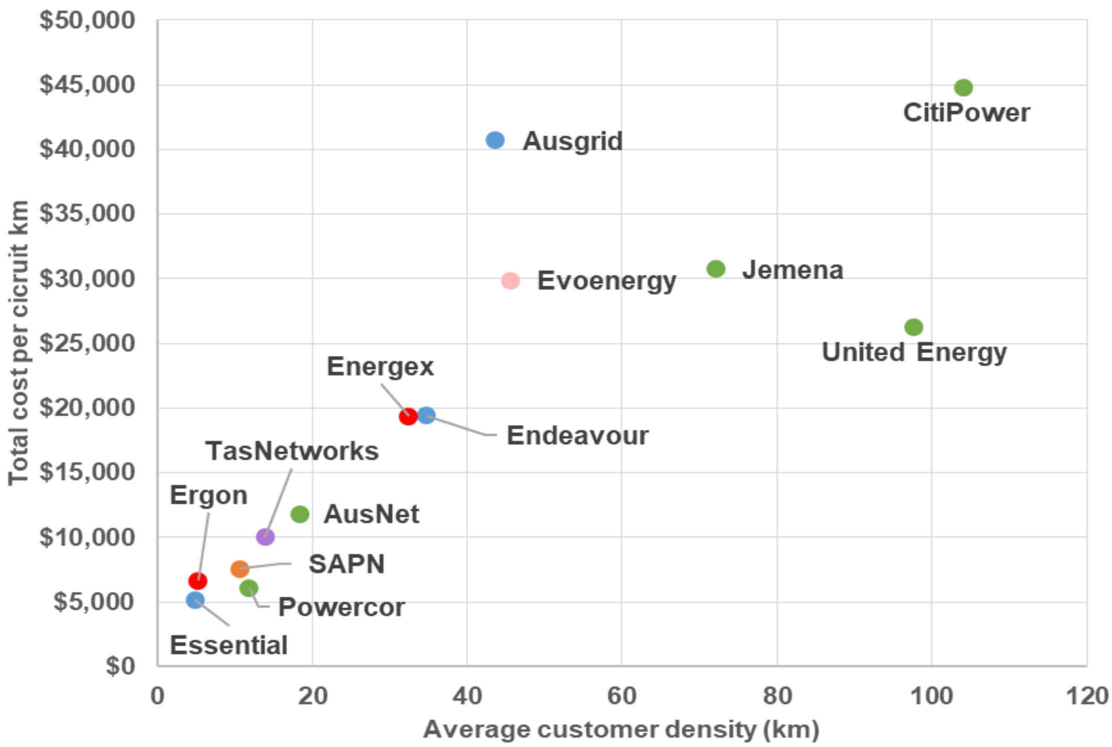
33 The customer numbers output carries the largest weight (in terms of per cent share of gross revenue) in the MTFP and MPFP indices. It also carries the largest weight (in terms of the magnitude of coefficient estimates) in the opex cost function models. See Economic Insights, *Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs*, November 2014, pp. 16, 21, 33-36.

Total cost per kilometre of circuit line

Figure 5.4 presents each DNSP's total cost per km of circuit line length. Circuit line length reflects the distance over which DNSPs must deliver electricity to their customers. Broadly, this measure favours DNSPs with lower customer density as it spreads their costs over a longer network. However, Ausgrid is an outlier with higher costs per kilometre relative to networks with similar customer density.

Figure 5.4 Total cost per kilometre of circuit line length ($2018) (average 2014–2018)

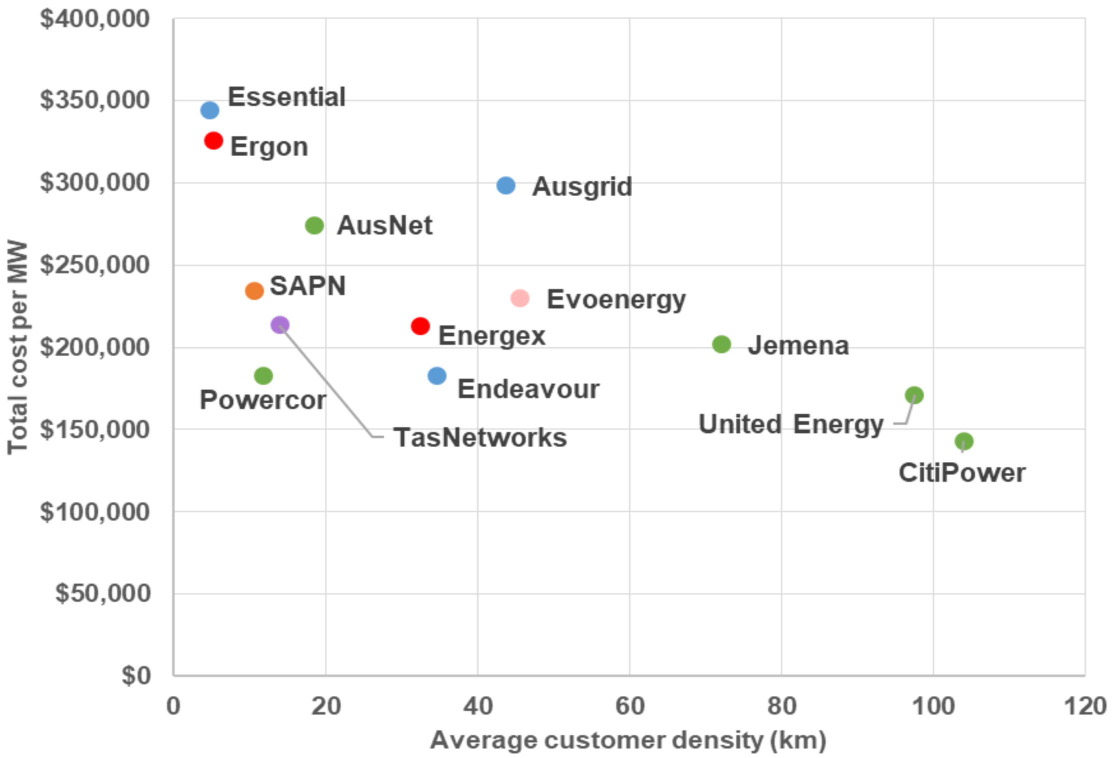


Source: AER analysis, Economic Benchmarking RINs.

Total cost per MW of maximum demand

Figure 5.5 shows each DNSP's total cost per MW of maximum demand. DNSPs install assets to meet maximum demand. Maximum demand is also an indirect driver of opex, as installed assets require maintenance (opex). Similar to total cost per customer, the measure of total cost per MW of maximum demand favours DNSPs with higher customer density. However, the spread of results tends to be narrower than that of the other metrics.

Figure 5.5 Total cost per MW of maximum demand ($2018) (average 2014–18)



Source: AER analysis, Economic Benchmarking RINs.

5.2.2 Cost category PPIs

This section presents category level cost PPIs over the 2014–18 period. These compare a DNSP's category level opex (vegetation management, maintenance, emergency response, and total overheads) against a relevant output.[34] The data for these PPIs are from the category analysis RIN and economic benchmarking RIN reported to the AER.[35]

When used in isolation, these category level PPI results should be interpreted with caution. This is because reporting differences between DNSPs may limit like-for-like category level comparisons. For example, DNSPs may allocate and report opex across categories differently due to different ownership structures, and the cost allocation policies it has in place at the time of reporting. There may also be differences in the interpretation and approaches taken by DNSPs in preparing their RIN data.

We use category level PPIs as supporting benchmarking techniques in our distribution determinations to identify potential areas of DNSP inefficiency.

Vegetation management

Vegetation management expenditure includes tree trimming, hazard tree clearance, ground clearance, vegetation corridor clearance, inspection, audit, vegetation contractor liaison, and tree replacement costs. We measure vegetation management per kilometre of overhead route line length because overhead line length is a proxy of vegetation management costs.[36]

Figure 5.6 shows that Endeavour Energy and United Energy has the highest vegetation management expenditure per kilometre of overhead circuit line length relative to other DNSPs in the NEM. It also shows that Evoenergy benchmarks relatively better compared to DNSPs with similar customer densities. One contributor to Evoenergy's performance may be due to the ACT Government having responsibility to undertake vegetation management in the public spaces in urban areas of the ACT up until 2018.

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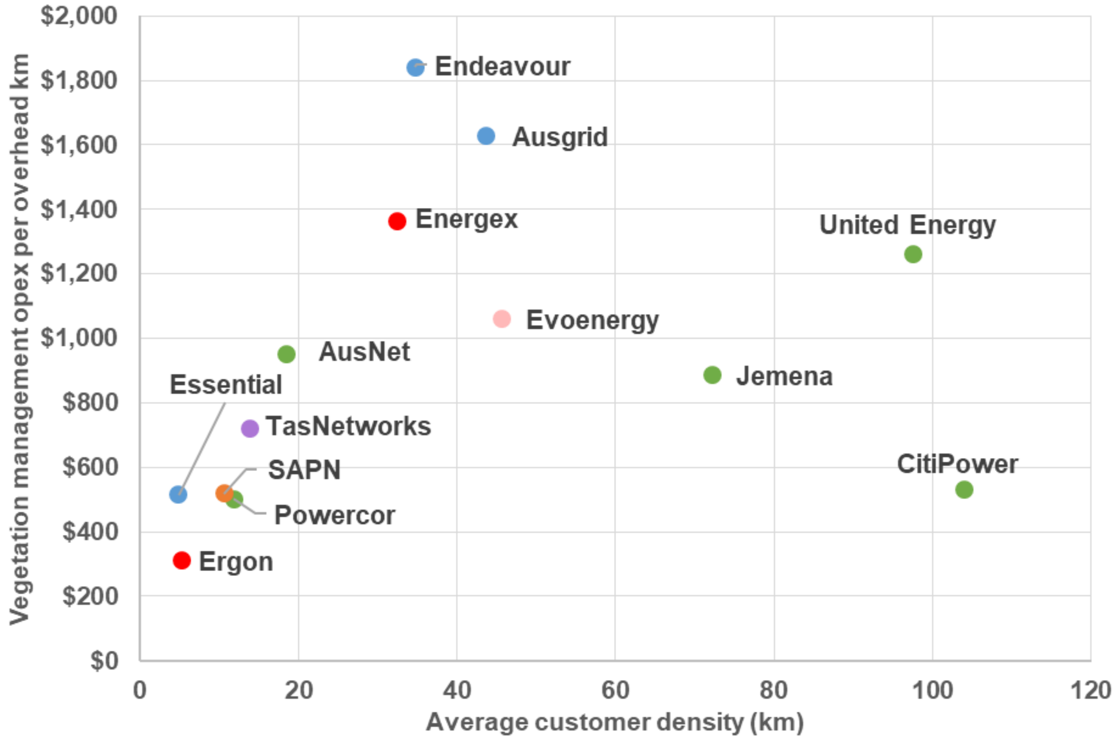
34 We have considered a number of possible output measures such as the length of lines, the energy delivered, the maximum demand and the number of customers served by the service provider. Each of these output measures have advantages and disadvantages. We have selected the output measures in this report that are most related to the cost category in question.

35 We have used the category analysis RIN for category level expenditure data, and the economic benchmarking RIN for non-expenditure data (i.e. route line length, number of interruptions etc.). The expenditure data reported in the category analysis RIN reflects the cost allocation methodology, service classification and reporting requirements in place at the time the RIN was submitted.

36 We note that route line length contains lengths of lines that are not vegetated. Vegetation maintenance spans is a better indicator of the length of vegetated spans. However, we have used overhead line length instead of vegetation maintenance span length due to DNSPs' estimation assumptions affecting maintenance span length data.

Figure 5.6 Vegetation management opex per km of overhead circuit length ($2018) (average 2014–18)



Source: AER analysis, Category Analysis RINs, Economic Benchmarking RINs.

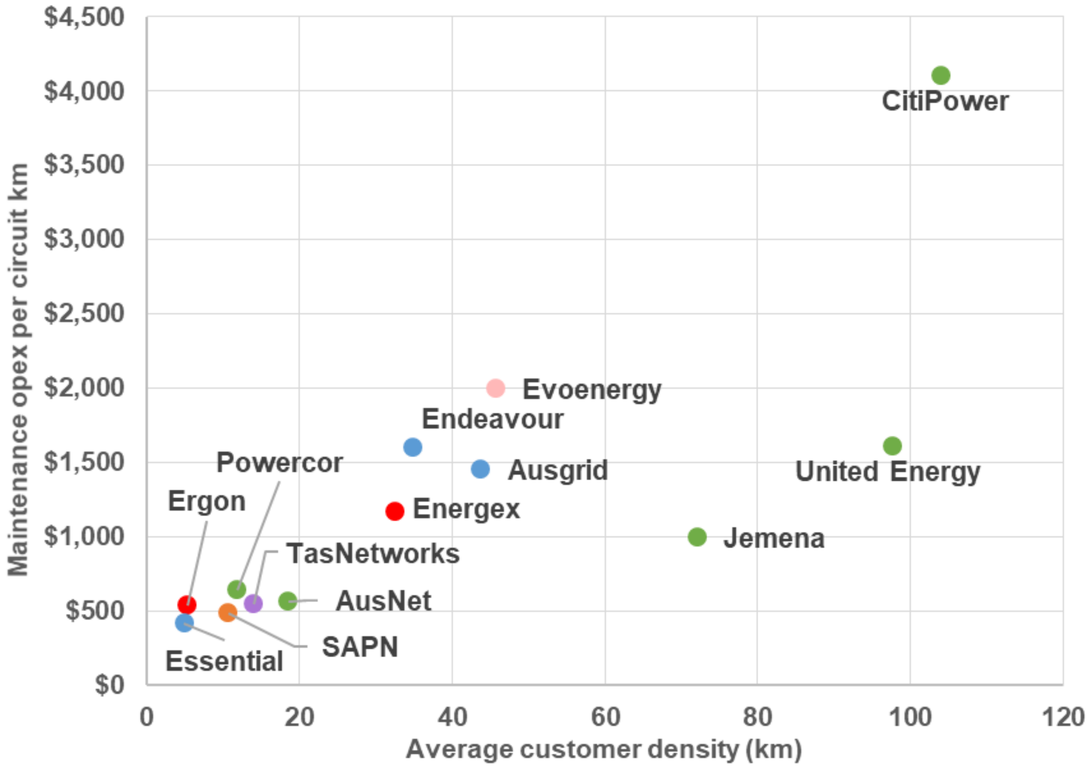
Maintenance

Maintenance expenditure relates to the direct operating costs incurred in maintaining poles, cables, substations, and protection systems. It excludes vegetation management costs and costs incurred in responding to emergencies. We measure maintenance per circuit kilometre because assets and asset exposure are important drivers of maintenance costs.[37] We used circuit length because it is easily understandable and a more intuitive measure of assets than transformer capacity or circuit capacity.

While Citipower is one of the best performers in our opex MPFP analysis, Figure 5.7 shows that it has highest maintenance opex spend per km of circuit length in the NEM. However, we note this circuit kilometre measure favours rural service providers who have longer circuit lines.

[37] Circuit line length includes both overhead and underground cables.

Figure 5.7 Average maintenance opex spend per circuit km ($2018) (average 2014–18)



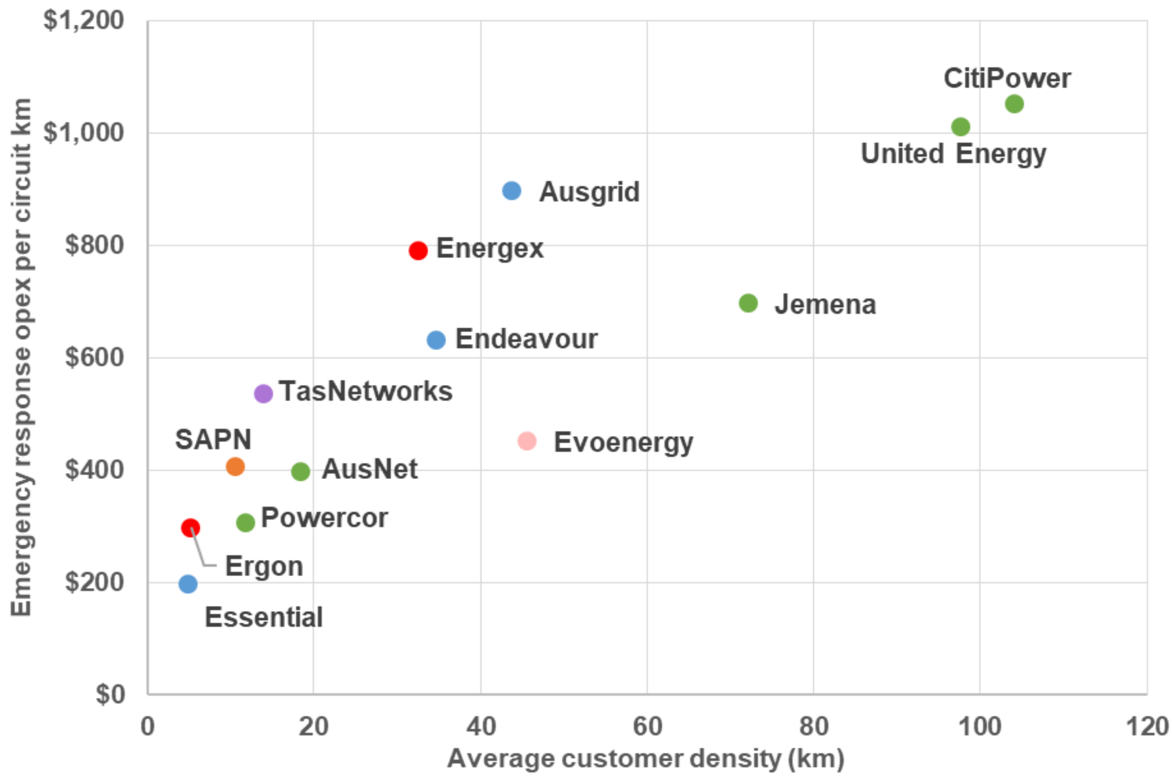
Source: AER analysis, Category Analysis RINs, Economic Benchmarking RINs.

Emergency response

Emergency response expenditure is the direct operating cost incurred in responding to network emergencies. We measure emergency response costs per circuit km because network emergencies primarily affect powerlines and poles in the field (e.g. due to storms, fires and road accidents leading to network interruptions and loss of power). Using circuit length also allows for comparisons with maintenance opex per km and vegetation management opex per overheads km. The amount of opex spent on maintenance and vegetation management can influence the instances and severity of emergency responses, and in turn there may be trade-offs between maintenance, vegetation management and emergency response.

Figure 5.8 shows that CitiPower, United Energy, Ausgrid and Energex have higher emergency response cost per km relative to other DNSPs of similar customer density, and in the NEM. In comparison, Essential Energy, Ergon Energy and Powercor have the lowest emergency response costs per km. There may be higher costs associated with responding to emergencies in more customer dense networks due to the costs of managing congestion (e.g. closing roads and managing traffic).

Figure 5.8 Average emergency response spend per circuit km ($2018) (average 2014–18)



Source: AER analysis, Category Analysis RINs, Economic Benchmarking RINs.

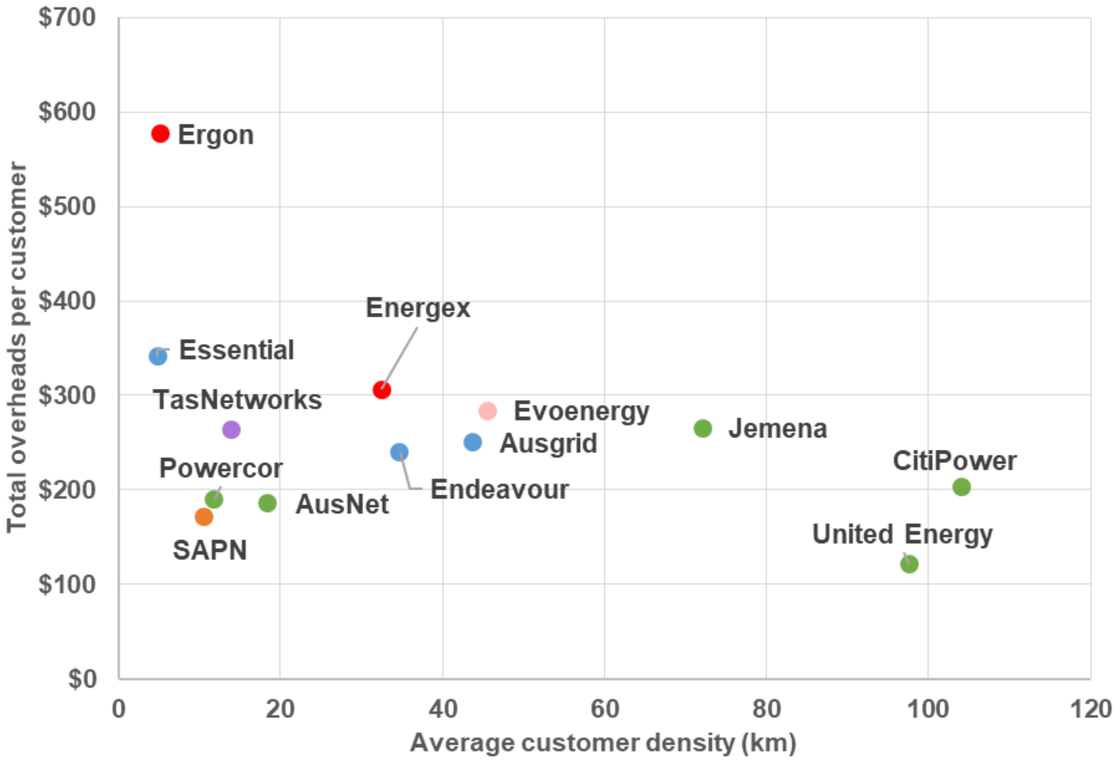
Note: Jemena's data excludes emergency response opex in 2015 and 2016. Jemena claimed confidentiality on its emergency response data for these years in its Category Analysis RIN.

Total overheads

Total overheads are the sum of corporate and network overheads allocated to standard control services. We measure total overheads allocated to both capex and opex to ensure that differences in a DNSP's capitalisation policy does not affect the analysis. It also mitigates the impact of a DNSP's choice in allocating their overheads to corporate or network services.

We have examined total overheads by customer numbers because it is likely to be a driver of overhead costs. Figure 5.9 shows that Ergon has higher overhead costs compared to all other DNSPs in the NEM. While the 'per customer' measure may favour DNSPs with higher customer density, we do not consider this explains Ergon's relative performance. This is because it has higher costs relative to DNSPs of similar customer densities such as Essential Energy.

Figure 5.9 Total Overheads per customer ($2018) (average 2014–18)



Source: AER analysis, Category Analysis RINs, Economic Benchmarking RINs.

6 Benchmarking development

We operate an ongoing program to review and incrementally refine elements of the benchmarking methodology and data. The aim of this work is to maintain and continually improve the reliability of the benchmarking results we publish and use in our network revenue determinations.

We categorise our benchmarking development work as:

- ongoing incremental improvement in data and methods that support our annual benchmarking reporting
- specific issues that have the potential to materially affect the benchmarking results and should involve consultation with affected stakeholders
- changes and improvements in the way that we and other stakeholders use economic benchmarking in decision making.

This section outlines some of our recent benchmarking developments and our priorities for future development work.

Recent benchmarking improvements

In 2018 and 2019, we made a number of improvements that reflected on the development work we had been pursuing in recent years. These addressed some of the concerns raised by the Australian Competition Tribunal and reflect our consideration of submissions from stakeholders to our benchmarking reports and regulatory determinations.

Our 2018 benchmarking report included a number of improvements:

- Additional benchmarking models and techniques, notably the addition of the Cobb-Douglas translog model and an additional benchmarking period (2012-17).
- Updated output weightings for productivity index models.
- More information about material differences in operating environments that may explain differences in measured productivity. This reflected a major review we undertook over 2017 and 2018 in consultation with industry, which drew on analysis undertaken for us by engineering and economic consultants Sapere-Merz. This is contained in section 4.3.

This year's benchmarking report builds off these improvements through further incremental refinements in the benchmarking dataset, and expanding the use of the Cobb-Douglas translog model to the 2006-18 benchmarking period.

We also evolved our approach to applying benchmarking in regulatory decisions. In our 2018 and 2019 regulatory determinations for Ausgrid, Evoenergy, Endeavour Energy and Essential Energy we examined the efficiency of each service provider's opex using the results of all of our econometric modelling. We also used the output weights from all of our benchmarking models (including opex MPFP) to forecast opex output growth.

These refine our previous approach, which only used the efficiency scores and output weights from a single econometric model (the Cobb-Douglas SFA model). Our refined approach, which uses all of our available models, helped to address concerns raised by the Australian Competition Tribunal in its 2016 merits review of our April 2015 decision for NSW electricity determinations. The Tribunal raised concerns about our reliance on a single model and in remitting the NSW decisions directed us to use a broader range of modelling and benchmarking.[38] It also addressed concerned raised by the AER's Customer Challenge Panel that reliance on the single Cobb-Douglas SFA model gives too much weight to customer numbers.[39]

Future benchmarking development

Our future development program is informed by submissions we received from DNSPs. This includes submission to our annual benchmarking reports (including the preparation of this report), issues raised throughout revenue determinations processes, and specific reviews such as our operating environment factor review.

The key areas for ongoing incremental improvement to our dataset include:

- Continual data refinements in response to our annual review of benchmarking RIN data and data issues identified by stakeholders.
- Improving and updating the quantification of material operating environment factors. This includes updating the datasets used to quantify individual OEFs, and quantifying the impact of OEFs that have not yet been considered. As set out in section 4.3, we aim to make progress in the next twelve months in collecting and analysing data to quantify operating environment factors identified in the Sapere-Merz report that have not been quantified – guaranteed service levels and vegetation management.
- Including Power and Water in our future benchmarking reports. This is briefly discussed in section 4.4. We aim to include Power and Water in our benchmarking reports in advance of the start of its next regulatory control period.

In addition to ongoing incremental development work, we and stakeholders have identified the following that have the potential to materially impact the benchmarking methodologies and analysis. This section outlines three issues:

- The implications for cost allocation and capitalisation differences on the benchmarking results
- The future review of benchmarking output specifications

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[38] Applications by Public Interest Advocacy Centre Ltd and Essential Energy [2016] ACompT 3, direction 1(a). The Tribunal's decision was upheld by the Full Federal Court. For more details, see: Australian Energy Regulator v Australian Competition Tribunal (No 2) [2017] FCAFC 79, [285].

[39] Consumer challenge Panel (subpanel 10), *Response to Evoenergy regulatory proposal 2019-24 and AER issues paper* - 16 May 2018, p. 10.

- The choice of benchmarking comparison point.

The most significant submission from stakeholders is the proposal that we review the implications of changes in cost allocation and capitalisation approaches between DNSPs (e.g. corporate overheads) on our benchmarking results. Some submissions suggest that differences in cost allocation approaches is leading to differences in benchmarking results that are unrelated to the productivity of different networks, and that some DNSPs are disadvantaged due to their cost allocation decisions. We are also observing a number of changes in cost allocation methods by DNSPs since we began benchmarking.

Over the next twelve months, we intend to consult on this issue. We consider this a priority area for benchmarking development. We discuss this further below.

Another important and emerging issue is the impact of increases in distributed energy resources (e.g. solar photovoltaics) and demand management activities across the industry on our benchmarking results. This reflects the evolution of the electricity distribution industry and the expected increase in distributed energy across the NEM. The rollout and penetration of distributed energy resources varies significant across the NEM, and currently affects some DNSPs more than others. This is likely to change as more distributed energy is rolled out across the NEM.

We consider that it will be appropriate to review the benchmarking models in the near future to ensure that they appropriately account for the impact of distributed energy resources on the electricity distribution industry. This would involve reviewing the need for changes in the output specifications of the benchmarking models. However, it is worth highlighting that distributed energy is still emerging across the NEM, and it may not yet be materially affecting the relative benchmarking results across the industry. More work will need to be done to properly assess this impact before reviewing the benchmarking models. We discuss this further below.

With this in mind, over the next twelve months we propose to prioritise a review of cost allocation and capitalisation ahead of a review of the benchmarking output specifications.

The AER's Consumer Challenge Panel has advocated for a review of the selection of the benchmark comparison points that we use in our regulatory decisions. In our opex forecasting decisions, we draw on the efficiency scores from our econometric models (as contained in section 5.1 of this report) to assess the efficiency of individual DNSPs' historical opex and base year opex. We do this by comparing the efficiency scores of individual DNSPs against a benchmark comparison score of 0.75 (adjusted further for OEFs), which reflects the upper quartile of possible efficiency scores by DNSPs. The Consumer Challenge Panel has advocated for a raising of our benchmark comparison point and a tightening of the analysis of whether a DNSP is “not materially inefficient”.

As we have previously noted, our benchmarking comparison point is conservative and provides a margin for general limitations of the models with respect to the specification of outputs and inputs, data imperfections and other uncertainties when forecasting efficient opex. We consider that it is appropriate to be conservative while our benchmarking models are maturing and the underlying data and method are being refined. It is also important to provide certainty to industry and other stakeholders because benchmarking is an input into decision making. We will continue to assess the appropriateness of the current benchmark comparison point in light of the refinements and improvements we make to our benchmarking approaches and metrics over time.

Differences in cost allocation and capitalisation approaches

This benchmarking report measures, amongst other things, the relative efficiency of opex for network services between DNSPs. Each DNSP's opex is prepared in accordance with applicable accounting standards, as well as their approved cost allocation methodologies applying in 2014 and associated capitalisation policies that classify and allocate costs as an asset or opex.

Economic Insights' report sets out our approach to cost allocation methodologies:[40]

> In line with previous practice, all Australian DNSPs' data for all years are based on the cost allocation methodologies (CAMs) that applied in 2014 rather than on more recently revised CAMs. The CAMs applying in 2014 (including ACT's revised CAM) led to opex/capex ratios being broadly consistent across DNSPs. 'Freezing' the CAMs at this point has minimised the scope for DNSPs to game the benchmarking results by reallocating costs between opex and capex and currently provides the best basis for like–with–like comparisons of overall network services opex.

In its submission to the AER's draft 2018 Benchmarking Report, AusNet Services observed that different DNSPs adopt different capitalisation approaches to allocate corporate overheads to opex and capex.[41] AusNet Services submitted that the different capitalisation approaches can materially impact the AER's opex benchmarking results and that these approaches are unrelated to the productivity of different networks. SA Power Networks has also submitted that it is disadvantaged in comparison with other DNSPs due its policy of expensing all corporate overheads.[42]

AusNet Services, Endeavour Energy and SA Power Networks submitted that the AER should apply a consistent approach to capitalisation policies between DNSPs.[43] AusNet Services and Endeavour Energy stated that the AER could apply a fixed capitalisation ratio for every networks' overheads and this would equalise the impact of differences in corporate overheads capitalisation. The uniform application of a fixed

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40 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Annual Benchmarking Report*, 5 September 2019, pp. 3-4

41 AusNet Services, *Re: Draft AER 2018 Benchmarking Reports*, October 2018, pp. 1-2.

42 SA Power Networks, *Submission to AER on preliminary 2019 economic benchmarking results*, 23 August 2019, p. 2

43 AusNet Services, *Re: Draft AER 2018 Benchmarking Reports*, October 2018, pp. 1-2; Endeavour Energy, *Submission to Draft 2019 Benchmarking Report for Distribution Service Providers*, 9 October 2019, p. 2; SA Power Networks, *Submission to AER on preliminary 2019 economic benchmarking results*, 23 August 2019, p. 2

capitalisation ratio would require a proportion of reported capital expenditures to be 'expensed' or a proportion of reported operating expenditures to be 'capitalised' for some or even all DNSPs.[44]

Ausgrid and AusNet Services have both submitted that the transparency of the benchmarking results could be improved by presenting benchmarking results on the basis of different capitalisation approaches. Ausgrid stated that this will provide customers with additional data to assess the underlying efficiency of their energy network provider.

Our previous consideration of differences in capitalisation policies

The AER has previously and carefully considered the influence of capitalisation decisions on the comparability of DNSP expenditures. Most notably, for the NSW, Queensland and ACT distribution determinations in 2015, we assessed whether differences in capitalisation policies at the time were leading to material differences in total opex between the NSW, Queensland and ACT service providers and the benchmark comparison firms.[45] These decisions addressed submissions from a number of stakeholders at the time about the effect of differences in capitalisation practices, in particular, on benchmarking.[46]

In these regulatory decisions, we specifically considered the specific question of adjusting the benchmarking opex to normalise for differences in overhead allocation:

> We are not satisfied that it is necessary to make adjustments to all of the service providers in the sample to adjust for differences in the reported allocation of overheads to opex and capex. The method in which service providers allocate direct costs between capex and opex is also likely to affect capitalisation rates. As a result rather than focusing on indirect costs it is better to compare the ratio of total opex to total capex. This measure will take into account the allocation of overheads between opex and capex, but also other factors such as opex capex trade-offs.

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[44] Endeavour Energy also stated that "irrespective of how the data is normalised, we consider the adjustment mechanism should not limit a DNSPs discretion to adopt a capitalisation approach that best aligns with their circumstances and accounting practices. It would also be important for the AER to be clear that differences between the standard rate and a DNSPs actual rate is a consequence of its normalisation approach rather than an assessment of the efficiency of a particular DNSPs capitalisation policy." See Endeavour Energy, *Submission to Draft 2019 Benchmarking Report for Distribution Service Providers*, 9 October 2019, p. 2

[45] These benchmark comparison firms were CitiPower, Powercor, SA Power Networks, United Energy and AusNet Services. See AER (2015), Final Decision Ausgrid distribution determination 2015-16 to 2018-19, Attachment 7 – Operating expenditure, April; AER (2015), Final Decision ActewAGL distribution determination 2015-16 to 2018-19, Attachment 7 – Operating expenditure, April.

[46] These decision considered submissions and reports from ActewAGL (now Evoenergy), Advisian, CEPA, the Consumer Challenge Panel, Frontier Economics, Ergon Energy, Energex, SAPN, and the NSW Service Providers. For more information on these submissions see AER, *Final Decision Ausgrid distribution determination 2015-16 to 2018-19, Attachment 7 – Operating expenditure*, April 2015, p. 7-192, and AER, *Preliminary Decision Ergon Energy distribution determination 2015-16 to 2019-20, Attachment 7 – Operating expenditure*, April 2015, p. 7-182.

Our analysis of total opex to total capex ratios at the time found that the NSW and Queensland DNSPs had similar opex to capex ratios as the customer weighted average of the benchmark comparison firms in Victoria and South Australia. This led us to conclude that differences in capitalisation practices between these DNSPs are not likely to lead to material differences in opex.

We found that ActewAGL (now Evoenergy) was an outlier and expensed more of its totex than any other service provider. As such our regulatory opex decision provided an 8.5 per cent adjustment to its benchmarking results for its capitalisation practices (as an OEF adjustment).[47] In our 2016 annual benchmarking report we amended ActewAGL's historic data to be consistent with a change in its cost allocation method we approved in 2013. The change in cost allocation brought ActewAGL more in line with other DNSPs' capitalisation policy. To provide a consistent time series, ActewAGL back cast its historical data from 2006 to 2014 to consistent with its new cost allocation method.[48]

Reviewing recent stakeholder submissions

AusNet Services' and Endeavour Energy's proposal that we apply a fixed capitalisation ratio to each network would potentially make corporate overhead data more consistent between DNSPs. However, it would not account for differences in the allocation of other costs between DNSPs, such as direct costs and network overheads. It would also not account for legitimate reasons why the rates of capitalisation may differ. This partial approach to addressing differences in capitalisation approaches has the potential to be less reflective of actual costs and potentially misleading benchmarking results. Hence we consider that further work and consultation should be undertaken before making material changes to the opex inputs to account for consistency of cost allocation and capitalisation approaches

There have been a changes in cost allocation methodologies by a large number of DNSPs since our first benchmarking report. Changes for CitiPower[49] and Powercor[50] in 2016 and Ergon Energy and Energex in 2018 lead to material changes in costs allocated to network services opex.[51] The AER also recently approved a change to Jemena's cost allocation method that will apply from 2021 onwards.[52] We expect that DNSP cost allocation methodologies will continue to change over time.

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47 AER, *Final Decision ActewAGL distribution determination 2015-16 to 2018-19, Attachment 7 – Operating expenditure*, April 2015, p. 7-190.

48 AER, *Annual Benchmarking Report Electricity Distribution Service Providers*, November 2016, p. 10

49 https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/cost-allocation-method/citipower-cost-allocation-method-2016

50 https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/cost-allocation-method/powercor-cost-allocation-method-2016

51 https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/cost-allocation-method/ergon-energy-cost-allocation-method-2018,

52 https://jemena.com.au/documents/price-reviews/electricity/our-regulatory-proposal/jen-cost-allocation-methodology_from-1st-jan-2021.aspx

These changes in cost allocation methods suggest that it is the right time to review the impact that changes and differences in cost allocation and capitalisation methodologies are having or may have on the benchmarking analysis.

While we will consult with stakeholders, our initial view is that a review would look holistically at the differences in cost allocation between DNSPs and over time, rather than focusing on a single category of expenditure. It would also consider how changes in cost allocation methodologies over time should be accounted for within the benchmarking analysis. It may also consider whether the consistency, reliability and comparability of benchmarking expenditure data could be potentially strengthened.

Our examination of cost allocation approaches across DNSPs, and their effect on benchmarking, will involve consultation with the distribution industry and other relevant stakeholders.

Review of benchmarking modelling to account for distributed energy

We have received submissions from some stakeholders about the impact that distributed energy resources is having, or is likely to have, on DNSPs' comparative benchmark performance. Distributed energy resources includes such things as rooftop photovoltaics (e.g. solar panels), batteries and electric vehicles.

In SA Power Networks' 2018 submission to our draft benchmarking report, it stated:[53]

> The installation of solar generation on our network commenced around 2012/11 and contributed to a reduction in our ratcheted maximum demand and energy delivered through our distribution network. These outcomes contribute significantly to the decline in our productivity performance measured by the AER's modelling.
>
> Nearly one in three customers on our network are now embedded generators, yet the AER's benchmarking model does not recognise the number of embedded generators, nor their customer exported energy as outputs.

It further suggested a change to the benchmarking analysis: [54]

> Inclusion of generator connection and energy export services by the AER in its Annual Benchmarking Report would be seen as recognition of the distributed energy transformation occurring across Australian distribution networks.

SA Power Network also recently submitted a report from NERA as part of its regulatory proposal that argued the benchmarking energy throughput output variable is not capturing the growth in embedded generation. It states:[55]

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53 SAPN submission to AER Draft 2018 Annual Benchmarking Report – Electricity distribution network service providers, 17 October 2018, p. 4

54 SAPN submission to AER Draft 2018 Annual Benchmarking Report – Electricity distribution network service providers, 17 October 2018, p. 4

Prior to recent growth in embedded generation and other load-altering technologies, energy throughput and distribution network costs might have been positively correlated. For instance, higher energy throughput might have coincided with higher operating costs due to growth in peak requirements and customer numbers. Growth in embedded generation tends to weaken or eliminate such positive correlation. Hence, while customer numbers and ratcheted peak demand continue to be important cost drivers for distribution networks, energy throughput ceases to be an appropriate proxy for these cost trends.

…

If the MPFP modelling imposes a positive relationship between opex and energy throughput, where in fact a negative relationship exists, DNSPs' actual efficient costs may exceed efficient costs estimated by MPFP modelling. This could lead to DNSP under-recovery of actual efficient costs, which is inconsistent with the operating expenditure criteria in the NER.

Ausgrid similarly observed that, while there has been growth in customer numbers across all the networks over the last five years, energy throughput and ratcheted maximum demand have not increased to the same extent due to investment in distributed generation and energy efficiency.[56] It suggested that:[57]

… we consider that it would be appropriate for the AER to investigate whether adjustments for 'demand side response' outputs should be incorporated into its productivity measures or a reduced weight be placed on ratcheted maximum demand.

Our consultant Economic Insights considered these arguments in its 2018 report:[58]

As transformation of the electricity supply industry progresses, we agree that the economic benchmarking specification will need to be reviewed and outputs possibly included that reflect the increasing role distributed generation is expected to play. This would most appropriately be done as part of a broader review conducted by the AER.

Currently, the energy throughput output variable captures changes in the amount energy delivered to customers over the distribution network as measured at the customer meter. It does not measure energy delivered into the distribution network via distributed energy resources, such as from residential roof-top solar panels. In the extreme, an increase in rooftop solar panels could potentially involve a substitution of

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55 SA Power Networks, *2020-2025 Regulatory proposal, Supporting document 6.5, NERA - Review of the AER's proposed output weightings*, December 2018, pp. 23-24

56 Ausgrid submission to AER Draft 2018 Annual Benchmarking Report for DNSPs, October 2018, p. 4

57 Ausgrid submission to AER Draft 2018 Annual Benchmarking Report for DNSPs, October 2018, p. 5

58 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2018 DNSP Annual Benchmarking Report*, 9 November 2018, p. 2

different energy sources amongst the same customers without changing the total energy consumed or materially changing the existing network in terms of circuit length or maximum demand. However, a distributor may be required to incur higher opex and/or capital to manage the safety and reliability of its network. In this situation there could be a material increase in inputs without a corresponding increase in any or all of the output measures.

We acknowledge that more work will need to be done to properly assess impacts of this nature. To the extent they are material, it would be appropriate to review the specifications of the outputs to appropriately account for the relationship between changes in inputs and growth in distributed energy. Such a review will not be confined to just removing certain outputs—it will need to consider whether it is appropriate to add new outputs as well as removing any obsolete outputs. Such a review would also need to consider the data requirements for any new output specification.

Shortened Forms

Shortened form	Description
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AGD	Ausgrid
AND	AusNet Services (distribution)
Capex	Capital expenditure
CIT	CitiPower
DNSP	Distribution network service provider
END	Endeavour Energy
ENX	Energex
ERG	Ergon Energy
ESS	Essential Energy
EVO	Evoenergy (previously ActewAGL)
JEN	Jemena Electricity Networks
MW	Megawatt
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
Opex	Operating expenditure
PCR	Powercor
RAB	Regulatory asset base
SAPN	SA Power Networks
TND	TasNetworks (Distribution)
UED	United Energy Distribution

Glossary

Term	Description
Efficiency	A Distribution Network Service Provider's (DNSP) benchmarking results relative to other DNSPs reflect that network's relative efficiency, specifically their cost efficiency. DNSPs are cost efficient when they produce services at least possible cost given their operating environments and prevailing input prices.
Inputs	Inputs are the resources DNSPs use to provide services. The inputs our benchmarking models include are operating expenditure and the physical measure of capital assets.
LSE	Least squares econometrics. LSE is an econometric modelling technique that uses 'line of best fit' statistical regression methods to estimate the relationship between inputs and outputs. Because they are statistical models, LSE operating cost function models with firm dummies allow for economies and diseconomies of scale and can distinguish between random variations in the data and systematic differences between DNSPs.
MPFP	Multilateral partial factor productivity. MPFP is a PIN technique that measures the relationship between total output and one input. It allows partial productivity levels as well as growth rates to be compared.
MTFP	Multilateral total factor productivity. MTFP is a PIN technique that measures the relationship between total output and total input. It allows total productivity levels as well as growth rates to be compared between businesses.
Network services opex	Operating expenditure (opex) for network services. It excludes expenditure associated with metering, customer connections, street lighting, ancillary services and solar feed-in tariff payments.
OEFs	Operating environment factors. OEFs are factors beyond a DNSP's control that can affect its costs and benchmarking performance.
Outputs	Outputs are quantitative or qualitative measures that represent the services DNSPs provide.
PIN	Productivity index number. PIN techniques determine the relationship between inputs and outputs using a mathematical index.
PPI	Partial performance indicator. PPIs are simple techniques that measure the relationship between one input and one output.
Ratcheted maximum demand	Ratcheted maximum demand is the highest value of maximum demand for each DNSP, observed in the time period up to the year in question. It recognises capacity that has been used to satisfy demand and gives the DNSP credit for this capacity in subsequent years, even though annual maximum demand may be lower in subsequent years.
SFA	Stochastic frontier analysis. SFA is an econometric modelling technique that uses advanced statistical methods to estimate the frontier relationship between

	inputs and outputs. SFA models allow for economies and diseconomies of scale and directly estimate efficiency for each DNSP relative to estimated best practice frontier.
TFP	Total factor productivity is a PIN technique that measures the relationship between total output and total input over time. It allows total productivity growth rates to be compared across networks but does not allow productivity levels to be compared across networks. It is used to decompose productivity change into its constituent input and output parts.

A References and further reading

Several sources inform this benchmarking report. These include ACCC/AER research and expert advice provided by Economic Insights.

Economic Insights publications

The following publications explain in detail how Economic Insights developed and applied the economic benchmarking techniques used by the AER.

- Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2019 DNSP Benchmarking Report*, 5 September 2019
- Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2018 DNSP Benchmarking Report*, 9 November 2018
- Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking Report*, 31 October 2017
- Economic Insights, *Memorandum – DNSP Economic Benchmarking Results Report*, November 2016
- Economic Insights, *Memorandum – DNSP MTFP and Opex Cost Function Results*, 13 November 2015
- Economic Insights, *Response to Consultants' Reports on Economic Benchmarking of Electricity DNSPs*, 22 April 2015 (link).
- Economic Insights, *Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs*, 17 November 2014 (link).
- Economic Insights, *Economic Benchmarking of Electricity Network Service Providers*, 25 June 2013

ACCC/AER publications

These publications provide a comprehensive overview of the benchmarking approaches used by overseas regulators.

- ACCC/AER, *Benchmarking Opex and Capex in Energy Networks – Working Paper no. 6*, May 2012 (link).
- ACCC/AER, *Regulatory Practices in Other Countries – Benchmarking opex and capex in energy networks*, May 2012 (link).
- WIK Consult, *Cost Benchmarking in Energy Regulation in European Countries*, December 2011 (link).

AER distribution determinations

The AER applies economic benchmarking to assess the efficiency of total forecast opex as proposed by distribution network service providers. These decisions provide examples of how the AER has applied benchmarking in its decision making:

- AER, Draft Decision, *Ergon Energy distribution determination 2020-21 to 2024-25, Draft Decision, Attachment 6 – Operating Expenditure,* October 2019 (link)
- AER, Draft Decision, *SA Power Networks distribution determination 2020-21 to 2024-25, Attachment 6 – Operating Expenditure*, October 2019 (link).
- AER, Draft Decision, *Ausgrid distribution determination 2019-20 to 2023-24, Attachment 6 – Operating Expenditure* November 2018 (link)
- AER, *Ausgrid distribution determination 2014-15 to 2018-19,* January 2019 (link)
- AER, *Jemena distribution determination 2016 to 2020, Attachment 7 – Operating Expenditure*, May 2016, p. 7-22 (link).
- AER, *Endeavour Energy distribution determination 2015–16 to 2018–19, Attachment 7 – Operating Expenditure*, April 2015 (link).
- AER, Preliminary decision, *Energex determination 2015–16 to 2019–20, Attachment 7 – Operating Expenditure*, April 2015 (link).
- AER, Preliminary decision, *Ergon Energy determination 2015–16 to 2019–20, Attachment 7 – Operating Expenditure*, April 2015 (link).

B Benchmarking models and data

This appendix contains further information on our economic benchmarking models, and the output and input data used in the benchmarking techniques.

B.1 Benchmarking techniques

This report presents results from three types of 'top-down' benchmarking techniques.

1. **PIN**. These techniques use a mathematical index to determine the relationship between outputs and inputs, enabling comparison of productivity levels and trends over time.
    - TFP relates total inputs to total outputs and provides a measure of overall productivity growth for a single entity (a network or the whole industry). It allows total productivity growth rates to be compared across networks but does not allow productivity levels to be compared across networks. It is used to decompose productivity change into its constituent input and output parts.
    - MTFP relates total inputs (opex and capital) to total outputs and can provide a measure of overall network efficiency. It allows total productivity levels to be compared between networks.[59] It is applied to combined time-series, cross-section (or 'panel') data.
    - MPFP is a partial efficiency measure, which uses the same output specification as MTFP but separately examines the productivity of opex and capital inputs against total output.
2. **Econometric opex models.** These model the relationship between opex (as the input) and outputs, and so measure opex efficiency. The report presents two types of econometric opex models — LSE and SFA – and uses two types of functional form for each model – Cobb Douglas and translog.
3. **PPIs.** These techniques, also partial efficiency measures, relate one input to one output (contrasting with the above techniques that relate one or all inputs to total outputs). PPIs measure the average amount of an input (such as total cost or opex category) used to produce one unit of a given output (such as total customer numbers, megawatts of maximum electricity demand or kilometres of circuit length).

There are a number of important differences across the various models. In particular:

- Operating environment factors**.** The productivity index and econometric models include allowance for the key network density differences (e.g. customer density, maximum demand density). The econometric models also account for the degree of network undergrounding.
- Output variables. The econometric models include three outputs whereas the productivity index models includes five outputs (the three outputs in the

[59] There may be minor differences in MTFP and TFP growth rates for a particular firm due to differences in the properties of the indices.

econometric models plus energy delivered and reliability). The PPIs only include one output variable per indicator.

- Estimation technique:
    - The econometric models estimate two types of cost functions. The LSE opex cost function models use least squares estimation, whereas the SFA models use frontier estimation methods. The econometric models also estimates two different types of functional form — Cobb-Douglas and translog.
    - The opex MPFP model uses a non–parametric method.
- Data. The productivity index models and the PPIs use Australian data only, whereas the econometric models use Australian data and overseas data.

Notwithstanding the differences in the features and data requirements of each model, the opex efficiency scores of each model are broadly consistent with each other (although there is some variation in individual DNSP results and the relative rankings of DNSPs). The similarity between the results from the opex MPFP model and the econometric models is particularly noteworthy, given the very different approaches. This reinforces the confidence in the results from each model.[60]

Economic Insights' 2019 report provides more detail on the econometric methodology and modelling results. The Economic Insights November 2014 report referenced in Appendix 6 also provide more information about each model, and the rationale supporting the choice of input and output specifications used in this report.

B.2 Benchmarking data

This appendix contains further information about the benchmarking data used in the benchmarking techniques (specifically the outputs and inputs data).

Inputs include a mix of the infrastructure assets needed to distribute electricity to end users and the network opex to run and maintain the network. DNSPs primarily exist to provide customers with access to a safe and reliable supply of electricity and a range of outputs have been selected to reflect this goal.[61]

60 Economic Insights, *Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs*, November 2014, pp. 46–47.

61 The November 2014 Economic Insights referenced in Appendix 6 details the input and output weights applied to constructing the productivity index numbers. The November 2018 Economic Insights report contains further information on the updated output weights.

Categories of inputs and outputs used in benchmarking

Inputs:

- Capital stock (assets) is the physical assets DNSPs invest in to replace, upgrade or expand their networks. Electricity distribution assets provide useful service over a number of years or even several decades. We split capital into:
  - overhead distribution (below 33kV) lines
  - overhead sub-transmission (33kV and above) lines
  - underground distribution cables (below 33kV)
  - underground sub-transmission (33kV and above) cables
  - transformers and other capital
- Operating expenditure (opex) is expenditure needed to operate and maintain a network. Opex is an immediate input into providing services and is fully consumed within the reporting year.

Outputs:

- Customer numbers. The number of customers is a significant driver of the services a DNSP must provide. We measure the number of customers as the number of active connections on a network, represented by each energised national metering identifier.
- Circuit length. This reflects the distances over which DNSPs deliver electricity to their customers.
- Ratcheted maximum demand (RMD). DNSPs endeavour to meet the demand for energy from their customers when that demand is greatest. This means that they must build and operate their networks with sufficient capacity to meet the expected peak demand for electricity.[62]
- Energy delivered (MWh). Energy throughput is a measure of the amount of electricity that DNSPs deliver to their customers.
- Reliability (Minutes off-supply). Reliability measures the extent to which networks are able to maintain a continuous supply of electricity. Minutes off-supply enters as a negative output and is weighted by the value of consumer reliability.

The November 2014 Economic Insights referenced in Appendix 6 details the rationale for the choice of these inputs and outputs.

The econometric modelling differs from the other benchmarking techniques in that it uses Australian and overseas data. The lack of variability in the Australian DNSP data means that sufficiently robust results cannot be produced with Australian DNSP data alone using econometric methods. Economic Insights incorporated comparable data

[62] The economic benchmarking techniques use 'ratcheted' maximum demand as an output rather than observed maximum demand. Ratcheted maximum demand is the highest value of peak demand observed in the time period up to the year in question for each DNSP. It recognises capacity that has been used to satisfy demand and gives the DNSP credit for this capacity in subsequent years, even though annual maximum demand may be lower in subsequent years.

from electricity DNSPs in Ontario and New Zealand to increase the size of the dataset and enable robust estimation of the opex cost function models. Sensitivity analysis of the econometric benchmarking results (using cost functions generated with and without the overseas data) indicates that the addition of the overseas data improves the robustness of the econometric model (by allowing better estimation of the opex cost function parameters) without distorting the estimation of individual DNSP's efficiency results. Appendix 6 contains references to further reading on how Economic Insights incorporated overseas data into the econometric models and the sensitivity analyses.

To prepare this year's report, each DNSP provided the AER with input and output data from their businesses as defined in standardised economic benchmarking regulatory information notices (EB RINs). The EB RINs require all DNSPs to provide a consistent set of data, which is verified by each DNSP's chief executive officer and independently audited. We separately tested and validated the data provided by the networks. Economic Insights prepared the benchmarking results using the set of agreed benchmarking techniques.[63] We provided the DNSPs with a draft version of the benchmarking report to allow each network to provide feedback on the results before we publically release the final benchmarking report.[64]

The complete data sets for all inputs and outputs from 2006 to 2018, along with the Basis of Preparation provided by each DNSP, are published on our website.[65]

B.2.1 Outputs

The techniques in the report measure output using some or all of customer numbers, circuit line length, maximum demand, energy throughput and reliability.

Customer numbers

The primary function of a distribution network is providing its customers with access to electricity. Regardless of how much electricity a customer consumes, infrastructure is required to connect every customer to the network. The number of customers, therefore, reflects a significant driver of the services a DNSP provides.[66]

Figure B.1 shows the average customer numbers of each DNSP over the five-year period from 2014 to 2018.

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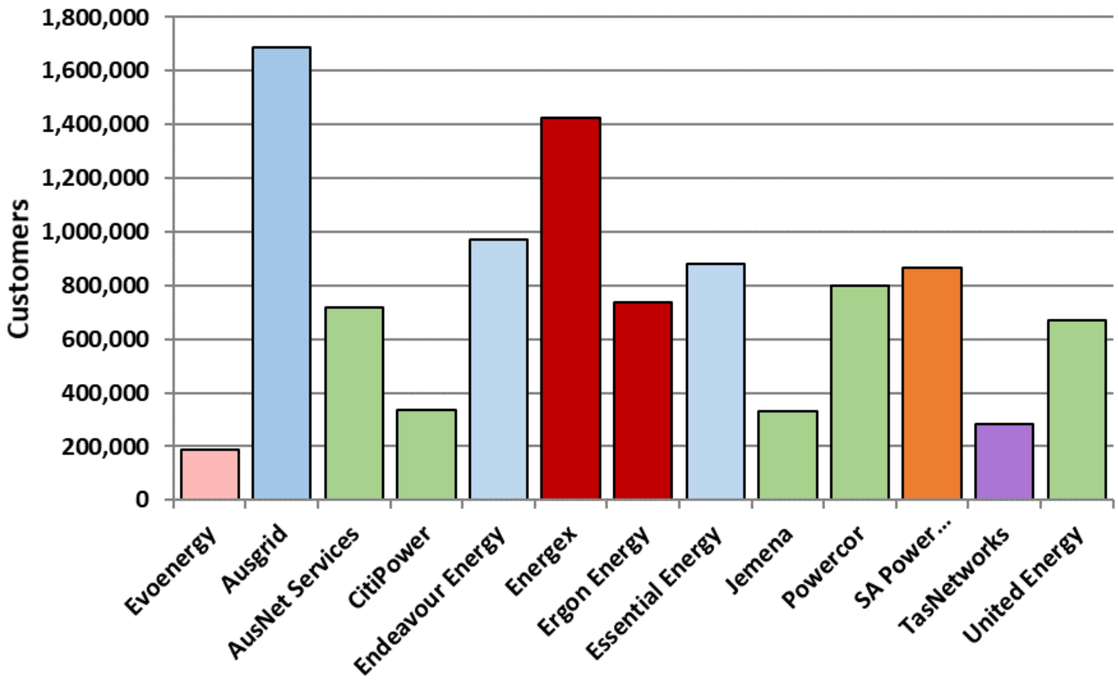
63 The Economic Insights report outlining the results for this year's report and the data and benchmarking techniques used can be found on the AER's benchmarking website.

64 NER, 8.7.4 (c) (1) (2).

65 This dataset is available at: https://www.aer.gov.au/node/483.

66 We measure the number of customers as the number of active connections on a network, represented by each energised national metering identifier.

Figure B.1 Five year average customer numbers by DNSP (2014–18)



Source: Economic Benchmarking RIN

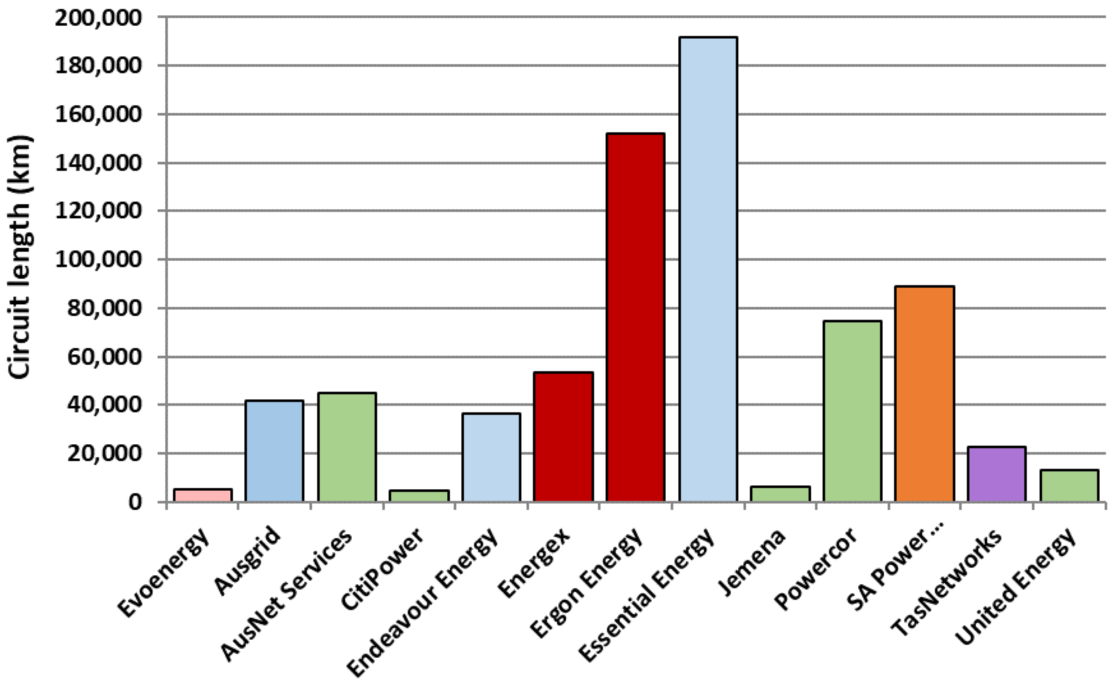
Circuit line length

Line length reflects the distances over which DNSPs deliver electricity to their customers. To provide their customers with access to electricity, DNSPs must transport electricity from the transmission network to their customers' premises. DNSPs will typically operate networks that transport electricity over thousands of kilometres.

In addition to measuring network size, circuit length also approximates the line length dimension of system capacity. System capacity represents the amount of network assets a DNSP must install and maintain to supply consumers with the quantity of electricity demanded at the places where they are located.

Figure B.2 shows each DNSP's circuit length, on average, over the five years from 2014 to 2018.

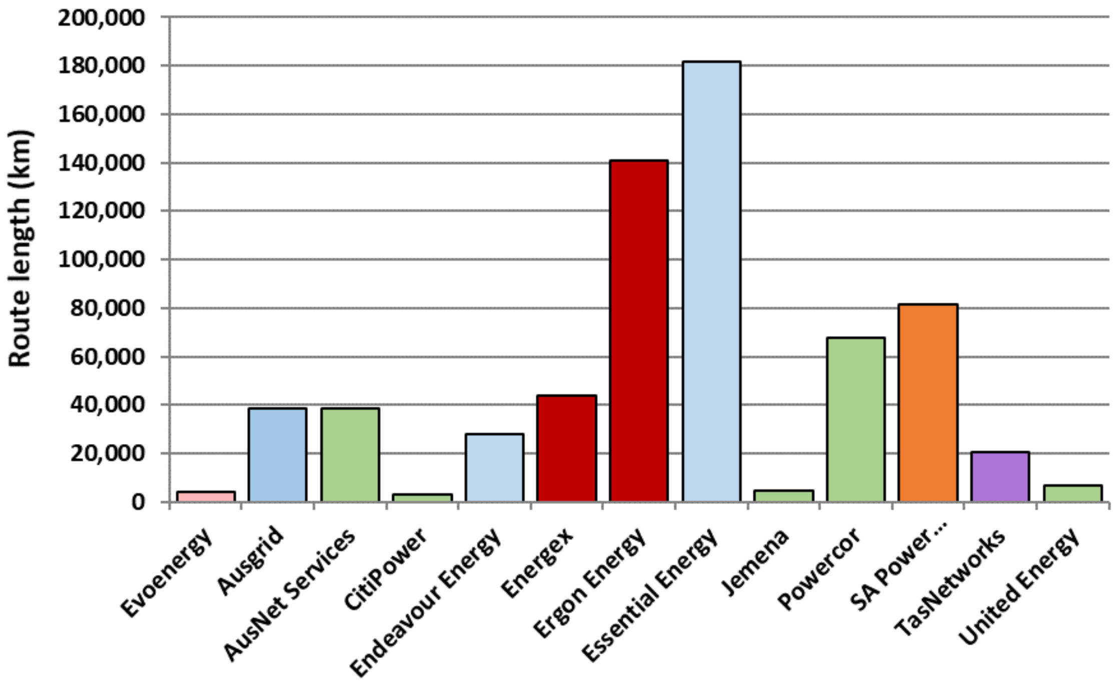
Figure B.2 Five year average circuit line length by DNSP (2014–18)



Source: Economic Benchmarking RIN

For PPI metrics, we use route length to calculate customer density because it is a measure of a DNSP's physical network footprint (because it does not count multiple circuits on the same route). Figure B.3 demonstrates that, for all DNSPs, route length is shorter than circuit length but there is no change in DNSP rankings.

Figure B.3 Five year average route line length by DNSP (2014–18)



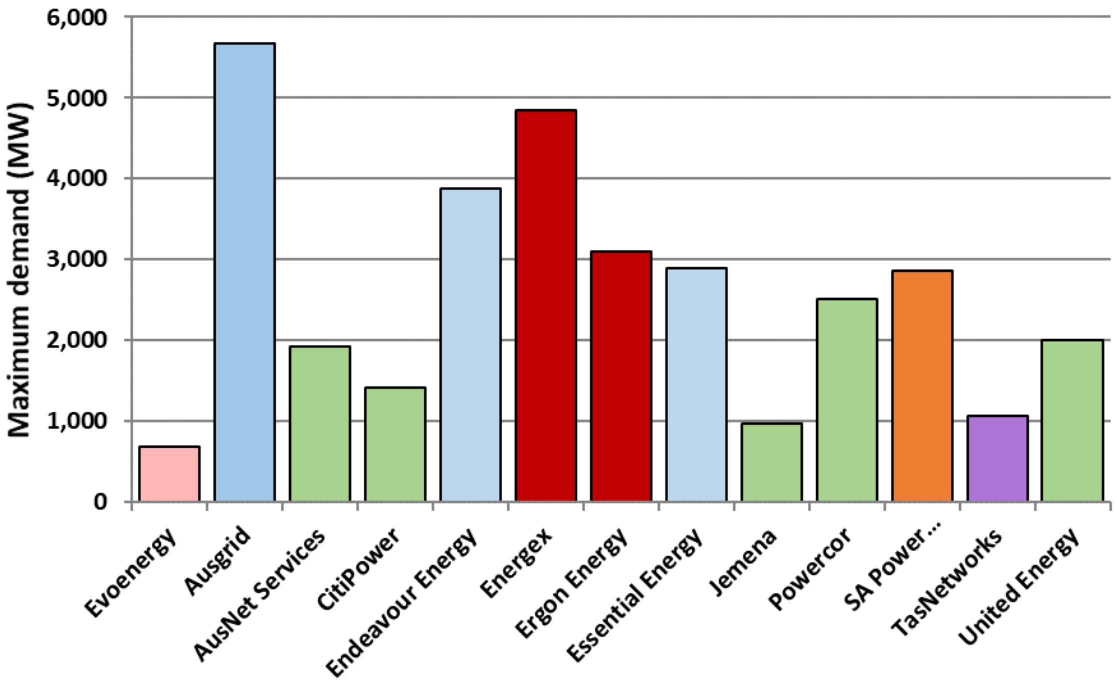
Source: Economic Benchmarking RIN

Maximum demand

DNSPs are required to meet and manage the demand of their customers. This means that they must build and operate their networks with sufficient capacity to meet the expected peak demand for electricity. Maximum demand is a measure of the overall peak in demand experienced by the network. The maximum demand measure we use is non-coincident summated raw system annual maximum demand, at the transmission connection point, measured in mega watts (MW).

Figure B.4 shows each DNSP’s maximum demand, on average, over the five years from 2014 to 2018.

Figure B.4 Five year average maximum demand by DNSP (2014–18)



Source: Economic Benchmarking RIN

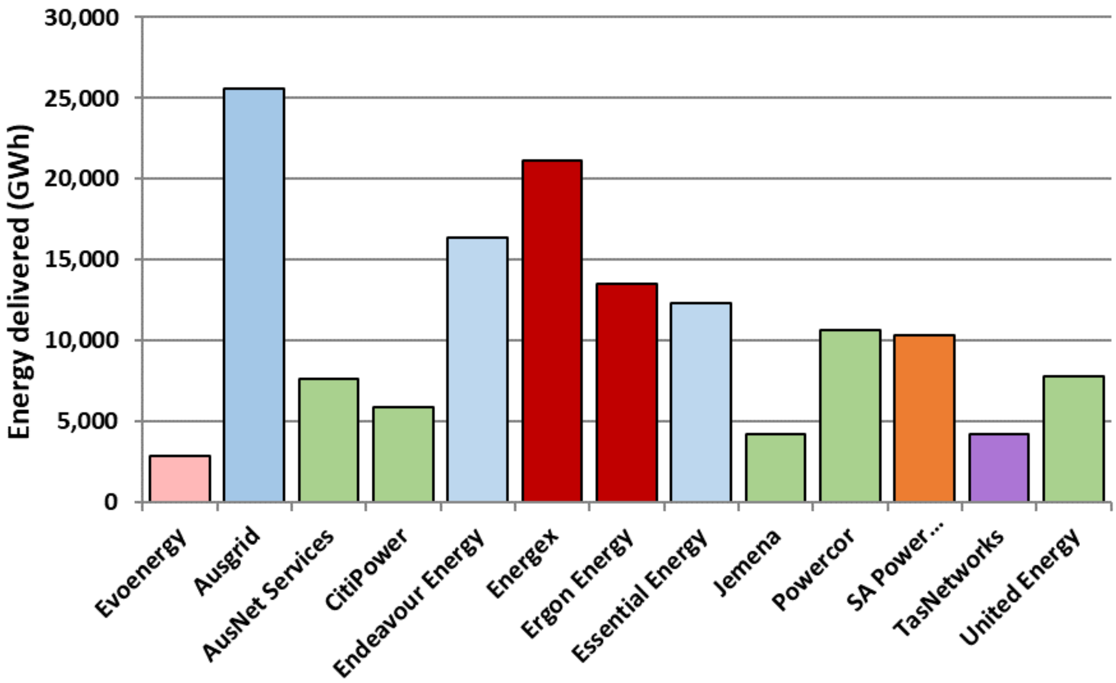
Note that the economic benchmarking techniques use 'ratcheted' maximum demand as an output rather than observed maximum demand. Ratcheted maximum demand is the highest value of peak demand observed in the time period up to the year in question for each DNSP. It thus recognises capacity that has actually been used to satisfy demand and gives the DNSP credit for this capacity in subsequent years, even though annual peak demand may be lower in subsequent years.

Energy delivered

Energy delivered is a measure of the amount of electricity that DNSPs deliver to their customers. While energy throughput is not considered a significant driver of costs (distribution networks are typically engineered to manage maximum demand rather than throughput) energy throughput reflects a service provided directly to customers. Energy delivered is measured in Gigawatt hours (GWh).

Figure B.5 shows each DNSP’s energy delivered, on average, over the five years from 2014 to 2018.

Figure B.5 Five year average energy delivered by DNSP (2014–18)

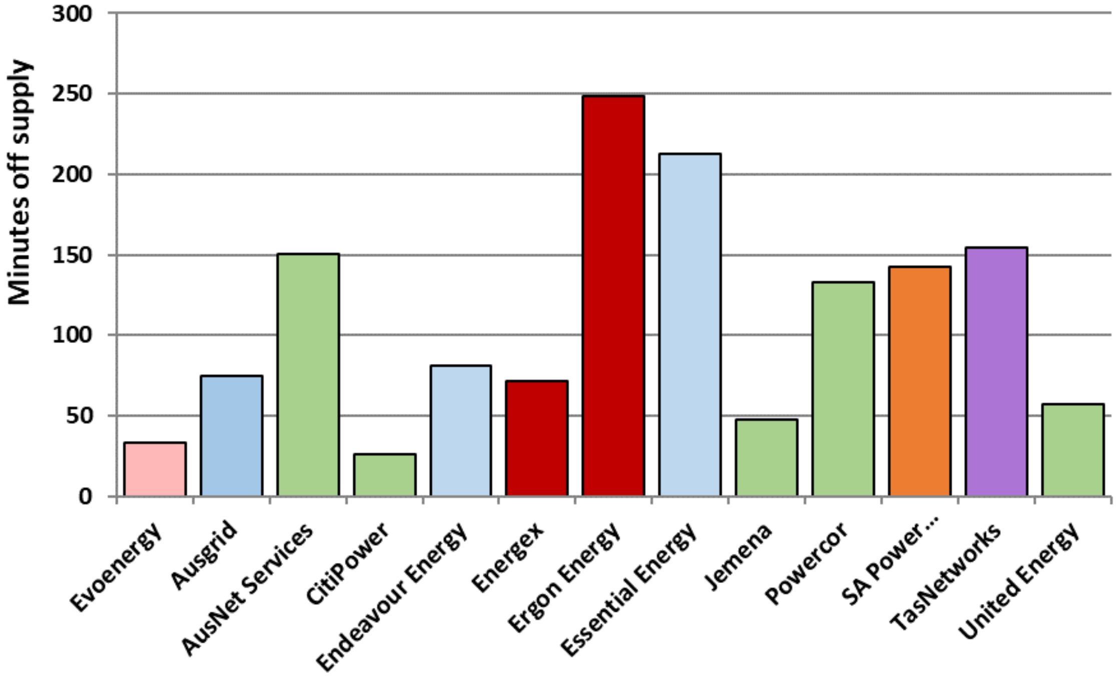


Source: Economic Benchmarking RIN

Reliability

Another dimension of the outputs of DNSPs is the reliability of their electricity supply. This is commonly measured as the average number of minutes off supply per customer (per annum) or the average number of interruptions per customer. Figure B.6 presents the average number of minutes off supply per customer, excluding the effects of major events, planned outages and transmission outages.

Figure B.6 Average minutes off supply per customer (2013–2017)

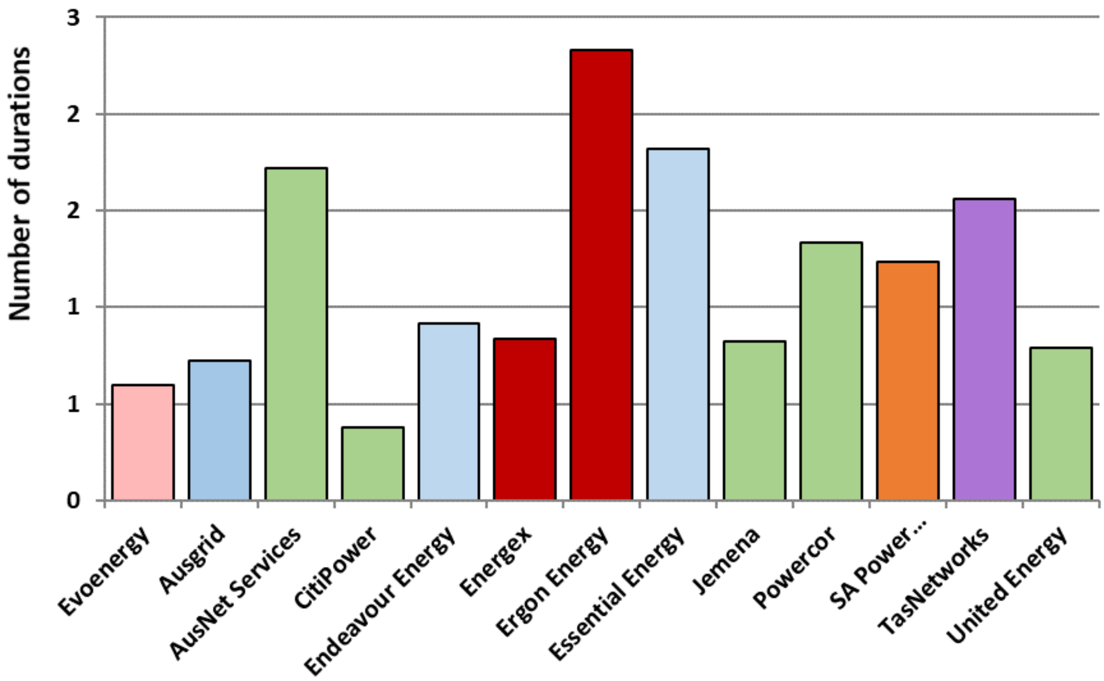


Source: Economic Benchmarking RIN.

Figure B.7 presents the average number of interruptions to supply per customer, excluding the effects of major events, planned outages and transmission outages. There are other measurements of reliability but the frequency and duration of interruptions to supply per customer are the Institute of Electrical and Electronics Engineers (IEEE) standard measures for DNSPs.

For productivity measurement purposes we use the number of customer minutes off–supply aggregated across all customers as the reliability output.

Figure B.7 Average number of interruptions per customer (2013–2017)



Source: Economic Benchmarking RIN.

B.2.2 Inputs

The inputs used in this report are assets and opex. DNSPs use a mix of assets and opex to deliver services. Electricity assets can provide useful service over several decades. However, benchmarking studies typically focus on a shorter period of time.

For our MTFP and TFP analyses we use physical measures of capital inputs. Using physical values for capital inputs has the advantage of best reflecting the physical depreciation profile of DNSP assets. Our MTFP and TFP analyses use five physical measures of capital inputs: the capacity of transformers, overhead lines of 33kV and above, overhead lines below 33kV, underground cables of 33kV and above, and underground cables below 33kV. The MTFP and TFP analyses also use constant dollar opex as an input. The November 2014 Economic Insights report referred to in Appendix 6 provides further detail on the capital inputs for MTFP and TFP.

For the purpose of PPI analysis we use the real value of the regulatory asset base as the proxy for assets as the starting point in deriving the real cost of using those assets. To be consistent with Economic Insights' MTFP and TFP analyses, and in response to a submission by Ausgrid,[67] we have adjusted the PPI analysis to remove assets associated with the first-stage of the two-step transformation at the zone substation

[67] Ausgrid, *Submission on the DNSP annual benchmarking report 2016*, 14 October 2016, p. 3.

level for those DNSPs with more complex system structures. This allows better like-with-like comparisons to be made across DNSPs.

Asset cost is the sum of annual depreciation and return on investment.[68] This measure has the advantage of reflecting the total cost of assets for which customers are billed on an annual basis, using the average return on capital over the period. This accounts for variations in the return on capital across DNSPs and over time.

Table B.2 presents measures of the cost of network inputs relevant to opex and assets for all DNSPs. We have presented the average annual network costs over five years in this table to moderate the effect of any one-off fluctuations in cost.

Table B.2 Average annual input costs for 2014–18 ($m, 2018)

	Opex	Asset cost
Evoenerg (ACT)	61.1	97.0
Ausgrid (AGD)	574.4	1,116.7
AusNet Services (AND)	205.7	320.5
CitiPower (CIT)	54.3	148.0
Endeavour Energy (END)	281.5	427.1
Energex (ENX)	374.6	655.2
Ergon Energy (ERG)	360.6	649.6
Essential Energy (ESS)	365.8	629.5
Jemena (JEN)	79.5	115.0
Powercor (PCR)	179.6	278.3
SA Power Networks (SAP)	246.8	424.1
TasNetworks (TND)	80.2	146.3
United Energy (UED)	127.0	216.0

Source: Economic Benchmarking RIN, AER analysis

68 To calculate asset costs relevant to PPIs, MTFP, TFP, Capital MPFP and Capital PFP, where possible we have applied annual weighted average cost of capital values calculated in accordance with the AER's approach to setting rate of return in the most recent determination. These include a market risk premium of 6.5 per cent, and a risk free rate based on the yield of ten year CGS (noting we use a 365 day averaging period for each year in the benchmarking report). For this benchmarking report, we choose to continue to use the approach in previous benchmarking reports that use the Bloomberg BBB fair value curve (365 day averaging period) to calculate the debt risk premium. The AER's present approach averages ten year maturity BBB yields from the RBA and Bloomberg (appropriately extrapolated out to ten years where necessary). However, historical data going back to 2006 is not available for the RBA curve. Given this, we have continued to rely solely on estimates based on the Bloomberg fair value curve data. Where relevant, the tax component uses gamma of 0.4.