Annual Benchmarking Report

Electricity distribution network service providers

November 2022

AUSTRALIAN ENERGY REGULATOR

Inquiries about this publication should be addressed to:

Australian Energy Regulator
GPO Box 520
Melbourne VIC 3001
Tel: 1300 585 165

Amendment record

Version	Date	Pages
Version 1	30 November 2022	86 pages

Executive Summary

We report annually on the productivity growth and efficiency of distribution network service providers (DNSPs), individually and as an industry as a whole, in the National Electricity Market (NEM). These service providers operate transformers, poles and wires to deliver electricity from the transmission network to residential and business customers. Distribution network costs typically account for around one-third of what customers pay for their electricity in most jurisdictions (with the remainder covering generation costs, transmission and retailing, as well as environmental policies).

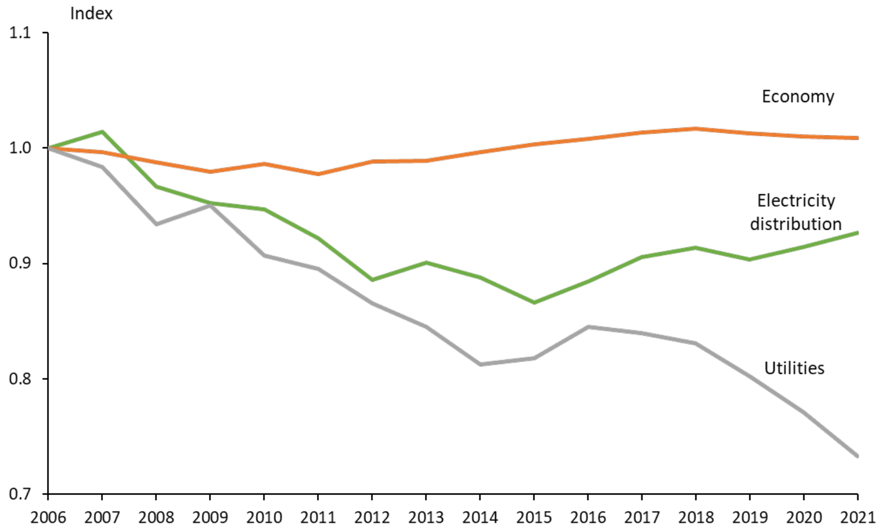
We use economic benchmarking to measure how productively efficient these networks are at delivering electricity distribution services over time and compared with their peers. Where distribution networks become more efficient, customers should benefit through downward pressure on network charges and customer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

In preparing this benchmarking report, we have taken into account stakeholder views received through our consultation process.

Distribution network industry productivity has increased in 2021, in line with the general trend since 2015

Electricity distribution productivity, as measured by multilateral total factor productivity (MTFP) time series analysis, increased by 1.5% over 2021 (see Figure 1). This is consistent with the recent upward trend, which was interrupted by a 1.1% decline in 2019. The increase in distribution network productivity in 2021 is primarily due to increases in reliability by most DNSPs. This increase in productivity is particularly noteworthy against the backdrop of reductions in productivity in the broader utilities sector (-5.0%) and the Australian market economy (-0.2%) over the same period. The annual electricity distribution productivity growth rate has been higher over the past five years (2017 to 2021, 0.6%) compared to the five years prior to that (2012 to 2016, 0.0%).

Figure 1 Electricity distribution, utility sector, and economy productivity, 2006–2021



Source: Quantonomics; AER analysis.

Changes in DNSP productivity over 2021

Over 2021, nine of the 13 DNSPs improved their productivity as measured by MTFP comparative analysis.

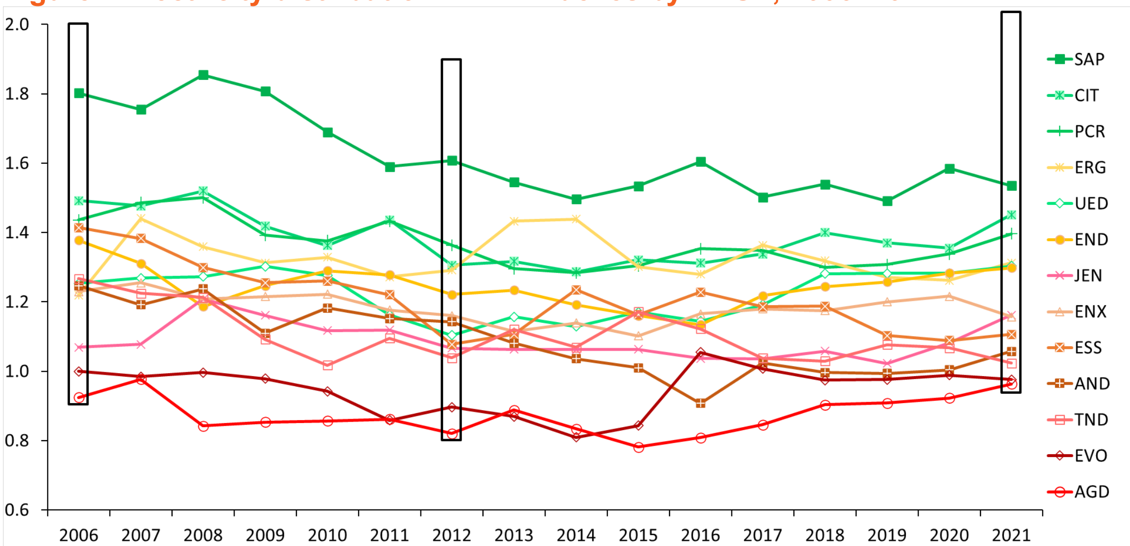
Jemena, CitiPower, AusNet Services and Powercor increased their productivity the most, by 14.4%, 13.7%, 10.3% and 8.5% respectively. Ausgrid, Ergon Energy and United Energy also had strong productivity increases of between 3 and 5%. Essential Energy and Endeavour Energy increased their productivity by between 1 and 2%. Increased reliability was generally the main source of these productivity improvements. Increased operating expenditure (opex) productivity, reflecting lower opex, was also a significant source of productivity improvements for Jemena, CitiPower and Ergon Energy.

Over the same period, four DNSPs became less productive. Energex had the largest decrease in productivity of 5.0%. TasNetworks and SA Power Networks had a reduction in productivity of a slightly less magnitude: 4.2% and 3.2% respectively. Evoenergy experienced a small decrease in productivity of 1.3%. Decreased opex productivity was generally the main source of the lower productivity of these DNSPs.

Figure 2 highlights the variability in productivity observed for individual DNSPs from year-to-year and emphasises the importance of considering the changes in productivity observed in 2021 in the context of longer-term trends.

MTFP accounts for some, but not all possible differences in the environments in which DNSPs operate. We consider the four outputs measured in the MTFP benchmarking are material drivers of opex and capital inputs and allow for the differences in customer, energy and demand density across DNSPs. That said, not all operating differences are incorporated and this is important to note when considering the relative efficiency and rankings between DNSPs, as beyond the above factors some DNSPs may operate in more or less favourable environments than their peers, and thus may appear more or less efficient than they otherwise would.

Figure 2 Electricity distribution MTFP indexes by DNSP, 2006–2021



Source: Quantonomics, AER analysis.

DNSP productivity levels have converged over time

Since 2006 there has been some convergence in the productivity levels of DNSPs as measured by MTFP. This can be seen from the three equal-sized black columns placed in 2006, 2012 and 2021 in Figure 2. This reflects a number of factors, including:

- Those DNSPs which have been the least productive over time have been improving their performance since 2012. In particular, Ausgrid and Evoenergy have increased their overall productivity, largely as a result of improvements in opex efficiency.
- Several middle-ranked DNSPs have also improved their relative MTFP performance to be closer to the top-ranked DNSPs. In recent years this includes United Energy, Jemena and Endeavour Energy, again reflecting improved opex efficiency.
- Further, while Powercor, SA Power Networks and CitiPower have consistently been the most productive DNSPs in the NEM, they have experienced a gradual overall decline in productivity for most of the period since 2006, with some improvement for CitiPower and Powercor in 2021. The productivity of SA Power Networks is now much closer to the DNSPs that are middle-ranked. Their declines in MTFP are primarily due to higher opex, including as a result of new regulatory obligations among other factors. However, since 2014 there has been an improvement in opex productivity for these three DNSPs.

Updates in this year's report

We operate an ongoing transparent program to review and incrementally refine elements of the benchmarking methodology and data. In this year's report there have been no changes to the methodology we use, and beyond incorporating financial year data for the Victorian DNSPs, minimal updates to the data other than incorporating that for the year being updated (2021).

We are currently undertaking development work relating to:

- The impact of differences in capitalisation on the benchmarking results and potential options for addressing these differences where material – we released on 29 October 2022 a draft guidance note on how we propose this will be addressed and are currently seeking submissions to inform a final guidance note.
- Examining the impact of export services on benchmarking and our measurement of productivity, including whether the model specifications used in the Productivity Index Number (PIN, the technique used for MTFP analysis) and opex econometric benchmarking remain appropriate – we released a paper to commence an external consultation process in August 2022 and a draft report will be released in November 2022
- Improving, where possible, the performance of the opex econometric cost function models and in particular the reliability performance of the Translog models.

We are also proposing to undertake further development work in the future. This includes:

- Independently reviewing the non-reliability output weights used in the PIN benchmarking method that we will progress in 2023–24
- Improving and updating the quantification of operating environment factors, particularly in relation to vegetation management.

Contents

1 Our benchmarking report

The National Electricity Rules (NER) require the AER to publish benchmarking results in an annual benchmarking report.[1] This is our ninth benchmarking report for DNSPs. This report is informed by expert advice provided by Quantonomics.[2]

National Electricity 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 using input to produce 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. We examine the change in productivity in 2021, compared to 2020, and trends in productivity over the full period of our benchmarking analysis (2006–2021) as well as shorter time periods.[3]

Our benchmarking report presents results from three types of 'top-down' benchmarking techniques.[4] Each technique uses a different method for relating outputs to inputs to measure and compare DNSP efficiency:

- **Productivity index numbers (PIN)**. These techniques use a mathematical index to measure the relationship between multiple outputs and inputs, enabling comparisons of measured productivity over time and between networks. We use

[1] NER, cll 6.27(a) and 6.27(c).

[2] The supplementary Quantonomics 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.

[3] Throughout this report, we refer to *regulatory years.* For non-Victorian DNSPs, this is financial years (for example, 2021 refers to the 2020–21 financial year). For Victorian DNSPs, this is calendar years up to 2020, and financial years for 2021 (for example, 2020 refers to the 2020 calendar year, but 2021 refers to the 2020–21 financial year).

[4] 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.

these PIN techniques for our MTFP-based analysis.

- **Econometric operating expenditure (opex) cost function models**. These estimate opex (as the input) as a function of outputs and some other operating environment factors to measure opex efficiency.
- **Partial performance indicators (PPIs)**. These simple ratio methods relate one input to one output.

Being top-down measures, each benchmarking technique cannot readily incorporate every possible exogenous factor that may affect a DNSP's performance. 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 (OEFs) that may not have been accounted for in the benchmarking modelling.

The PIN techniques we use in this report to measure the productivity performance of individual DNSPs in the NEM are multilateral total factor productivity (MTFP) and multilateral partial factor productivity (MPFP). The indexes allow comparisons of absolute levels and growth rates of the measured productivity. MTFP examines the overall productivity of using all inputs in producing all outputs. Opex or capital MPFP examines the productivity of either opex or capital in isolation. The econometric opex cost function models also examine the productivity of opex in isolation.

As discussed in Section 2, the benchmarking report provides important information to stakeholders on the relative efficiency of the electricity networks they use, own and invest in. We make use of benchmarking results in our revenue determinations, where we must ensure that DNSP revenues reflect the efficient cost of provision. We use our top-down benchmarking tools, and other assessment techniques, to test whether DNSPs have been operating efficiently.

This is particularly relevant for examining the opex costs revealed in the most recent years prior to DNSPs' revenue determination processes. Where a DNSP is responsive to the financial incentives under the regulatory framework to make cost reductions, and retain the gains for a period (5 years after making the gain), actual opex should provide a good estimate of the efficient costs required to operate in a safe and reliable manner and meet relevant regulatory obligations. The benchmarking analysis allows us to test this assumption. The results from the opex econometric cost function models are central in this assessment (as presented in Section 5). Importantly, this needs to include consideration and quantification of material OEFs that are not directly incorporated into the economic benchmarking models (as presented in Section 7). We use the other benchmarking approaches to qualitatively cross-check and confirm the results from the econometric opex cost function models.

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 can deliver more outputs for a given level of inputs, this reflects an increase in its productivity. Multilateral TFP 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 driver of the services a DNSP must provide (about 19% weight).
- Circuit line length. Line length reflects the distances over which DNSPs deliver electricity to their customers (about 39% weight).
- Ratcheted maximum demand (RMD). 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 (about 34% weight).
- Energy delivered. Energy throughput is a measure of the amount of electricity that DNSPs deliver to their customers (about 9% weight).
- Reliability (Minutes off-supply). Reliability measures the extent to which networks can maintain a continuous supply of electricity (customer minutes off-supply enters as a negative output and is weighted by the value of customer reliability).

The November 2014 Economic Insights report referenced in Appendix A details the rationale for the choice of these inputs and outputs. Economic Insights updated the weights applied to each output in November 2018 and again in November 2020, which are used by Quantonomics in producing this year's results. We also discuss the outputs and inputs used further in Appendix B.

In order to assist with the ability to understand these inputs and outputs, as well as how they are used in the benchmarking analysis, we have provided some further detail in relation to these variables.

In terms of the inputs being used in the benchmarking analysis:

- the opex input reflects the costs associated with the labour, materials and services that are purchased and consumed in a given year. These costs are deflated by a price index of these inputs to establish a quantity measure of opex
- the capital inputs, such as transformers and overhead lines and underground cables, measures the physical quantity of the assets (e.g., capacity*kilometres of

overhead lines or capacity of transformers). This is used as a proxy for annual capital service flow as we assume relatively constant flow of services over the life of an asset, and thus that the annual flow is proportionate to capital stock.

At the start of the benchmarking program there was general agreement that outputs should be included on a functional rather than billed basis, reflecting that under the building block model approach to regulation there is not typically a direct link between the revenue requirement and how a DNSP structures its prices.[5] It was also noted that the outputs included should reflect services provided directly to customers, rather than activities undertaken by the DNSP which do not directly affect what the customer receives. In terms of the outputs being used in the benchmarking analysis and the services provided:

- Customer numbers provides a measure of the services and benefits ultimately provided to end users of the distribution networks regardless of how much they consume. It is an indicator of network complexity and connectivity.
- Circuit length reflects the geographic distribution of customers that DNSPs need to construct networks to connect in order to deliver energy. In combination with customer numbers, these variables will reflect the impact of different levels of end user density within an area on distribution costs.
- Ratcheted maximum demand reflects the (non-coincident) maximum demand from customers on the distribution network. The highest system peak demand observed in the period (up to the year in question) is used to give credit for the provision of capacity to meet higher maximum demand in the earlier years.
- Energy throughput reflects the energy delivered to customers.
- Reliability (Customer Minutes Off-Supply) reflects the extent to which networks are able to maintain a continuous supply of electricity.

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. Our website also contains this year's benchmarking report from our consultant Quantonomics and the benchmarking data and results.

1.1 Updates in this benchmarking report

This benchmarking report uses the same benchmarking methodology as set out in previous reports, including the minor updates in the 2021 report relating to the opex price index, the reliability index and the annual user cost of capital.[6]

[5] The AER generally sets the revenue requirement and, separately, prices are set in order to recover this revenue requirement.

[6] AER, *Annual Benchmarking Report, Electricity distribution network service providers*, November 2021, pp. 3–4.

There is a key change in the data collected for the 2021 regulatory year as the Victorian DNSPs have submitted annual economic benchmarking data on a financial year rather than calendar year basis for the first time, reflecting new reporting requirements. This has resulted in a six-month data overlap for the Victorian DNSPs between the 2020 calendar year and the 2021 financial year (i.e. July to December 2020). For the purposes of economic benchmarking we considered two options to address this change in reporting. We concluded that our preferred approach was to use both calendar year data (2006 to 2020) and financial year data (2021) for the Victorian DNSPs, instead of using historical recast financial year data for the Victorian DNSPs. From our analysis we did not consider the six-month data overlap in using the 2020 calendar year and 2021 financial year data exerted undue influence over the benchmarking modelling. This also took account of the data availability and quality issues associated with using historical recast financial year data.

This approach was supported by Ausgrid, Essential Energy, Jemena and SA Power Networks in submissions on the preliminary benchmarking results from Quantonomics.[7] Further, Jemena indicated that it would be an onerous exercise to provide historical financial year data, and Essential Energy considered recasting or estimating historical financial year data to be problematic.[8] This approach was not opposed by any of the DNSPs.

In Sections 3 and 4 of this report we discuss electricity distribution productivity growth rates at the industry, state and individual DNSP level. For the purpose of making comparisons between Victorian and non-Victorian DNSPs at the state and individual DNSP level, the growth rates for Victorian DNSPs between the 2020 calendar year and the 2021 financial year, which only represent a six-month period, are doubled to measure the annualised growth rate. We consider this to be the most appropriate method for the purpose of making comparisons between Victorian and non-Victorian DNSPs in this report; however, as raised by Ausgrid, we acknowledge that there are other possible methods for calculating an annualised growth rate for the Victorian DNSPs, such as dividing the growth rate between the 2019 calendar year and 2021 financial year by 1.5.[9] For the purpose of calculating industry growth rates, the growth rates are again annualised, this time using the weighted average period length between the 2020 and 2021 regulatory years across DNSPs with weighting based on their relative size in terms

[7] Ausgrid, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results*, received on 25 August 2022; Essential Energy, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results*, received on 25 August 2022; Jemena, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 26 August 2022; SA Power Networks, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results*, received on 29 August 2022.

[8] Jemena, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 26 August 2022; Essential Energy, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results*, received on 25 August 2022.

[9] Ausgrid, Submission to 2022 AER draft distribution benchmarking report, 26 October 2022, p. 2.

of total output.[10]

This report also includes a number of minor updates in the benchmarking data. These updates reflect minor refinements to the historical Australian DNSP dataset, consistent with previous years' benchmarking reports, and are set out in the consolidated benchmarking dataset published on our website.[11]

1.2 Benchmarking development program

We seek to progressively 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.

This year we have advanced our thinking around the implications of capitalisation differences on the benchmarking results. In particular, we released a draft guidance note in relation to our views on how the impact of capitalisation differences on the benchmarking results can best be addressed and are currently seeking stakeholder feedback. We expect to finalise the guidance note in 2023 and will incorporate the proposed approach to address capitalisation issues into future annual benchmarking reports as appropriate.

In addition, this year we have progressed our consideration of the impact of export services on benchmarking and our measurement of productivity, including whether the model specifications used in the PIN and opex econometric benchmarking remain appropriate. We released a paper to commence an external consultation process in August 2022 and a draft report will be released in November 2022, followed by a final report in March 2023. This process is seeking to understand the impact of export services, and its materiality, on the benchmarking results. It is proposed the outcomes of the final report will be incorporated into subsequent annual benchmarking reports as appropriate.

This year we also considered, with Quantonomics, possible options for improving the performance of the Translog econometric opex cost function models. We discuss this issue and our progress further in Section 8.1.

We also carried work to improve the models setting out the quantification of OEF adjustments, and how these are used in our opex efficiency analysis, and sought and received feedback from several DNSPs. A key focus of this feedback was in relation to calculating the vegetation management OEF. We intend to consult further with DNSPs in refining the data and methodology for calculating this and other OEFs.

[10] Total output is measured by the multilateral output index in the MTFP comparative analysis. The weights applied are 24.8% for Victorian DNSPs' six-month period and 75.2% for non-Victorian DNSPs' 12-month period.

[11] Refinements are outlined in the 'Data revisions' sheet of the consolidated benchmarking data file.

A further important piece of development work, as noted by several stakeholders, is an independent review of the non-reliability output weights. This follows the changes we made in the 2020 Annual Benchmarking Report for distribution to the non-reliability output weights used in the PIN benchmarking to correct an error identified in how these had been calculated in previous years' reports. We scoped this review and included these details in our 2021 Annual Benchmarking report. However, due to resource availability the independent review did not occur this year. It remains an important development priority and we aim to complete the review in the 2023–24 financial year.

Beyond this, in following years we will examine the choice of benchmarking comparison point when making our opex efficiency assessments. We will make other incremental improvements such as the way we measure the quantity of lines and cable inputs and considering whether GSL payments should be included in opex for benchmarking.

1.3 Consultation

In developing this report, we have undertaken consultation with external stakeholders in two stages, consistent with the approach we adopted in previous years. This involved consultation in relation to the preliminary benchmarking results and report prepared by our consultant, Quantonomics, and then further consultation in relation to a draft of this year's annual benchmarking report.[12] We sought submissions from DNSPs and customer representative groups. We also sought stakeholder feedback in relation to some OEF modelling improvements that we made.

In response to a draft of this year's report, several stakeholders made suggestions that we have reflected in this report, such as:

- Making the limitations of the MTFP and MPFP results clearer, in particular drawing attention to their inability to account for different operating environments between DNSPs[13]
- Providing further detail about the method used to the handle the transition from calendar year to financial year reporting by the Victorian DNSPs and the subsequent effect on the calculation of annualised growth rates, drawing attention to other possible methods of calculating growth rates for the Victorian DNSPs[14]

[12] Quantonomics' final report has addressed issues raised in submissions to the preliminary benchmarking results. For more details, see: Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, pp. 9–11.

[13] Evoenergy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; Energy Queensland, *Submission to 2022 AER draft distribution benchmarking report*, 25 October 2022, p. 1; Essential Energy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1.

[14] Ausgrid, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; CitiPower, Powercor and United Energy, *Submission to 2022 AER draft distribution benchmarking report*, 9 November 2022, p. 1; AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 2–3.

- Better highlighting more recent productivity trends relative to the Australian economy and utility sector by commenting on trends over the past five and ten years.[15]

There were also recurring themes about the benchmarking program and methodology across the consultation process, and with previous years, with stakeholders suggesting that:

- The AER should provide clear timeframes for completing future benchmarking development work, which should take place through standalone consultation processes rather than through individual reset determinations[16] and / or should undertake a holistic review of the benchmarking framework.[17] Our development priorities are set out in Section 8, including issues we are currently consulting on. At this stage we propose to work through these priorities prior to undertaking a holistic review.
- They were concerned about the continued problems with the Translog models, particularly given the proximity of the 2023 NSW / ACT regulatory determinations.[18] Further, that the AER should give stakeholders more time to consider the Quantonomics memorandum, circulated with the draft benchmarking report, on options to resolve monotonicity problems in the econometric models, possibly through a separate consultation process.[19] We agree with this suggestion to provide more time and are now asking for further submissions by Friday, 10 February 2023 (see Section 8).
- The report should consider sensitivities associated with using reported opex rather than 2014-CAM opex, excluding Guaranteed Service Levels (GSLs) opex and

[15] Energy Networks Australia, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2.

[16] Evoenergy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; Energy Queensland, *Submission to 2022 AER draft distribution benchmarking report*, 25 October 2022, p. 2; Essential Energy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–2; SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1.

[17] Ausgrid, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 3; AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1.

[18] Ausgrid, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results*, received on 25 August 2022.

[19] Evoenergy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; Ausgrid, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; Energy Queensland, *Submission to 2022 AER draft distribution benchmarking report*, 25 October 2022, p. 2; Essential Energy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; Energy Networks Australia, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2.

Natural Disaster pass through amounts and applying OEFs.[20] We will consider this as a part of our ongoing development work.

- The AER should prioritise addressing the impact of export services on its benchmarking.[21] As noted above, this is the subject of current and ongoing development work.

In response to the OEF modelling improvements we made (noted above and outlined in Section 7), AusNet Services, Evoenergy, Essential Energy, CitiPower, Powercor and United Energy expressed concern about the AER's proposed measurement of operating environment factors (OEF) adjustments, particularly those relating to vegetation management.[22] Evoenergy noted that the vegetation management OEF as currently calculated does not reflect the risk of bushfires and impact on vegetation management costs, but rather the impact of bushfire-related regulations imposed on Victorian networks in 2011. Further, that there have been changes to Evoenergy's vegetation management obligations in 2018 that were not currently taken into account. AusNet Services and CitiPower, Powercor and United Energy did not consider differences across jurisdictions in the division of responsibility for vegetation clearance to be a material factor. Jemena recommended that the AER update one of the key numbers used in the calculation of this factor.

AusNet Services expressed concern that some relevant OEFs, such as differences in terrain or remoteness, or in the characteristics of the customer base, have not been taken into account, and suggested that the report included sensitivity analysis for the effects of OEFs, and that the AER was becoming too reliant on OEFs to amend the benchmarking results. AusNet Services has also requested that the AER confirm that the latest taxes and levies data it provided would be used for the calculation of its taxes and levies OEF.[23] As discussed in more detail in Section 7, currently only a portion of this data is used in the OEF calculation. As noted in Section 8.1, we will review this calculation as part of our ongoing incremental improvement of the benchmarking datasets and methods.

We discuss some of these issues in Sections 7 and 8, including the work we are doing

[20] AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–4.

[21] SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–3.

[22] Evoenergy, *Email to AER – Refined benchmarking roll-forward model and OEF spreadsheets,* received on 19 August 2022; Essential Energy, *Email to AER – Refined benchmarking roll-forward model and OEF spreadsheets,* received on 21 August 2022; AusNet Services, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 26 August 2022; CitiPower, Powercor and United Energy, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 26 August 2022.

[23] AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–2.

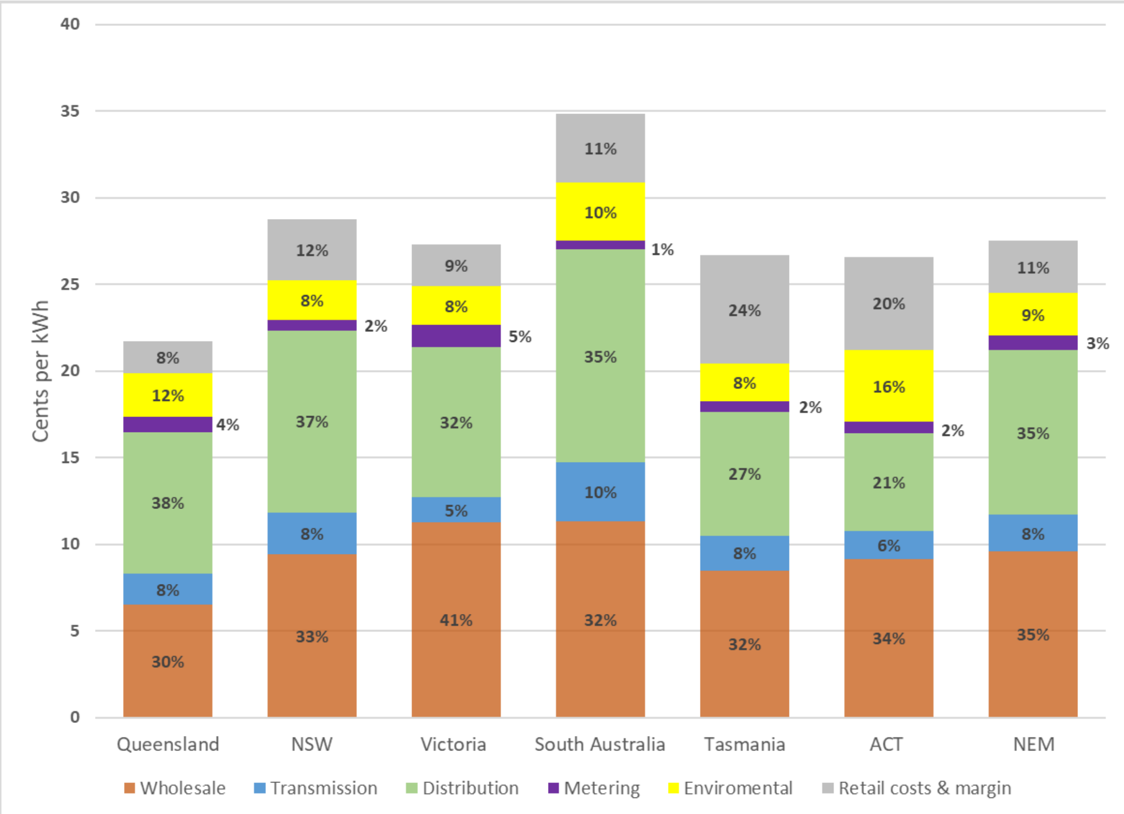
on capitalisation and noting future work in relation to other aspects.

2 Why we benchmark electricity networks

Electricity networks are 'natural monopolies' that do not face the typical commercial pressures experienced by businesses in competitive markets. They do not need to consider how and whether 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 around one-third of what consumers pay for their electricity in most jurisdictions. The remainder covers the costs of generating, transmitting and retailing electricity, as well as various regulatory programs related to environmental policies. Figure 3 provides an overview of the typical electricity retail bill.

Figure 3 Network costs as a proportion of retail electricity bills, 2021



Source: AEMC, *Residential Electricity Price Trends 2021,* Final Report, November 2021

Note: Figures may differ slightly from source due to rounding.

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 require at the start of each five-year regulatory period. The AER determines network revenues through a 'propose-respond' framework.[24] 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 capital expenditure (capex) and opex, and to publish the benchmarking results in this annual benchmarking report.[25] The AEMC added requirements to the NER in 2012:

- to reduce inefficient capex and opex 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 Network Service Provider (NSP) to help them participate in regulatory determinations and other interactions with their NSP.[26]

Economic benchmarking gives us an important source of information on the efficiency of historical network expenditures (opex and capex) 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. This can help us understand why network productivity is increasing or decreasing and where best to target our expenditure reviews.[27] As discussed in Section 1, this is particularly relevant for examining the opex costs revealed in the most recent years prior to DNSPs' revenue determination processes.

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 network costs, productivity and ultimately electricity prices. Additionally, benchmarking can

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

[25] NER, cll. 6.27(a), 6.5.6(e)(4) and 6.5.7(e)(4).

[26] AEMC, Rule Determination, *National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012*, *National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012*, 29 November 2012, p. viii.

[27] AER, *Explanatory Statement, Expenditure Forecast Assessment Guideline,* November 2013, pp. 78–79.

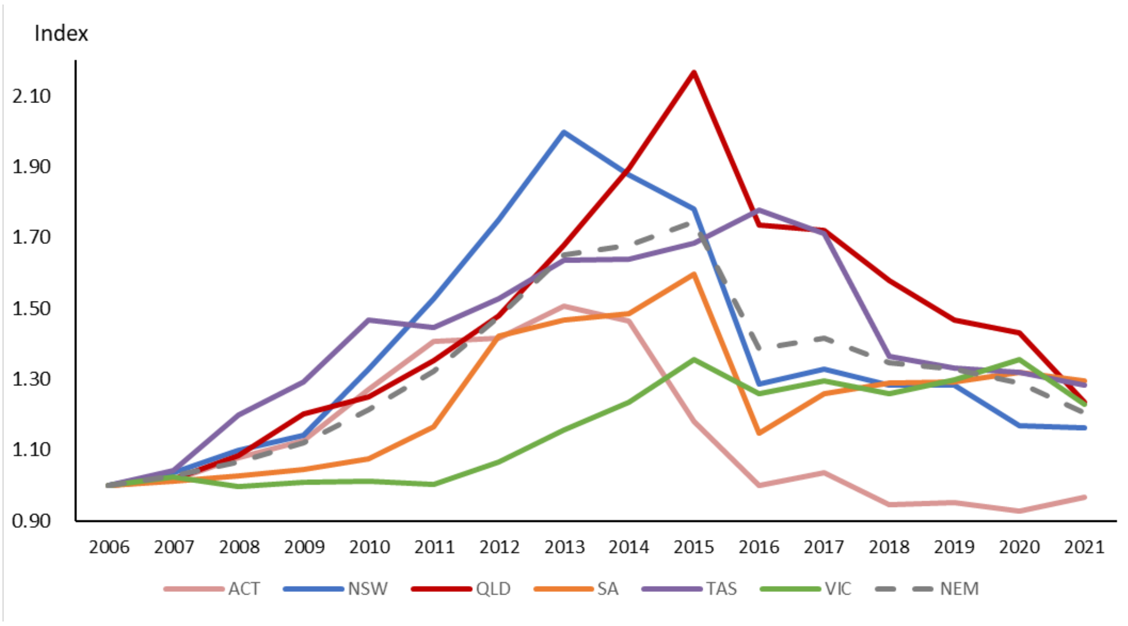
provide information that may contribute to the assessment of the success of the regulatory regime over time.

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 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 DNSPs and the retail prices faced by consumers.

Figure 4 shows that distribution network revenues (and consequently network charges paid by consumers) have fallen in all jurisdictions in the NEM since 2015. This reversed the increase seen across the NEM from 2007 to 2013, which contributed to the large increases in retail electricity prices.[28] 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 4 Indexes of distribution network revenues by jurisdiction, 2006–2021



Source: Economic Benchmarking Regulatory Information Notices (RIN); AER analysis.

[28] AER, *State of the Energy Market 2018*, p. 151.

3 The productivity of the electricity distribution industry as a whole

Key points

- Productivity in the electricity distribution industry, measured by MTFP time series analysis, increased by 1.5% in 2021. This was largely driven by improved reliability (contributing +1.9 percentage points to TFP growth), with no other input or output relatively having a notable impact, but collectively contributing a net negative 0.4 percentage points.
- This follows a similar increase in 2020 (+1.2%) and continues the generally upward trend since 2015.
- Distribution sector productivity increased in 2021, whereas there were reductions in the utilities sector (-5.0%) more broadly and the overall Australian market economy (-0.2%).
- Distribution industry TFP has decreased slightly over the period 2006–2021, with the long-term decline in capital partial factor productivity driving this result.

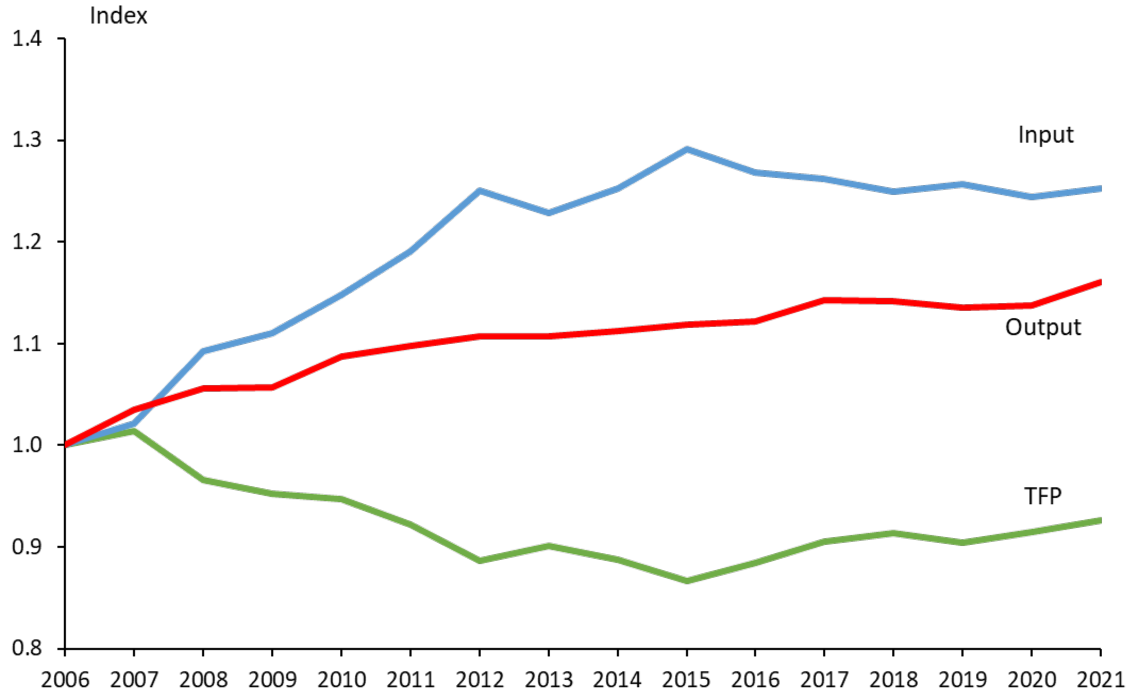
This chapter presents TFP results at the electricity distribution industry level over the 2006–2021 period and specifically for the regulatory year 2021.[29] This is our starting point for examining the relative productivity and efficiency of individual DNSPs. The variability in productivity from year-to-year can be seen in the results below and emphasises the importance of considering the changes in productivity in 2021 in the context of longer-term trends.

Industry-wide productivity increased by 1.5% in 2021. The result was largely driven by improved reliability (contributing +1.9 percentage points to TFP growth), with no other input or output individually having a notable impact, but collectively contributing a net negative 0.4 percentage points. While reliability can fluctuate from year to year, as shown in Figure 5, the TFP increase in 2021 follows a similar increase in 2020 (+1.2%) and continues the generally upward trend in distribution industry productivity since 2015.

Figure 5 also shows that over the 2006–2021 period, TFP for the electricity distribution industry declined, by 0.5% per year on average. Over this 15-year period, input use grew faster (1.5% per year on average) than outputs (1.0% per year on average).

[29] See Section 1.1 for further detail about the how the transition from calendar to financial year reporting for Victorian DNSPs in regulatory year 2021 has affected the calculation of productivity growth rates at the industry, state and individual DNSP level.

Figure 5 Industry-level distribution input, output and TFP indices, 2006–2021

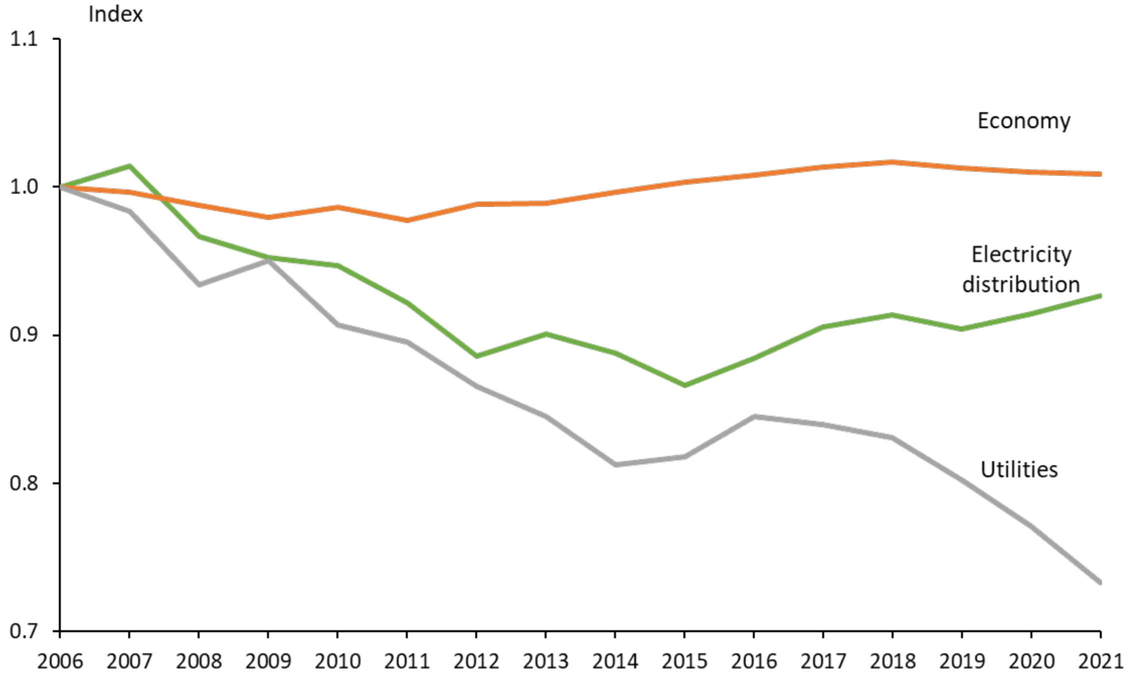


Source: Quantonomics.

Figure 6 compares the TFP of the electricity distribution industry over time relative to estimates of the overall Australian economy and utilities sector.[30] Distribution industry productivity increased in 2021, while there were reductions in the utilities sector (-5.0%) more broadly as well as the Australian market economy (-0.2%). Growth in electricity distribution productivity has been higher on average than that of both the Australian economy and the utilities sector since 2015. The annual electricity distribution productivity growth rate has been higher over the past five years (2017 to 2021, 0.6%) compared to the five years prior to that (2012 to 2016, 0.0%).

[30] Electricity, gas, water and waste services (EGWWS).

Figure 6 Electricity distribution, utility sector, and economy productivity, 2006–2021



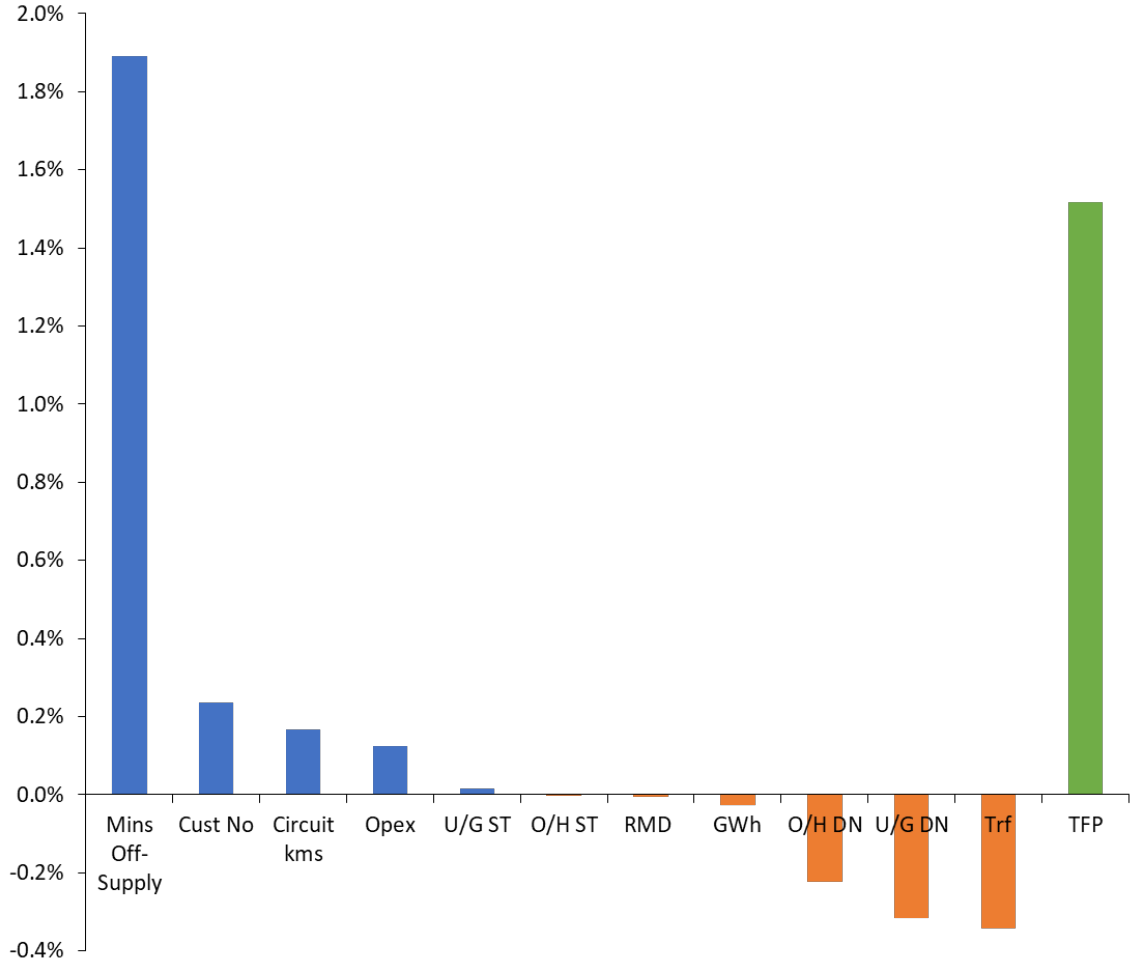
Source: Quantonomics; Australian Bureau of Statistics.

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 1.0 in 2006.

Figure 7 helps us understand the drivers of change in electricity distribution productivity by showing the contributions of each output and each input to the average annual rate of change in TFP in 2021. Outputs consist of customer numbers, circuit length, ratcheted maximum demand, energy throughput and reliability (minutes off-supply), with an increase in output increasing TFP, all else equal. Inputs consist of opex and capital (for example, the length and capacity of overhead distribution lines), with an increase in inputs decreasing TFP, all else equal.

Figure 7 shows that the increase in electricity distribution productivity in 2021 was primarily driven by improved reliability (contributing +1.9 percentage points to TFP growth). Customer numbers, circuit line length and opex had a small positive impact on TFP growth, contributing +0.2, +0.2 and +0.1 percentage points respectively. Conversely, transformers, underground and overhead distribution lines had a small negative impact on TFP growth, contributing -0.3, -0.3 and -0.2 percentage points respectively. The remaining inputs and outputs had very little impact on TFP growth.

Figure 7 Electricity distribution output and input percentage point contributions to annual TFP change, 2021



Source: Quantonomics.

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).

Conversely, over the 2012–2021 period, improved reliability only contributed a small positive amount (less than 0.1 percentage points) to the average annual electricity distribution productivity change of 0.5%. Instead, opex reductions played the largest role in driving electricity distribution productivity over the 2012–2021 period, contributing +0.9 percentage points.[31] The individual contributions from other drivers of TFP change in 2021 and in the 2012–2021 period are relatively similar.

Figure 8 displays TFP, opex PFP and capital PFP in the electricity distribution industry from 2006 to 2021. Consistent with the above observations, since 2012, opex reductions

[31] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, p. 20.

have been the most significant contributor to TFP growth, with opex partial factor productivity increasing on average by 3.1% each year. This level of sustained growth in opex productivity since 2012 raises the question of whether our current productivity growth rate assumption for DNSPs of 0.5% per year, used in regulatory decisions, is still appropriate. This is something that we may consider reviewing in future. Capital PFP has declined consistently over time, largely due to network inputs (particularly transformers and underground cables) growing at a faster pace than key outputs such as customers and ratcheted maximum demand as well as energy throughput which slightly fell. Improvements in the reliability output is the main driver of the increases in opex PFP, capital PFP and TFP in 2021. The steadier nature of the trend in capital PFP might be expected given that the capital inputs used in the model are a stock measure and the largely sunk and long-lived nature of DNSP capital assets. We also note that we are currently considering whether our outputs are, or are not, fully capturing all of the outputs provided by DNSPs related to export services (see Section 8.2.2).

Figure 8 Electricity distribution, total, capital and opex productivity, 2006–2021

Source: Quantonomics.

4 The relative productivity of distribution network service providers

Key points

Nine DNSPs became more productive in 2021 as reflected by their MTFP results:

- Jemena (14.4%), CitiPower (13.7%), AusNet Services (10.3%) and Powercor (8.5%) increased their productivity the most.
- Ausgrid, Ergon Energy and United Energy also increased their productivity by between 3 and 5%.
- Essential Energy and Endeavour Energy increased their productivity in 2021 by between 1 and 2%.
- Increased reliability was generally the main driver of increased productivity for these DNSPs.
- Increased opex productivity reflecting lower opex was also a significant source of productivity improvements for Jemena, CitiPower and Ergon Energy.

Four DNSPs became less productive in 2021 as reflected by their MTFP results:

- Energex (-5.0%), TasNetworks (-4.2%), SA Power Networks (-3.2%) and Evoenergy (-1.3%) experienced decreases in productivity.
- Increasing opex and reduced reliability were generally the main drivers of decreased productivity for these DNSPs.
- SA Power Networks, CitiPower and Powercor have consistently been amongst the most productive distributors in the NEM since 2006, although their productivity declined for most of the period between 2006 and 2021. Endeavour Energy and United Energy have both shown strong increases in productivity since 2016 and remain close to the most productive distributors in 2021 alongside Ergon Energy.
- On a State level, South Australia had the highest distribution total productivity ranking, as measured by MTFP, in 2021 and over the period 2006 to 2021. In 2021 Queensland was ranked second, followed by Victoria, NSW and Tasmania. Distribution productivity in the ACT was the lowest ranked of the states in 2021.
- The results from the MTFP models include the impact of some OEFs, such as energy, demand and customer density, but not all material OEFs are captured. This is important when considering the relative efficiency and rankings between DNSPs, as some DNSPs may have more or less favourable OEFs than their peers and may appear more or less efficient than they otherwise would. It is desirable to further account for operating environment conditions not included in the benchmarking models that can affect the benchmarking results. Our benchmarking report includes information about the most material OEFs driving apparent differences in productivity and operating efficiency between the distribution networks in the NEM. These are set out in Section 7.

This section presents economic benchmarking results as measured by MTFP (and opex and capex MPFP) comparative analysis at a state and DNSP level and provides our key observations on the reasons for changes in relative productivity of each DNSP in the NEM.

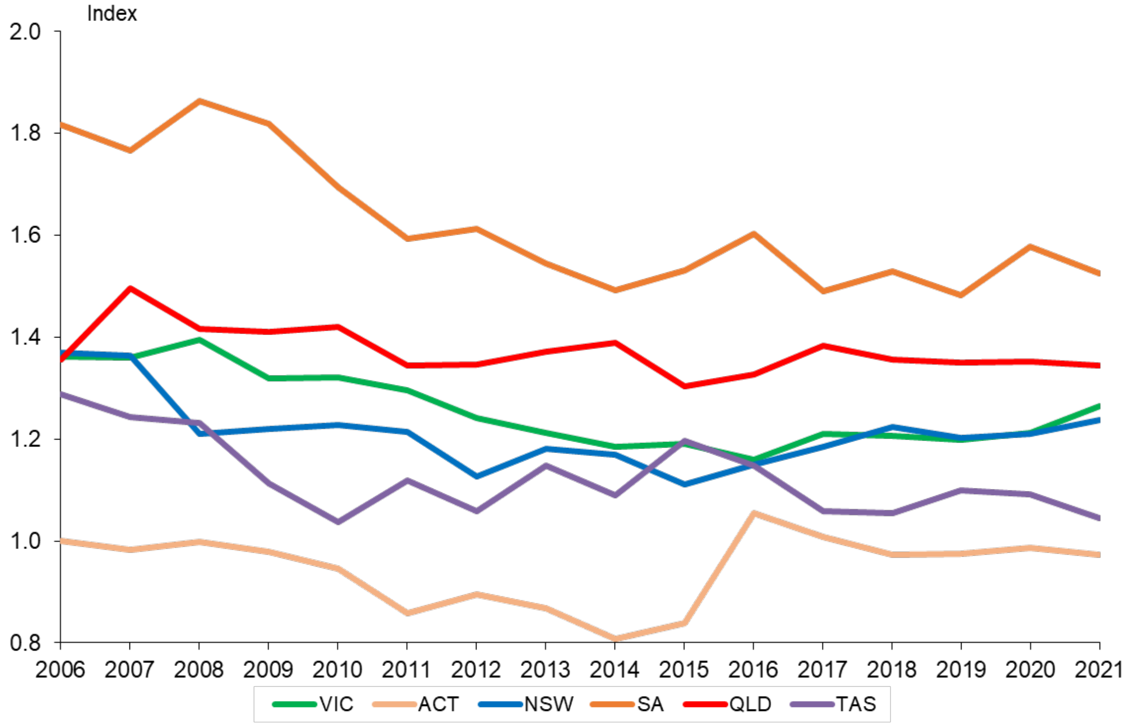
4.1 MTFP productivity results for DNSPs

The MTFP technique allows us to measure and compare the relative total factor productivity of states and individual DNSPs. This is supported by the corresponding partial productivity measures of opex and capital inputs.

Figure 9 presents the relative distribution productivity levels and rankings by state, as measured by MTFP over the period 2006 to 2021. This shows that South Australia is the most productive state in the NEM in both 2021 and over the period 2006 to 2021, although its productivity has declined over this timeframe. In 2021, the next most productive state is Queensland, followed by Victoria and NSW on around the same level. Tasmania is next, with the ACT's distribution total productivity level the lowest of the states in the NEM in 2021, which also reflects its general performance over the period 2006 to 2021. 32 All states/territories have a lower productivity level in 2021 than in 2006, although Queensland and the ACT are relatively constant.

[32] 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 sub-transmission assets and has a comparatively high proportion of lower voltage distribution lines. This disadvantages TasNetworks' MTFP ranking because low voltage assets generally receive the highest capital input weighting under our benchmarking models. Our previous consultant, Economic Insights, advised 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).

Figure 9 Electricity distribution MTFP levels by state, 2006–2021



Source: Quantonomics, AER analysis.

Note: These results do not reflect the impact of a range of material OEFs (see Section 7).

The remainder of this section examines the relative productivity of individual DNSPs in the NEM. Table 1 presents the MTFP rankings for individual DNSPs in 2021 and 2020, the annual growth in productivity in 2021 (column four) and the average annual growth in the 2006–2021 and 2012–2021 periods (columns five and six).

Table 1 Individual DNSP MTFP rankings and annual growth rates

DNSP	2021 Rank	2020 Rank	Change (2021)	Change (2006–2021)	Change (2012–2021)
SAP	1	1	-3.2%	-1.1%	-0.5%
CIT	2	2	13.7%	-0.2%	1.2%
PCR	3	3	8.5%	-0.2%	0.3%
ERG	4↑	6	4.0%	0.5%	0.2%
UED	5	5	3.3%	0.3%	2.0%
END	6↓	4	1.2%	-0.4%	0.7%
JEN	7↑	9	14.4%	0.6%	1.0%
ENX	8↓	7	-5.0%	-0.4%	0.0%
ESS	9↓	8	1.7%	-1.6%	0.3%
AND	10↑	11	10.3%	-1.1%	-0.9%
TND	11↓	10	-4.2%	-1.4%	-0.2%
EVO	12	12	-1.3%	-0.2%	0.9%
AGD	13	13	4.3%	0.3%	1.8%

Source: Quantonomics, AER analysis.

Note: All scores are calibrated relative to the 2006 Evoenergy score which is set equal to one. These results do not reflect the impact of a range of material OEFs (see Section 7).

We observe some moderate changes in the rankings: Ergon Energy and Jemena rose two places to 4th and 7th respectively, whereas Endeavour Energy dropped two places to 6th. Similarly, AusNet Services rose one place to 10th, while Energex, Essential Energy and TasNetworks dropped one place to 8th, 9th and 11th respectively. We also note the significant improvements in productivity level as measured by MTFP in 2021 by Jemena, CitiPower, AusNet Services and Powercor. Improved reliability and increasing opex productivity reflecting lower opex were the two main drivers of these results.

Figure 10 presents MTFP results for each DNSP from 2006 to 2021.

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

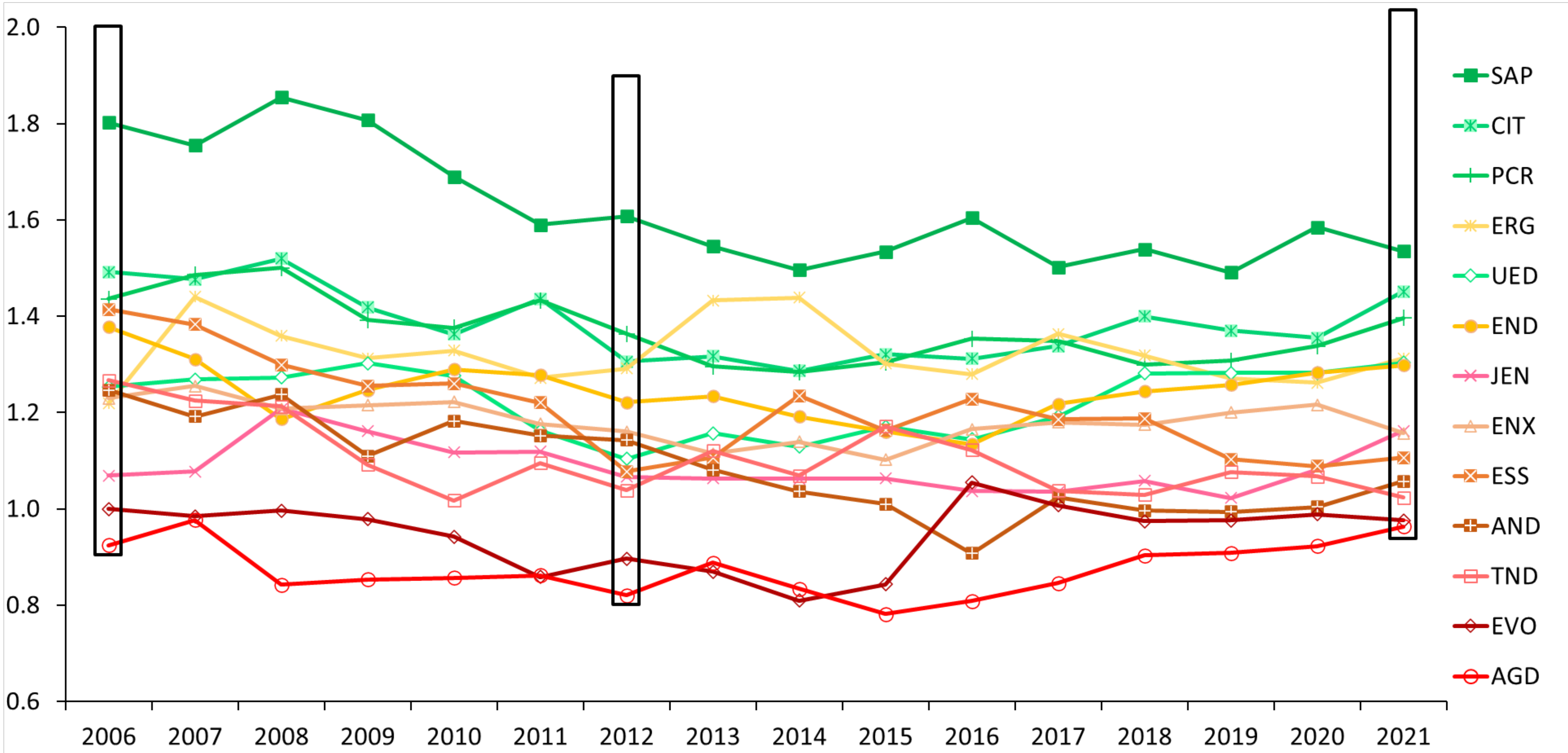
- Opex MPFP is shown in Figure 11. This considers the productivity of the DNSPs' opex.
- Capital MPFP is shown in Figure 12. This considers the productivity of the DNSPs' use of capital inputs, namely overhead lines and underground cables (each split into distribution and sub-transmission components) and transformers.

These partial approaches assist in interpreting the MTFP results by examining the contribution of capital assets and opex to overall productivity. They use the same output specification as MTFP but provide detail about the contribution of the individual components of capital and opex to changes in productivity. However, we note these results do not account for synergies between capital and opex like the MTFP analysis.

Being top-down analysis, these results are only indicative of the DNSPs' relative performance. Importantly, 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 OEFs can affect a DNSP's costs and benchmarking performance. The differences in MTFP results across DNSPs or over time may reflect changes in the OEFs not accounted for in the modelling, noting that it is not feasible to account for all possible OEFs. Section 7 provides more information about some of these additional factors.

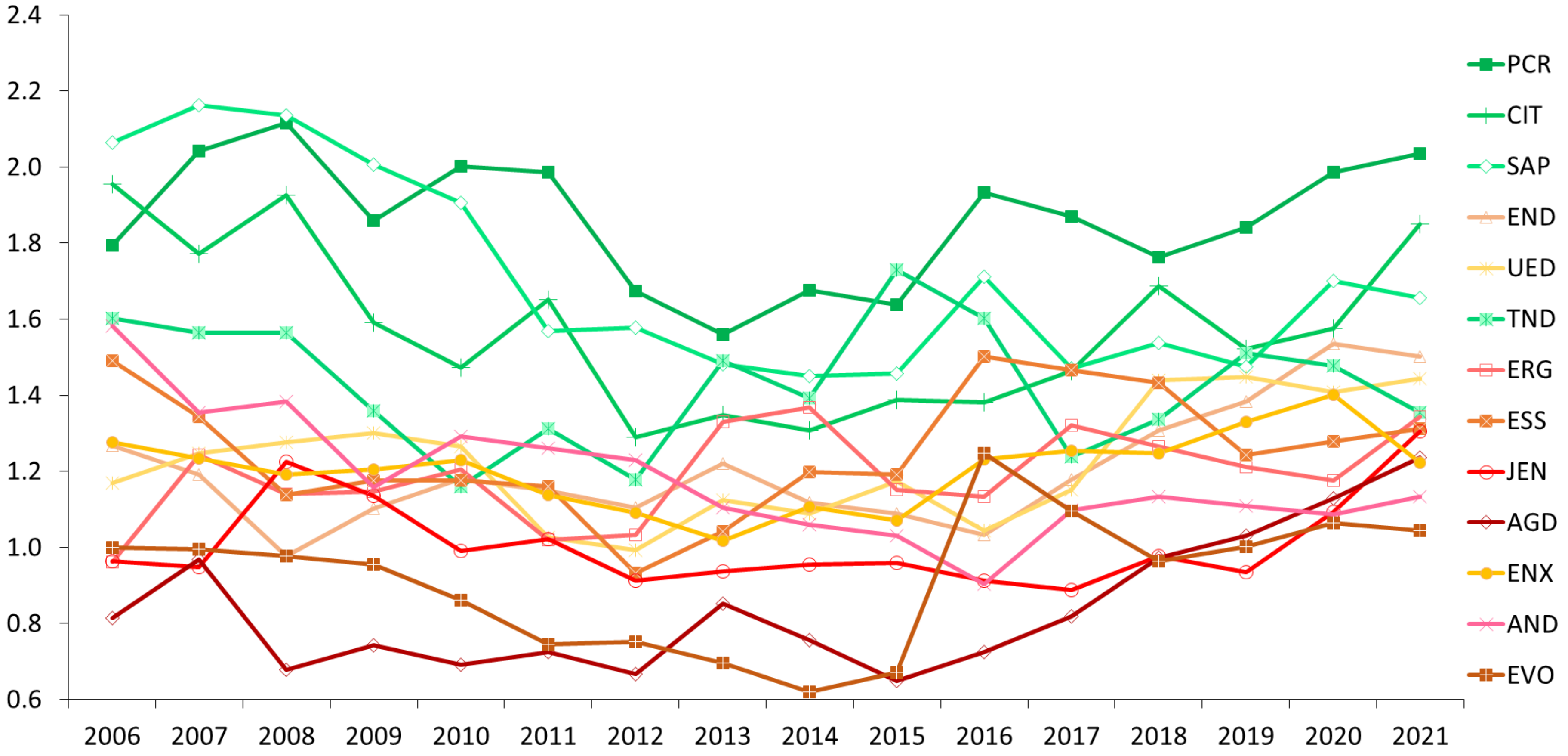
Our observations about these MTFP and MPFP results are discussed in Section 4.2.

Figure 10 MTFP indexes by individual DNSP, 2006–2021



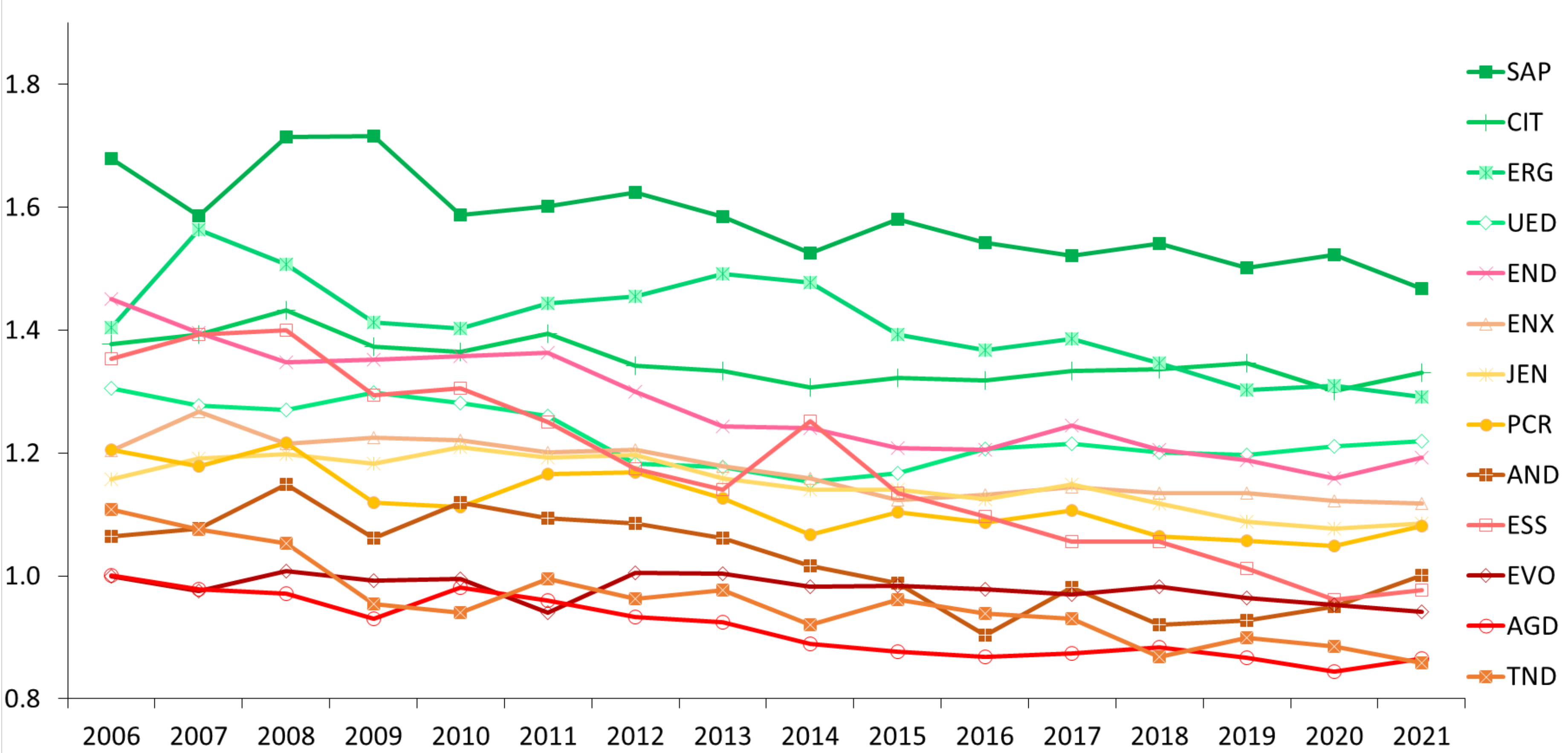
Source: Quantonomics; AER analysis. Note: These results do not reflect the impact of a range of material OEFs (see Section 7).

Figure 11 DNSP opex multilateral partial factor productivity indexes, 2006–2021



Source: Quantonomics; AER analysis. Note: These results do not reflect the impact of a range of material OEFs (see Section 7).

Figure 12 DNSP capital multilateral partial factor productivity indexes, 2006–2021



Source: Quantonomics; AER analysis. Note: These results do not reflect the impact of a range of material OEFs (see Section 7).

4.2 Key observations about changes in productivity

This section describes some of our key observations about changes in the relative productivity of DNSPs both for 2021 and recent years, based on the MTFP and MPFP results presented above. As discussed in Section 1.1, for the purposes of making comparisons between Victorian and non-Victorian DNSPs, annualised growth rates for Victorian DNSPs have been calculated by doubling the growth rate between the 2020 calendar year and 2021 financial year, reflecting the fact that this would otherwise only represent a six-month period of change.[33]

4.2.1 Significant changes in productivity in 2021

Nine DNSPs became more productive in 2021

As can be seen in Figure 10, nine of the 13 DNSPs became more productive in 2021 as reflected by their MTFP results. Jemena, CitiPower, AusNet Services and Powercor increased their productivity by 14.4%, 13.7%, 10.3% and 8.5% respectively in 2021, which were the largest increases among the DNSPs in the NEM. Ausgrid, Ergon Energy and United Energy also had strong productivity increases of between 3 and 5%. Essential Energy and Endeavour Energy increased their productivity by between 1 and 2%. Increased reliability was generally the main driver of the results for these distributors.[34] Increased opex productivity reflecting lower opex was also a significant source of productivity improvements for Jemena, CitiPower and Ergon Energy.

Of the DNSPs which had increases in MTFP in 2021, Jemena's and CitiPower's opex productivity measured in terms of opex MPFP increased by 35.4% and 32.0% respectively in 2021, the largest increases in the NEM (drivers for Jemena's and CitiPower's opex reductions are discussed further below). Four other DNSPs increased their opex productivity in 2021 by more than 5% – Ergon Energy (13.3%), Ausgrid (9.0%), AusNet Services (8.2%) and United Energy (5.0%), while Powercor's opex productivity increased by 4.9%. Ergon Energy's opex MPFP ranking rose from 9th to 7th place in 2021 and Jemena also rose two places, from 11th to 9th place. CitiPower's significant increase in opex productivity saw it move from 3rd to 2nd place, and much closer to Powercor, which remained the top ranked distributor in terms of opex MPFP.

Endeavour Energy was the only DNSP which had an increase in MTFP in 2021, but a decrease in opex productivity as measured by opex MPFP in 2021 (-2.1%). An increase in opex was the main driver of its reduction in opex MPFP.[35]

[33] As noted in Section 1.1, we consider this to be the most appropriate method for the purpose of making comparisons between Victorian and non-Victorian DNSPs in this report; however, we acknowledge that there are other possible methods for calculating an annualised growth rate for the Victorian DNSPs.

[34] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, pp. 79, 84, 89, 99, 104, 109, 114, 119, 124.

[35] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, p. 89.

For those DNSPs which had increases in MTFP in 2021, AusNet Services had the largest increase in capital productivity as measured by capital MPFP in the NEM. Its increase of 10.3% was comfortably larger than all other DNSPs. Powercor and CitiPower had moderate increases in capital MPFP of 6.1% and 4.4% respectively, and the remaining DNSPs had increases of between 1.0 and 3.0%, with the exception of Ergon Energy, which had a 1.4% decrease in capital MPFP. SA Power Networks remains the most productive DNSP in terms of capital productivity in the NEM in 2021, despite its decline in capital productivity as measured by capital MPFP of 3.6% in 2021. TasNetworks moved from 12th to 13th to become the lowest ranked DNSP in terms of capital MPFP in 2021. There were few significant changes in the capital productivity rankings in 2021, with the exception of AusNet Services, which moved from 11th to 9th.

Four DNSPs became less productive in 2021

Four DNSPs became less productive in 2021 as reflected by their MTFP results. Figure 10 shows that Energex had the largest decrease in productivity of 5.0%, driven largely by an increase in opex.[36] TasNetworks (-4.2%), SA Power Networks (-3.2%), and Evoenergy (-1.3%) also experienced moderate decreases in productivity. Increasing opex and reduced reliability were generally the main drivers of decreased productivity for these DNSPs.[37]

All of the DNSPs with reduced MTFP in 2021 also had decreased opex productivity as measured by opex MPFP in 2021. Energex, TasNetworks, SA Power Networks and Evoenergy had decreases in opex productivity of -13.8%, -8.8%, -2.7% and -1.8% respectively. Again, increased opex and reduced reliability were generally the main drivers of these reductions in opex MPFP.[38] Energex's opex MPFP ranking fell from 7th to 11th.

All of the DNSPs with reduced MTFP in 2021 also had decreased capital productivity as measured by capital MPFP in 2021. SA Power Networks, TasNetworks, Evoenergy and Energex had decreases in capital productivity of -3.6%, -3.0%, -1.1% and -0.4% respectively. Reduced reliability and increased transformer inputs were generally the main drivers of these reductions in capital MPFP.

Reliability increased for most DNSPs in 2021

Nine DNSPs had higher reliability in 2021, reflecting a decrease in customer minutes off-supply by 13.0% at the industry level. Eight DNSPs – AusNet Services, United Energy, CitiPower, Powercor, Endeavour Energy, Ausgrid, Jemena and Essential Energy – experienced increases in reliability of greater than 10% in 2021, with AusNet Services (60.4%), United Energy (48.0%), CitiPower (46.8%) and Powercor (40.9%) increasing by more than 40%. Several DNSPs highlighted the benign weather conditions in terms

[36] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, p. 94.

[37] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, pp. 47–48, 68, 73–74, 94.

[38] Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, pp. 47–48, 68, 73–74, 94.

of temperature and frequency of storms and bushfires experienced from January to July 2021 as the key driver for improvements in reliability in 2021, particularly when considered relative to the challenging weather conditions experienced from January to July 2020.[39] In part this is reflected in fewer issues impacting reliability in 2021 than there were in 2020. Over the previous five years, distribution industry productivity largely increased despite a trend of decreasing reliability. In 2021, distribution industry productivity has again increased, but this time largely due to increased reliability.

Opex input decreased significantly for some DNSPs in 2021

Five DNSPs had lower levels of opex in 2021, with an average decline across the industry of 0.3%. Jemena, CitiPower and Ergon Energy had the largest reductions in opex of -33.1%, -28.3% and -13.4% respectively. Jemena pointed to its transformation program and temporary impacts due to COVID-19 as the key drivers of its reduction in opex.[40] CitiPower pointed to its significant reduction in vegetation management, due to a higher volume of spans cut and ground-based inspections carried out in previous years, and in overheads, due to efficiencies realised across network and corporate overheads.[41] Ausgrid had a smaller reduction of -5.4%, and United Energy had a marginal reduction of -0.9%.

4.2.2 Productivity levels across the industry have converged over time

Since 2006 there has been some convergence in the productivity levels of DNSPs, both at the MTFP level and in opex MPFP. The spread of productivity levels in 2021 is smaller than in 2012, which was also smaller than in 2006. This can be seen from the three equal-sized black columns placed in 2006, 2012 and 2021 in Figure 10, with a broadly similar pattern observed for opex MPFP in Figure 11.

The convergence is due to a number of factors, some of which are discussed below.

One important factor is that those DNSPs which have been the least productive over time have improved their performance, particularly since 2012. The least productive DNSPs in 2012 as measured by MTFP (Ausgrid and Evoenergy) have increased their productivity at higher rates than some DNSPs within the middle-ranked group. Since

[39] Ausgrid, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on Ausgrid's 2021 EB RIN data*, received on 8 March 2022; Endeavour Energy, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on Endeavour Energy's 2021 EB RIN data*, received on 11 March 2022; Essential Energy, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on Essential Energy's 2021 EB RIN data*, received on 10 March 2022; Jemena, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on Jemena's 2021 EB RIN data*, received on 11 March 2022; CitiPower, Powercor and United Energy, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on CPU's 2021 EB RIN data*, received on 16 March 2022; AusNet Services, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on AusNet Services' 2021 EB RIN data,* received on 22 March 2022.

[40] Jemena, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on Jemena's 2021 EB RIN data*, received on 11 March 2022.

[41] CitiPower, Powercor and United Energy, *Email to AER – AER 2022 Annual Benchmarking Report - follow up questions on CPU's 2021 EB RIN data*, received on 16 March 2022.

2012, Ausgrid and Evoenergy have increased their overall productivity (MTFP) by 1.8% and 0.9% per annum respectively, compared with the industry average of 0.5% per annum. The growth in productivity of these DNSPs can be largely attributed to improvements in opex efficiency.

In addition to these DNSPs improving their MTFP performance, several middle-ranked DNSPs have also improved their relative MTFP performance to be closer to the top-ranked DNSPs. In recent years this includes United Energy, Jemena and Endeavour Energy, again reflecting improved opex efficiency. Since 2012, the NSW and ACT DNSPs have been among the most improved in the NEM in terms of MTFP and opex MPFP performance.

Further, while Powercor, SA Power Networks and CitiPower have consistently been the most productive DNSPs in the NEM as measured by MTFP over the 2006 to 2021 period, they have experienced a gradual decline in productivity over this period, with some improvement for CitiPower and Powercor in 2021. That said, from 2012 to 2021 CitiPower improved its MTFP at a similar rate to Ausgrid and Evoenergy (1.2%) and Powercor also improved its productivity as measured by MTFP by 0.3%. Although SA Power Networks' MTFP rise in 2020 increased its gap over the rest of the DNSPs, this was slightly reduced following its fall in MTFP in 2021. The productivity of SA Power Networks is now much closer to the DNSPs that are middle-ranked than in 2006. The narrowing of the productivity performance of DNSPs may be influenced by new regulatory obligations among other factors.

Changes in opex productivity as measured by opex MPFP are the main driver of productivity convergence in the electricity distribution industry. It has increased since 2012 (as seen in Figure 11) with twelve out of the thirteen (all bar AusNet Services) DNSPs increasing their opex productivity as measured by opex MPFP. In contrast, capital productivity as measured by capital MPFP has consistently declined since 2006 throughout the NEM and there has been little convergence among DNSPs. All DNSPs have reduced capital MPFP in 2021 as compared to 2006. This is only marginally different when comparing 2021 to 2012, as United Energy is the only DNSP that has increased its capital productivity since then.

4.2.3 Interpreting the results

As noted above and explained further in Sections 7 and 8, these results should be interpreted with a level of caution. There are inherent limitations with all benchmarking exercises, including with respect to model specification and the specification of outputs and inputs, and data imperfections. In addition, the results for all DNSPs do not reflect the impacts, both positive and negative, on measured productivity of a range of material OEFs, including capitalisation practices. We recognise these limitations in the conservative way we interpret and apply our benchmarking results to particular DNSPs in the context of revenue determinations. However, we consider that the trends over time we observe for measured productivity in the wider industry are consistent with our general expectations.

Improving our quantification of material OEFs and examining the impact of capitalisation remain key focuses for our benchmarking development, as discussed in Section 8. In relation to the impact of capitalisation more specifically, we have released on 29 October 2022 a draft guidance note on how we propose this will be addressed. We are currently seeking submissions and expect to finalise the guidance note in 2023. We will incorporate the proposed approach to address capitalisation issues into future annual benchmarking reports as appropriate.

That said, we consider our MTFP model accounts for differences in DNSPs outputs and as a result relevant density factors are accounted for in the output index. By implication, energy density, demand density, and similarly customer density, do not need to be used as additional OEFs when interpreting efficiency scores. We consider the four outputs measured are material drivers of opex and allow for the difference in customer, energy and demand density across DNSPs (reflecting different customer composition). We also note our benchmarking results have found both predominantly rural and urban networks being in the top, middle and bottom ranked groups.

5 Opex econometric models

Key points

- Powercor, CitiPower, SA Power Networks, TasNetworks and United Energy are the most efficient DNSPs in terms of opex efficiency scores, for both the 2006 to 2021 and 2012 to 2021 periods.
- Due to improvements in opex efficiency in recent years, all DNSPs except for CitiPower, Jemena, SA Power Networks and AusNet Services are more efficient over the 2012 to 2021 period compared with the 2006 to 2021 period.
- Opex efficiency scores from the opex cost function models are broadly consistent with opex MPFP efficiency scores.
- The opex econometric models take into account some OEFs e.g. relevant density factors and some service classification differences for opex and undergrounding of cables, but do not include other OEFs. It is desirable to further take into account OEFs not included in the benchmarking models that can materially affect the benchmarking results. Our benchmarking report includes information about material OEFs driving apparent differences in estimated productivity and operating efficiency between the distribution networks in the NEM. These are set out in Section 7.
- The results from the opex econometric cost function models are central in our assessment of the opex costs revealed in the most recent years prior to a DNSP's revenue determination processes.
- We continue to observe some issues with the reliability of the performance of the Translog models. This is an area for development that we discuss further in Section 8.

This section presents the results of four econometric models that compare the relative opex efficiency of DNSPs in the NEM. These results reflect an average efficiency score for each DNSP over a specified period. The periods we look at are the 2006 to 2021 (long) period and the 2012 to 2021 (short) period. Examining the shorter time period provides a more recent picture of relative efficiency of DNSPs in the NEM and takes into account that it can take some time for more recent improvements in efficiency by previously poorer performing DNSPs to be reflected in period-average efficiency scores.

The four econometric opex cost function models presented in this section represent the combination of two cost functions (Cobb-Douglas and Translog) and two methods of estimation (Least Squares Econometrics (LSE) and Stochastic Frontier Analysis (SFA)), namely:[42]

- Cobb-Douglas Stochastic Frontier Analysis (SFACD)

[42] Further details about these econometric models can be found in the Economic Insights 2014 and 2018 reports (full references are provided in Appendix A).

- Cobb-Douglas Least Squares Econometrics (LSECD)
- Translog Stochastic Frontier Analysis (SFATLG)
- Translog Least Squares Econometrics (LSETLG).

A key economic property required for these econometric opex models is monotonicity: that is, that an increase in output can only be achieved with an increase in inputs, holding other things constant.[43] Cobb-Douglas models assume that the response of opex to output changes (output elasticity) is constant across all observations, and so as long as the estimated output coefficients, which reflect the sample-average output elasticity, are positive then this property is satisfied. However, this property may not hold across all the data points in the more flexible Translog models that allow for varying output elasticities.

Before 2018 the results from the Translog SFA model were not presented in our annual benchmarking reports as this property was not met. In the 2018 Annual Benchmarking Report the Translog SFA model results were included for the short period as this property was largely satisfied for most DNSPs. Then in the 2019 Annual Benchmarking Report the results for this and the long period were included as again this property was largely met for most DNSPs. In the 2020 and 2021 Annual Benchmarking Reports the number of instances where this property was not met became somewhat more prevalent for the models over the short period.

For the current report, the number of instances where this property does not hold in the Translog models is prevalent again, although slightly better than last year. This year, for the 2006 to 2021 period, the property is satisfied for all of the Australian[44] DNSPs in both Translog models. This is an improvement from last year, where over the long period the Translog LSE model had violations of this property for a majority of observations for three DNSPs.

For the shorter period from 2012 to 2021, the results are again slightly better than last year. Only the Translog SFA model, as opposed to both Translog models last year, presents violations in a majority of observations for most of the Australian DNSPs:

- For the Translog SFA model there are nine DNSPs for whom a majority of their data points do not satisfy this property: Evoenergy, Ausgrid, CitiPower, Endeavour Energy, Energex, Jemena, Powercor, AusNet Services and United Energy.
- For the Translog LSE model there are five DNSPs where this property is not satisfied: Ausgrid, CitiPower, Energex, Jemena and United Energy.

Almost all of these cases where the property is not satisfied related specifically to the elasticity of opex with respect to the customer numbers output, and the Translog SFA model also estimates a negative elasticity of opex with respect to customer numbers for

[43] Technically, this is known as the monotonicity property. See Quantonomics' report accompanying this report for further details: Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2021 DNSP Annual Benchmarking Report*, November 2022, p. 33–34.

[44] As discussed in Appendix B, we include both the NEM DNSPs and overseas DNSPs in the opex econometric models sample of DNSPs.

Australian DNSPs at the sample-average level.

As per the approach used in last year's benchmarking report, where a majority of a DNSP's observations in a given model violate this property (indicated by a hatched pattern in Figure 14), we exclude that model's efficiency score in calculating that DNSP's model-average score (shown by the horizontal black lines for each DNSP in these figures).[45] Furthermore, if a model shows monotonicity violations for the majority of Australian DNSPs, then we exclude the model from calculating the model-average efficiency score for all Australian DNSPs even though the property is satisfied for some DNSPs. This is the case for the shorter (2012–2021) period for the SFA Translog model in this benchmarking report, which is excluded for the purpose of calculating the model-average efficiency scores for all Australian DNSPs (as shown in Figure 14).

As discussed further in Section 8, we have undertaken some consideration of how we can improve the performance of these models in relation to monotonicity and whether or not the alternative results considered are presented or used in future benchmarking reports.

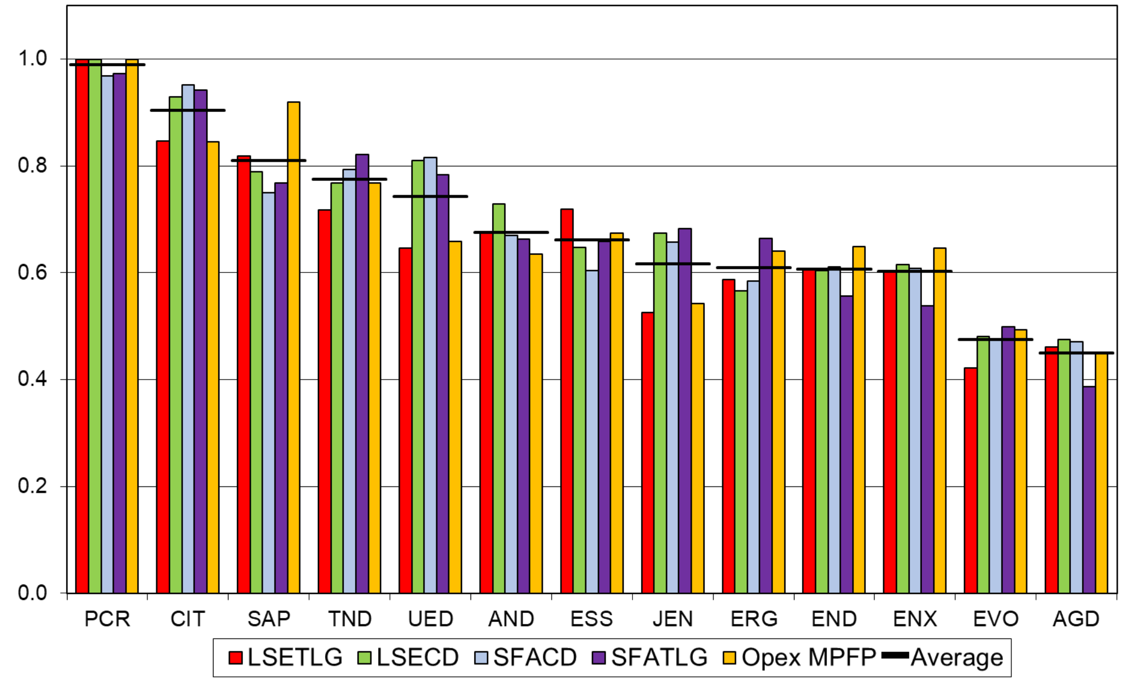
Figure 13 presents average efficiency scores for the above four models (plus opex MPFP) over the long period (2006–2021), ranked from highest to lowest according to model-average score including opex MPFP. Powercor and CitiPower have the highest average efficiency scores under the majority of models, followed by SA Power Networks, TasNetworks and United Energy. Ausgrid and Evoenergy have the lowest average opex efficiency scores over this period.

As can be seen in Figure 13 the opex MPFP results (in the orange columns) are broadly consistent with the results from these econometric opex cost function models.[46] The opex MPFP results are somewhat higher for SA Power Networks, Endeavour Energy, Energex and Ergon Energy and somewhat lower for CitiPower, United Energy, AusNet Services, and Jemena.

[45] The model-average score includes Opex MPFP.

[46] The opex MPFP model has a slightly different combination of outputs than the econometric opex cost function models. See Appendix B and Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Annual Benchmarking Report*, November 2022, pp. 5–9.

Figure 13 Opex efficiency scores and opex MPFP, (2006–2021)



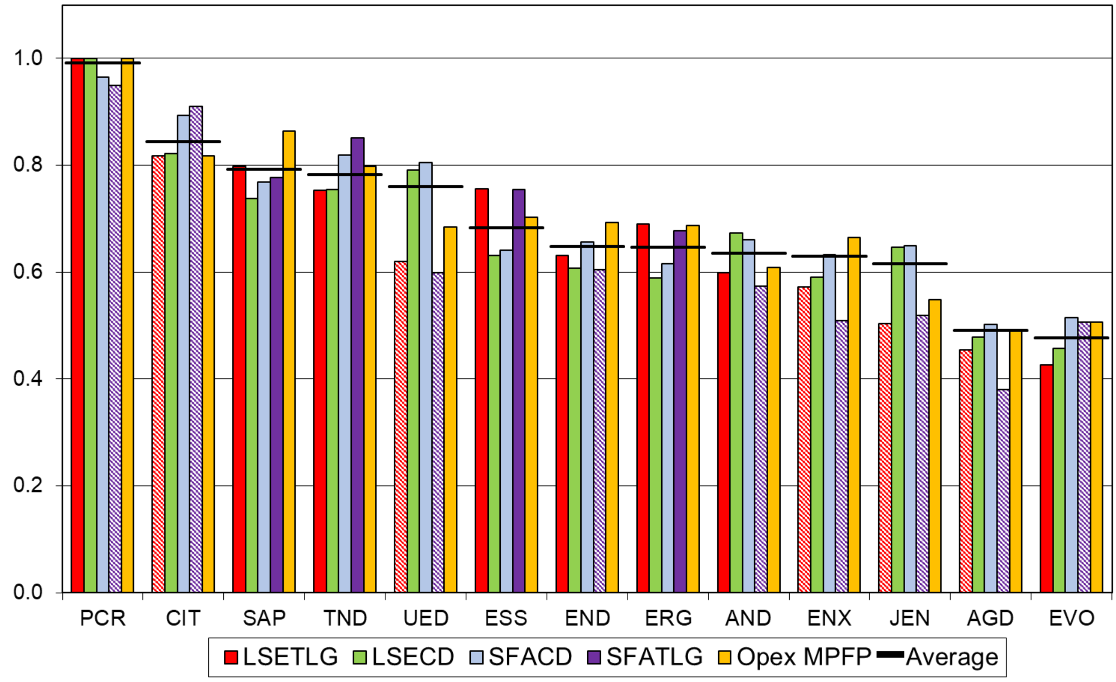
Source: Quantonomics; AER analysis.

Figure 14 presents the average opex efficiency of each DNSP for these four models (plus opex MPFP) over the short period (2012–2021). Again, the model-average (including only those models which satisfy the economic property noted above) is shown by the horizontal black lines for each DNSP. As discussed above, in the case of the shorter period, the Translog SFA model has been excluded for the purpose of calculating the model-average efficiency scores for all Australian DNSPs.

Figure 14 also shows that the corresponding opex MPFP results are broadly consistent with the results from the opex cost function models.

While the average opex efficiency results are similar between the long and short periods, particularly for those DNSPs that have the highest and lowest efficiency scores, there are some changes in average opex efficiency scores of the other DNSPs. Similar to trends observed in Section 4, many middle and lower ranked DNSPs in terms of opex efficiency have improved their performance over recent years. This has a more pronounced effect on their opex efficiency scores for the shorter rather than the longer period. All DNSPs except for CitiPower, Jemena, SA Power Networks and AusNet Services improved their opex efficiency scores in the shorter period relative to the longer period, and Endeavour Energy (10th to 7th), Essential Energy (7th to 6th), Ergon Energy (9th to 8th), Energex (11th to 10th) and Ausgrid (13th to 12th) also have higher rankings in the shorter period than in the longer period.

Figure 14 Opex efficiency scores and opex MPFP, (2012–2021)



Source: Quantonomics; AER analysis.

Note: Columns with a hatched pattern represent results that violate the key property that an increase in output is achieved with an increase in cost. However, for the SFA Translog model, as the majority of DNSPs have violations of this property, and as the models estimate negative elasticities of opex with respect to customer numbers on average for Australian DNSPs, we have excluded the efficiency scores of the SFA Translog model from the average efficiency score calculation for all the DNSPs (represented by the black horizontal line). These results do not reflect the impact of a range of material OEFs (see Section 7).

An important limitation of these results is that, apart from relevant density factors, some service classification differences for opex and undergrounding of cables, the opex econometric models do not include the impact of all material OEFs. It is desirable to take into account operating environment conditions not included in the benchmarking models that can materially affect the benchmarking results. Section 7 includes information about material OEFs driving apparent differences in estimated productivity and operating efficiency between the distribution networks in the NEM. In summary, these 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.

We are also considering the impact of differences in capitalisation practices on these benchmarking results and as noted above which is discussed further in Section 8.

How we use average opex efficiency scores in our revenue determinations to assess relative efficiency of actual opex 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 opex efficiency over the 2006–2021 period and the 2012–2021 period. Where there are rapid increases or decreases in opex, it may take some time before the period average efficiency scores reflect these changes, in particular for the longer period. 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, particularly in the context of our revenue determination processes, we can estimate the efficient opex of a benchmark efficient service provider operating in the circumstances of the DNSP in question. We do this by first averaging the DNSP's actual opex over the relevant benchmarking period (deflated by the opex price index) and calculating its average efficiency score from the models. We then compare the DNSP's opex efficiency score against a benchmark comparison point of 0.75[47] (the best possible efficiency score is 1.0), adjusted for the impact of OEFs (see the box in Section 7 for further detail on how we apply OEF adjustments). Where the DNSP's efficiency score is below the adjusted benchmark score, we adjust the DNSP's average opex down by the difference between the two efficiency scores. This results in an estimate of period-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 included 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.

Examples of how we have applied this approach in practice are in the AER's opex final decisions for Jemena and AusNet Services for the 2021–26 regulatory control period, including the application of material OEFs that we have been able to quantify.[48]

During 2022 we have undertaken work to improve the models which implement the modelling described in the above box, particularly in terms of the transparency and usability of the models. This includes the models calculating and comparing the opex efficiency scores as well as those which calculate the OEFs that are used to adjust the benchmarking comparison point. We have provided these models to DNSPs and received feedback in relation to them, particularly in relation to the way the OEFs are calculated. This is discussed further in Sections 7 and 8.

Appendix B provides more information about our econometric models.

[47] The benchmark comparators are those DNSPs that have an econometric model-average efficiency score above the 0.75 benchmark comparison score.

[48] AER, *Final Decision*, *Jemena distribution determination 2021–26 - Attachment 6 - Operating Expenditure*, April 2021; AER, *Final Decision, AusNet Services distribution determination 2021–26 - Attachment 6 - Operating Expenditure*, April 2021.

6 Partial performance indicators

Key points

DNSPs with higher customer densities (such as CitiPower, United Energy and Jemena) tend to perform well on 'per customer' metrics. However:

- Powercor (with relatively low customer density) performs more strongly on 'per customer' metrics compared to many DNSPs with higher customer densities.

DNSPs with lower customer densities (such as Essential Energy, Powercor, Ergon Energy and SA Power Networks) tend to perform well on ‘per km’ metrics. However:

- United Energy and Jemena perform well on some 'per km' metrics compared to other DNSPs with lower customer densities.
- Ausgrid (with average customer density) is outperformed on some 'per km' metrics compared to other DNSPs with higher customer densities.

PPI techniques are a simpler form of benchmarking that compares inputs 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.

On a 'per customer' metric, large predominantly rural DNSPs will generally 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, larger, more rural DNSPs will perform better because their costs are spread over a longer network. Where possible, we have plotted PPIs against customer density,[49] to enable readers to visualise and account for these effects when interpreting the results.

We have updated the PPIs to include 2021 data and present them as an average for the five-year period 2017–2021.[50] The results are broadly consistent with those presented in the 2021 Annual Benchmarking Report with no major changes.

[49] Customer density is calculated as the total number of customers divided by the route line length of a DNSP.

[50] The updated PPIs are in dollar values as at the end of June quarter 2021.

6.1 Total cost PPIs

This section presents total cost PPIs averaged over the 2017–2021 period. These compare each DNSP's total costs (opex and asset cost) against a number of outputs in turn.[51] Total cost has the advantage of reflecting the opex and assets for which customers are billed on an annual basis. The three total cost PPIs shown here are:

- Total cost per customer
- Total cost per circuit length kilometre
- Total cost per megawatt (MW) of maximum demand.

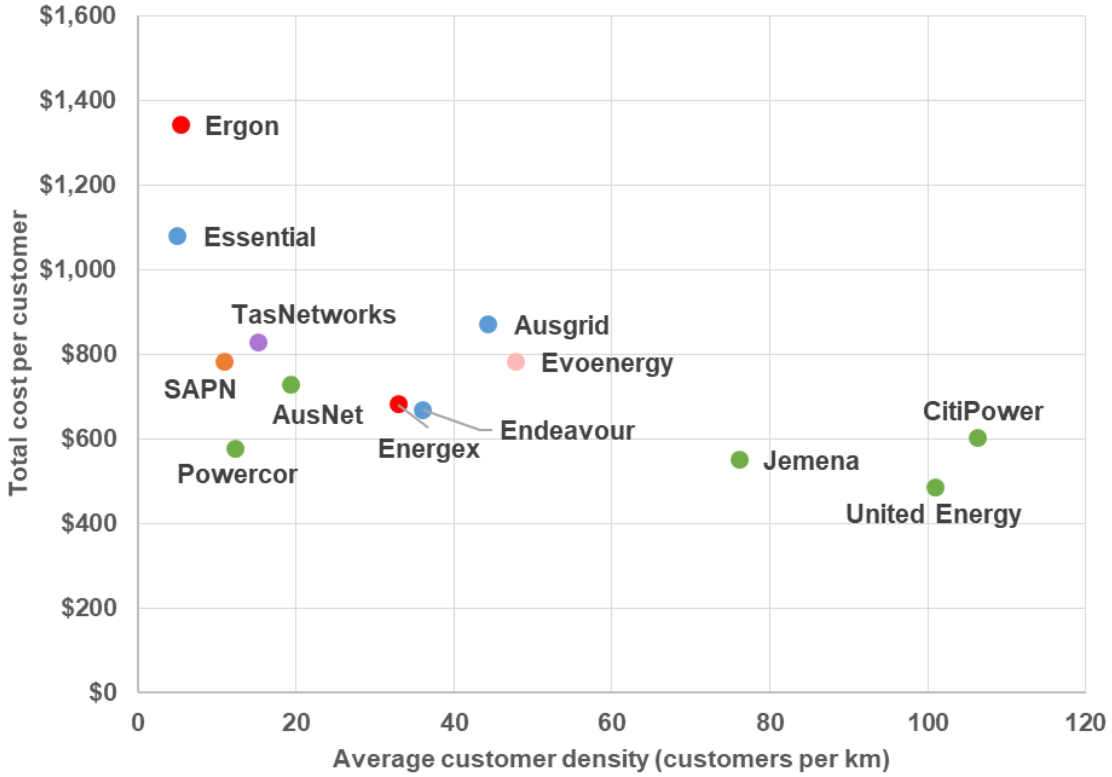
6.1.1 Total cost per customer

Figure 15 shows each DNSP's total cost per customer. Customer numbers are one of the main outputs DNSPs provide. The number of customers connected to the network is one of the factors that influences demand and the infrastructure required to meet that demand.

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. Both Ergon Energy and Essential Energy have a relatively higher total cost per customer compared to other largely rural DNSPs, including SA Power Networks, Powercor, AusNet Services and TasNetworks. Ausgrid also has relatively higher costs per customer compared to other networks with similar customer densities and most networks with lower customer densities.

[51] Asset cost is the sum of annual depreciation and return on investment associated with the historical and current capex of a DNSP (as included in its regulatory asset base), using the annual weighted average cost of capital. In economic benchmarking studies, it is generally referred to as the annual user cost of capital. We have applied to the PPI calculations the same annual user cost of capital approach we applied to *MTFP and MPFP* analysis. We have updated the calculation of the annual user cost of capital for the regulatory years 2020 and 2021 to reflect the AER's Rate of Return Instrument 2018. In previous years the annual user cost of capital calculations broadly reflected the 2013 rate of return guideline. For more details, see: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/rate-of-return-instrument-2018/final-decision.

Figure 15 Total cost per customer ($2021) (average 2017–2021)

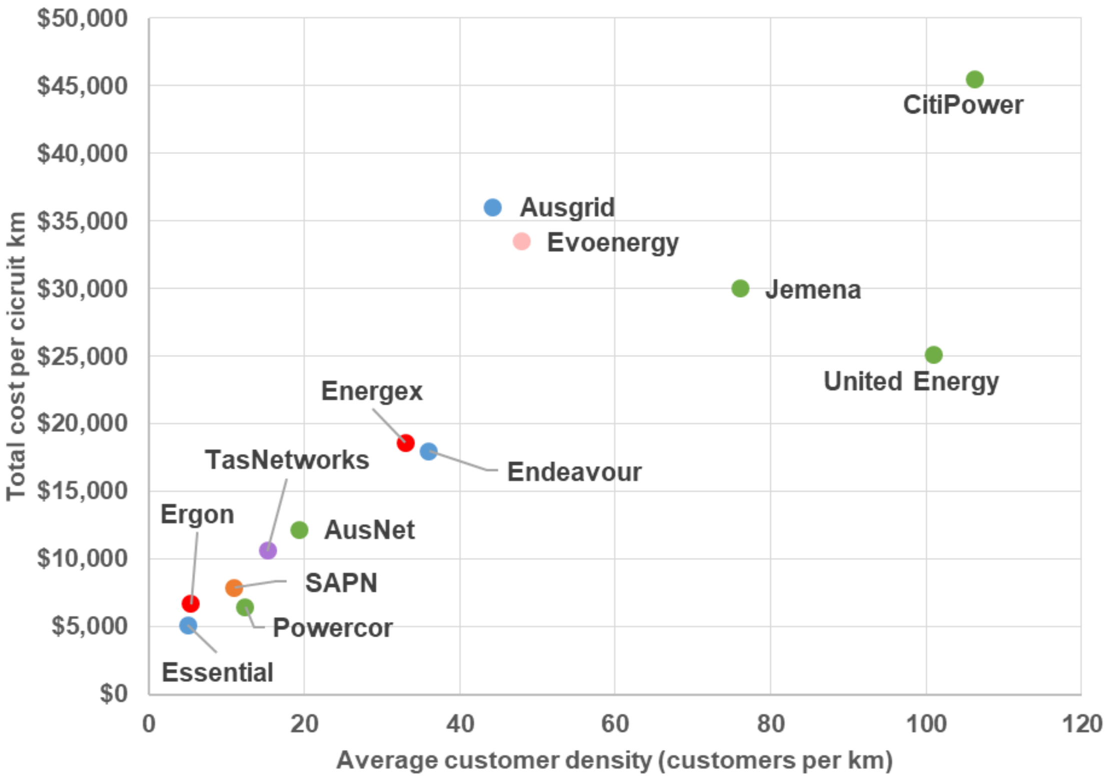


Source: AER analysis; Economic Benchmarking RINs.

6.1.2 Total cost per kilometre of circuit line

Figure 16 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. CitiPower has the highest total cost per kilometre of circuit line length. As the most customer-dense network in the NEM, this finding must be considered with caution, as 'per km' metrics tend to favour DNSPs with lower customer densities. However, compared to United Energy, which has a similar average customer density, CitiPower performs relatively poorly. Ausgrid reports the second-highest total cost per kilometre of circuit line length in the NEM, and performs worse than some networks with higher customer densities (Evoenergy, Jemena and United Energy).

Figure 16 Total cost per kilometre of circuit line length ($2021) (average 2017–2021)

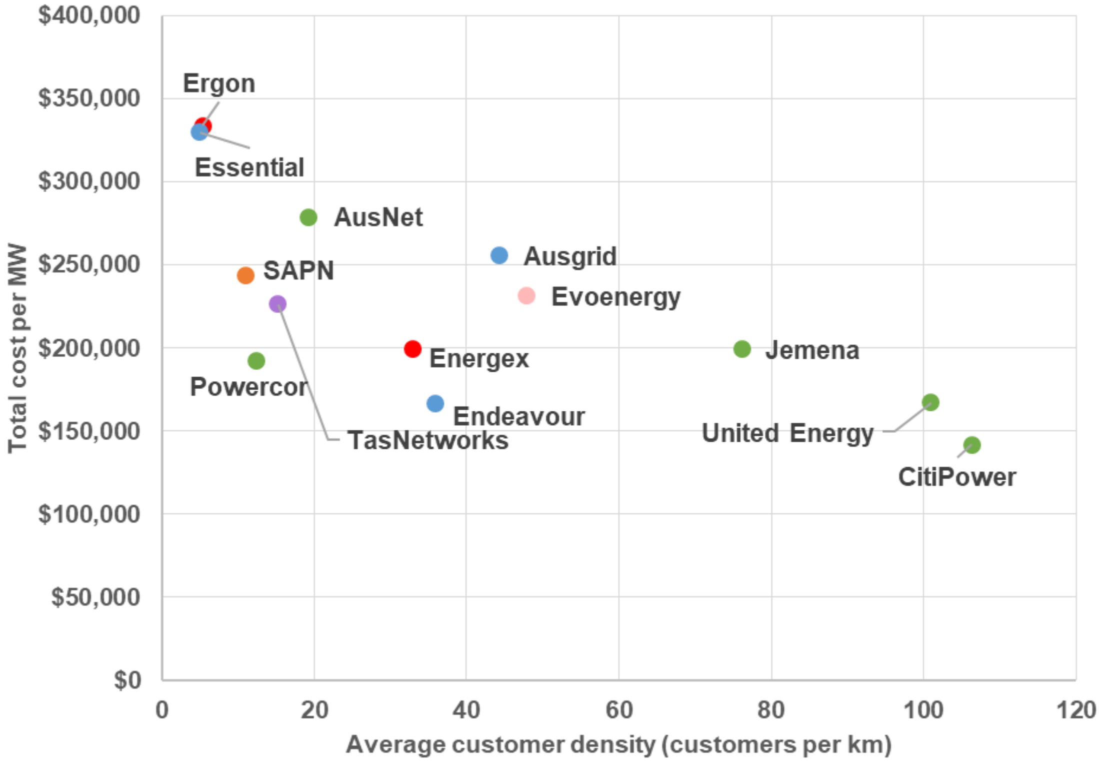


Source: AER analysis; Economic Benchmarking RINs.

6.1.3 Total cost per MW of maximum demand

Figure 17 shows each DNSP's total cost per MW of maximum demand. DNSPs install assets to meet maximum demand. Maximum demand also influences opex, as DNSPs need to operate and maintain assets installed to meet demand at peak time. 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 17 Total cost per MW of maximum demand ($2021) (average 2017–2021)



Source: AER analysis; Economic Benchmarking RINs.

6.2 Cost category PPIs

This section presents the opex category level cost PPIs averaged over the 2017–2021 period. These compare a DNSP's category level opex (vegetation management, maintenance, emergency response) and total overheads against a relevant output.[52] The data for these PPIs are from the category analysis RIN and economic benchmarking RIN reported to the AER.[53]

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

[52] 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 explain our choice of selected output measure for each of the PPIs below.

[53] 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 for each DNSP at the time the RIN was submitted.

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 revenue determinations, particularly to identify potential areas of DNSP inefficiency in relation to opex.

6.2.1 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 circuit line length because overhead line length is the most relevant proxy of vegetation management costs.[54]

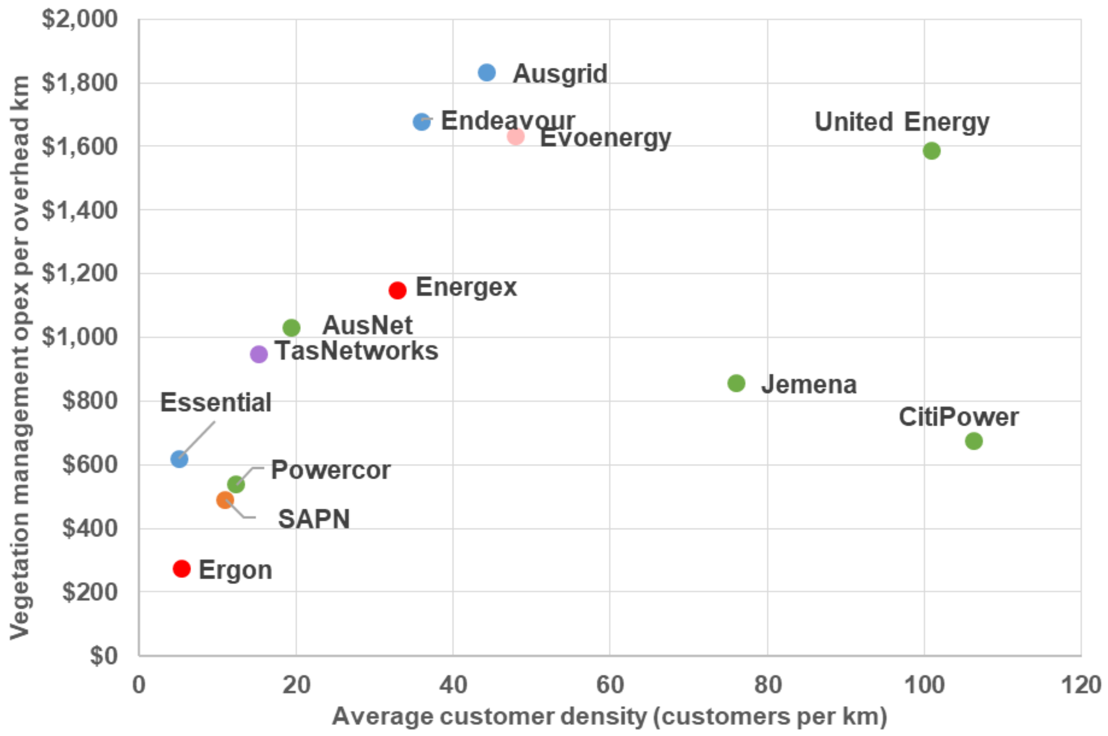
In 2021, Endeavour Energy incurred lower vegetation management opex compared to the previous five years. In contrast, Ausgrid and Evoenergy incurred higher vegetation management opex than before. These have resulted in changes in their relative position, to each other and to the other DNSPs, from the analysis shown in last year's benchmarking report.

Figure 18 shows that Ausgrid, Endeavour Energy, United Energy and Evoenergy have the highest vegetation management expenditure per kilometre of overhead circuit line length relative to other DNSPs in the NEM, including DNSPs with similar customer density.

In contrast, Ergon Energy, Essential Energy, SA Power Networks and Powercor have the lowest vegetation management expenditure per kilometre of overhead circuit line length in the NEM. As ‘per km’ measures tend to favour networks with smaller customer densities, the relative performance of these DNSPs is somewhat expected.

[54] We note that circuit 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 route line length instead of vegetation maintenance span length due to DNSPs' estimation assumptions affecting maintenance span length data.

Figure 18 Vegetation management opex per km of overhead circuit length ($2021) (average 2017–2021)



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

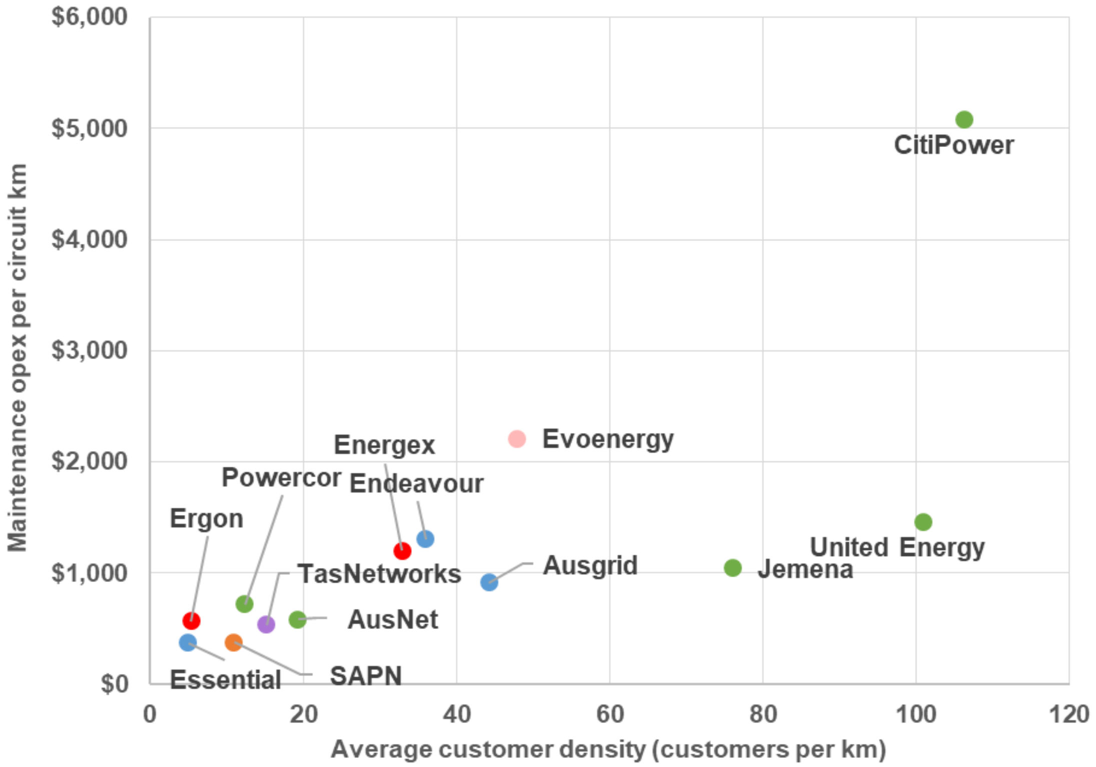
6.2.2 Maintenance

Maintenance expenditure relates to the direct opex 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.[55] 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 and econometric benchmarking, Figure 19 shows that it has one of the highest maintenance opex spend per km of circuit length in the NEM. As a high customer density network, CitiPower is likely to be somewhat disadvantaged through the use of 'per km' metrics. However, even compared to other customer-dense networks in the NEM, CitiPower still performs relatively poorly on this measure.

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

Figure 19 Average maintenance opex spend per circuit km ($2021) (average 2017–2021)



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

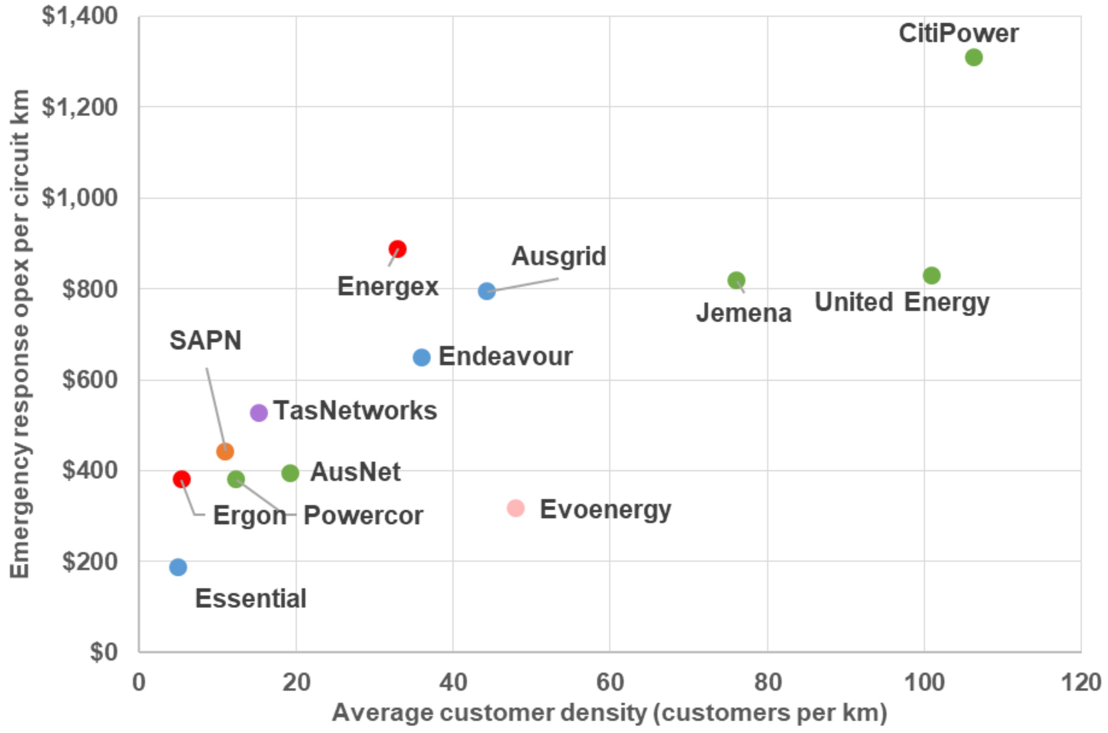
6.2.3 Emergency response

Emergency response expenditure is the direct opex incurred in responding to network emergencies.[56] We measure emergency response costs per circuit km because network emergencies primarily affect power lines 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 overhead 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.

[56] A future area for examination is the consistency of the emergency response opex reported by DNSPs, as noted in Section 8.1.

Figure 20 shows that CitiPower, United Energy, Jemena, Ausgrid and Energex have higher emergency response cost per km relative to other DNSPs in the NEM. Similar to its maintenance costs, CitiPower has one of the highest emergency response opex spends per km of circuit length in the NEM. In comparison, Essential Energy, Ergon Energy, Powercor and Evoenergy have relatively low 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 20 Average emergency response spend per circuit km ($2021) (average 2017–2021)



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

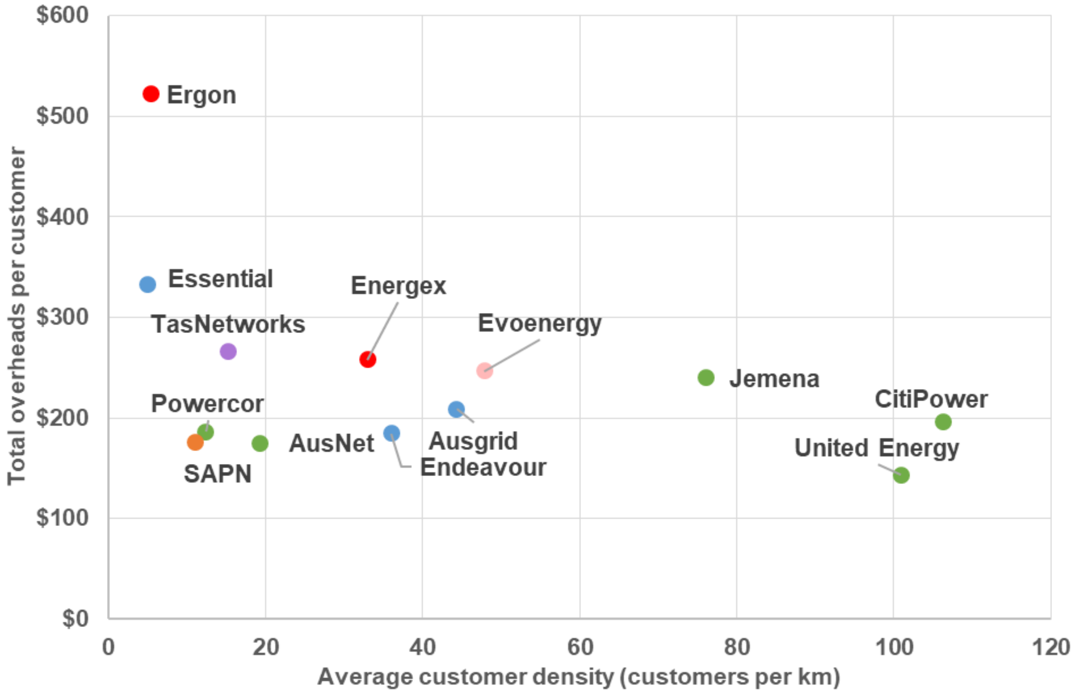
Note: Jemena's data excludes emergency response opex in 2016. Jemena claimed confidentiality on its emergency response data for these years in its Category Analysis RIN.

6.2.4 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 DNSPs' capitalisation policies do not affect the analysis.[57] 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 influence overhead costs. Figure 21 shows that Ergon Energy has higher overhead costs compared to all other DNSPs in the NEM, including those DNSPs with similar customer densities. While the 'per customer' measure may favour DNSPs with higher customer density, we do not consider this explains Ergon Energy's relative performance. This is because it has significantly higher costs relative to DNSPs of similar customer densities such as Essential Energy.

Figure 21 Total Overheads (totex) per customer ($2021) (average 2017–2021)



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

[57] By doing this, any differences in capitalisation policy between DNSPs, i.e. whether to expense or capitalise overheads, does not impact the comparison. This is important because there are differences in capitalisation policies between DNSPs, and some DNSPs have changed their polices over time. As mentioned in this report, we are currently consulting on the impact of capitalisation differences on our benchmarking.

7 The impact of different 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. We have also quantified many of the OEFs set out below to include in revenue determinations as a part of our opex efficiency analysis, particularly when using the results from the four opex econometric cost function models. See the box at the end of this section for more details on how we apply OEF adjustments to the opex econometric benchmarking model efficiency scores.

DNSPs do not all operate under the same operating environments. When undertaking a benchmarking exercise, it is desirable to take into account how 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.

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

- The benchmarking models (excluding the PPIs) account for differences in customer, energy and demand densities 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 opex cost function econometric models also include a variable for the proportion of power lines that are underground. DNSPs with more underground cables will, all else equal, face lower maintenance, vegetation management and emergency response costs and fewer outages.
- The opex included in the benchmarking is limited to the network service activities of DNSPs. This excludes 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 removing them better enables like-for-like comparisons.

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. As a result, we, and the consultants we engaged to provide us advice on OEFs in 2017, Sapere-Merz, used the following criteria to identify relevant OEFs.[58]

Criteria for identifying relevant OEFs

- 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.
- 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.
- 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 OEF. To do so would be to double count the effect of the OEF.[59]

Sapere-Merz identified a limited number of OEFs that materially affect the relative opex of each DNSP in the NEM, reflecting its (and our) analysis and consultation with the electricity distribution industry.[60] These are:

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

Sapere-Merz's analysis and report also provided:

- preliminary quantification of the incremental opex of each OEF on each DNSP in

[58] In 2017, we engaged Sapere Research Group and Merz Consulting ('Sapere-Merz') to provide us with advice on material OEFs driving differences in estimated productivity and operating efficiency between DNSPs in the NEM. For more details, see: Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018.

[59] 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 route length would double count the effect of line length on opex. Another example is that we exclude metering services from our economic benchmarking data. In this case, an operating environment adjustment for the metering services is not needed.

[60] 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.

the NEM, or a method for quantifying these costs

- 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.[61]

A brief overview of each of the material factors follows.

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 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 as they are more complex to maintain and higher voltage lines generally require specialised equipment and crews.[62] 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 most of the NSW and QLD DNSPs require 4–6% more opex to maintain their sub-transmission assets, compared to a reference group of efficient DNSPs. Conversely, TasNetworks requires 4% less opex because it has far fewer sub-transmission assets.[63]

Vegetation management

DNSPs are required to ensure the integrity and safety of overhead lines by maintaining adequate clearances from vegetation, which involves various activities (see section 6.2). Vegetation management expenditure accounts for between 10–20% of total opex for most DNSPs and can differ due to factors outside of their control. Some of these factors include:

- Different climates and geography affect vegetation density and growth rates, which may affect vegetation management costs per overhead line kilometre and the

[61] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 35.

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

[63] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 55.

duration of time until subsequent vegetation management is again required

- State governments, through enacting statutes, decide whether to impose bushfire safety regulations on DNSPs
- State governments also make laws on how to divide responsibility for vegetation management between DNSPs and other parties.

Sapere-Merz found that variations in vegetation density and growth rates, along with variations in regulation around vegetation management, are likely to be a material and exogenous driver of variations in efficient vegetation management opex. However, under its suggested methods, it could not quantify this OEF based on available data.[64] Sapere-Merz observed that while total vegetation management opex is collected, data about the spans impacted and the density of vegetation needs refinement and consultation with DNSPs to ensure consistency. Sapere-Merz noted that if reliable and consistent data was available, then an OEF could be estimated. It also proposed refinements in relation to regulatory (bushfire regulation and division of responsibility) data.[65]

Recognising this as an area for improvement, in 2020 we undertook some analysis into the quantity and quality of data related to vegetation management. Our main focus was assessment of network characteristic data in the RINs relating to spans, including the total number of vegetation management spans, with a view to calculating an OEF.[66] However, we were not able to develop any clear conclusions from this analysis due to concerns regarding the comparability and consistency of some of the data. For example:

- there may be some inconsistency in DNSPs' definitions of active vegetation management span
- differences in contractual arrangements and vegetation management cycles.

While not able to use Sapere-Merz's suggested methodology, or our further work, to quantify the impacts of any differences arising due to vegetation management, in our most recent revenue determinations for Queensland and Victorian DNSPs we included a vegetation management OEF in our benchmarking analysis.[67] This used the same

[64] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, pp. 65–66.

[65] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, pp. 67–68.

[66] A span refers to the distance between two poles. If a DNSP records poles rather than spans, the number of spans can be calculated as the number of poles less one. Total vegetation management spans refer to the number of spans in a DNSP's network that are subject to active vegetation management practices (i.e. not merely inspection) in the relevant year.

[67] AER, *Final decision Ergon Energy distribution determination 2020−25 Attachment 6 - Operating expenditure*, June 2020, p. 25; AER, *Draft decision Energex distribution determination 2020−25 Attachment 6 - Operating expenditure*, June 2020, p. 57–79; AER, *Final decision Jemena distribution determination 2021−26 Attachment 6 - Operating expenditure*, April 2021, pp. 29–30; AER, *Final decision AusNet Services distribution determination 2021−26 Attachment 6 - Operating expenditure*, April 2021, pp. 28–29.

method as in the previous (2015) Queensland determination and involved the summation of two exogenous factors:

- Differences in vegetation management obligations relating to managing bushfire risk
- Differences in the division of responsibility for vegetation clearance with local councils, road authorities and landowners.

As done in 2015, we quantified the differences in the costs related to bushfire obligations by examining the increase in costs faced by Victorian DNSPs following the 2009 Black Saturday bushfires. These reflect an incremental difference in bushfire risk and responsibilities between the Victorian and non-Victorian DNSPs. This quantification was based on forecast costs of step changes and opex pass throughs for the Victorian DNSPs that we approved for the 2011–15 period. The increased opex incurred as a result of these new regulations is used as a proxy for the differences in costs of managing bushfire risks in Victoria compared to other states. We updated the cost estimates for the relevant benchmark periods and new comparator benchmark DNSPs.

We calculated a division of responsibility OEF for Ergon Energy and Energex[68] to reflect the cost disadvantage these DNSPs face in the scale of vegetation management responsibility compared to the benchmark comparator firms in Victoria and South Australia. This is because in Queensland DNSPs are responsible for vegetation clearance from all network assets, whereas other parties such as councils, landowners and roads authorities are responsible for some vegetation clearance in Victoria and South Australia. We derived the OEF adjustment by calculating:

- How much of the vegetated lines in Victoria and South Australia were managed by parties other than the DNSPs (e.g. local councils) in those states, and
- Then multiplying the proportion of opex that relates to vegetation management by the proportionate increase in responsibility the Queensland DNSPs faced relative to the Victorian and South Australian distribution businesses.

In light of the further work we have done to improve the models setting out the OEF adjustments, and how these are used in our opex efficiency analysis (noted in Section 5), we received feedback from several DNSPs in relation to the above approach to calculating the vegetation management OEF. Evoenergy, CitiPower, Powercor and United Energy, Essential Energy and AusNet Services raised concerns about the above method and did not consider it appropriate to apply to this approach to the benchmarking results without further refinement.[69] Evoenergy noted that the vegetation management

[68] This OEF adjustment is by definition zero for any Victorian or South Australian DNSP since the cost disadvantage is calculated by comparison to the division of responsibility applying in Victoria or South Australia.

[69] Evoenergy, *Email to AER – Refined benchmarking roll-forward model and OEF spreadsheets,* received on 19 August 2022*;* Essential Energy, *Email to AER – Refined benchmarking roll-forward model and OEF spreadsheets,* received on 21 August 2022; AusNet Services, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 30 August 2022; CitiPower, Powercor and United Energy, *Email to AER – AER 2022 Annual Benchmarking Report for distribution - preliminary benchmarking results,* received on 26 August 2022.

OEF as currently calculated does not reflect the risk of bushfires and impact on vegetation management costs, but rather the impact of bushfire-related regulations imposed on Victorian networks in 2011. Further, that there have been changes to Evoenergy's vegetation management obligations in 2018 that were not currently taken into account. AusNet Services and CitiPower, Powercor and United Energy did not consider the division of responsibility for vegetation clearance to be a material factor. Jemena recommended that the AER update one of the key numbers used in the calculation of the division of responsibility factor.

These DNSPs also encouraged the AER to consult more broadly and transparently to develop a more appropriate method to calculate a vegetation management OEF. As discussed in Section 8, we intend to consult further with DNSPs in refining the data and methodology for calculating this OEF.

Cyclones

Cyclones require a significant operational response including planning, mobilisation, fault rectification and demobilisation. DNSPs in tropical cyclonic regions may also have higher insurance premiums and/or higher non-claimable limits. Ergon Energy is the only DNSP in the NEM that we benchmark 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.[70]

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%). However, Sapere-Merz estimated that TasNetworks requires 5% more opex than other DNSPs due to significant costs imposed by the Tasmanian Electrical Safety Inspection Levy.[71]

In its submission on this year's draft report, AusNet Services requested that the AER confirm that the latest taxes and levies data it provided would be used for the calculation of its taxes and levies OEF. The data provided by AusNet Services covers seven different categories of taxes and levies across the 2009 to 2015 financial years: land tax, water rates, council rates, an Ombudsman levy, regulator fees, a fire services levy, and

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

[71] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 72.

other government charges and levies. Currently, only the Ombudsman levy from 2010 to 2015 is used in the OEF calculation. As noted in Section 8.1, we will review the appropriateness of this calculation as part of our ongoing incremental improvement of the benchmarking datasets and methods.

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. On the basis of information provided by Evoenergy, Sapere-Merz estimated that Evoenergy requires 1.6% more opex than other DNSPs in the NEM to manage backyard power lines in the ACT.[72]

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 (particularly wooden poles) 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. Its preliminary analysis suggested that termite exposure primarily affects Ergon Energy and Essential Energy, where they require 1% more opex to manage termites.[73] Ausgrid has recently noted a data error in the number of wooden poles owned by Ausgrid used in previous calculations of this OEF. This will be corrected for future applications.

Network accessibility

Some DNSPs may incur higher cost of network access to undertake route maintenance (e.g. due to adverse climate and heavy rainfall). In its final report, Sapere-Merz noted that a network accessibility OEF for Power and Water in the Northern Territory would require further data and analysis to determine if it met the OEF criteria.[74]

In our most recent revenue determination for Ergon Energy, we included a network accessibility OEF in our benchmarking analysis.[75] We had included this OEF in our previous (2015) Ergon Energy decision, and considered that the network accessibility

[72] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 80.

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

[74] Sapere Research Group and Merz Consulting, *Independent review of Operating Environment Factors used to adjust efficient operating expenditure for economic benchmarking*, August 2018, p. 31.

[75] AER, *Final decision Ergon Energy distribution determination 2020−25 Attachment 6 - Operating expenditure*, June 2020, pp. 23–24.

circumstances faced by Ergon Energy have likely not changed since our 2015 assessment.[76] We relied on our 2015 assessment approach, with updated data on network without standard vehicle access up to 2018. Where this OEF is relevant and data is satisfactory, we intend to apply this approach.

How we apply OEF adjustments to the benchmarking scores

As discussed at the end of Section 5 in relation to the econometric opex cost function models, we use a 0.75 benchmark comparator point to assess the relative operating efficiency of DNSPs (the best possible efficiency score is 1.0.) We adjust the benchmark comparison point for opex for the impact of material differences in the OEFs between the business and the benchmark comparators that are not already captured in the modelling. The benchmark comparators are those DNSPs that have an econometric model-average efficiency score above the 0.75 benchmark comparison score.

To calculate the adjustment for an OEF for a particular DNSP, the cost of that factor as a percentage of (efficient) opex is compared with the customer-weighted average cost percentage for the comparator DNSPs. Where this difference is positive (negative), indicating a relative cost disadvantage (advantage) for that DNSP, this results in a positive (negative) OEF adjustment. We apply the OEF adjustment by adjusting the 0.75 benchmark comparison point (upwards for negative OEFs, downwards for positive OEFs). This adjusted comparison point is then compared to the business's efficiency score (from the benchmarking models), allowing us to account for potential cost differences due to material OEFs between the business and the benchmark comparison businesses.

The application of OEF adjustments as described above is illustrated with the following hypothetical example of a DNSP with a 'raw' opex efficiency score of 0.50 and which faces an exogenous condition unique to its operating environment and its attendant costs. As shown below, the 0.75 comparator point is as a result adjusted downwards to 0.68.

Hypothetical example:

A	Raw benchmarking efficiency score	0.5
B	Efficient total opex ($ million)	100
C	Opex on unique operating environment factor ($ million)	10
D	OEF as a percentage of total opex (C/B)	10/100=0.10
E	Adjusted 0.75 comparator point (0.75/(1+D))	0.75/(1+0.10)=0.68
F	Efficiency adjustment to period average opex (1-(A/E))	(1-0.5/0.68)=27%

We do not expect to be able to quantify and apply OEF adjustments for all operating environment differences between DNSPs; however, we consider that the OEFs we do

[76] AER, *Preliminary decision Ergon Energy distribution determination 2015−20 Attachment 7 - Operating expenditure*, April 2015, p. 248; AER, *Final decision Ergon Energy distribution determination 2015−20 Attachment 7 - Operating expenditure*, October 2015, p. 53.

apply, listed in Section 7 above, capture the most material differences in addition to those already captured in the modelling. More detail on the mechanics of our approach is contained in past decisions and our work in 2022 to improve the models setting out the OEF adjustments.[77]

[77] AER, *Preliminary decision, Ergon Energy determination 2015–20, Attachment 7 – Operating expenditure*, April 2015, pp. 93–138; AER, *Draft decision, Ausgrid distribution determination 2019–24, Attachment 6 – Operating expenditure*, November 2018, pp. 31–33; AER, *Draft decision, Endeavour Energy distribution determination 2019–24, Attachment 6 – Operating expenditure*, November 2018, pp. 27–29.

8 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 and applicability 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, changes and improvements that have the potential to materially affect the benchmarking results and the way they are used that should involve consultation with affected stakeholders.

Our past annual benchmarking reports outlined recent benchmarking improvements and our priorities for future development work.[78] Our future development program has been informed by submissions we received from DNSPs and other stakeholders. This included submissions to our annual benchmarking reports (including the preparation of this report), issues raised throughout revenue determination processes, and specific reviews such as our capitalisation and export services reviews.

This year we examined the data issue around how to manage the transition of the Victorian DNSPs from a calendar year basis to a financial year basis in 2021. This involved considering two possible options and consulting with stakeholders about our preferred approach of using both calendar year and financial year data for the Victorian DNSPs. This preferred approach has been implemented in this report.

In addition, we have undertaken work to improve the models which implement the opex efficiency modelling, particularly in terms of the transparency and usability of these models. This included the models calculating and comparing the opex efficiency scores, as well as those calculating the OEFs that are used to adjust the benchmarking comparison point. Further, in terms of the opex efficiency benchmarking, building on last year's work, this year we have considered, with Quantonomics, possible further options for improving the reliability performance of the Translog econometric opex cost function models (see Section 8.1).

This year we also have advanced our thinking around the implications of capitalisation differences on the benchmarking results with the release of a draft guidance note (see Section 8.2.1) and we commenced a consultation and review process in relation to whether the benchmarking needs to be updated to account for export services and if so how this would best be done (see Section 8.2.2). Due to competing priorities, including these reviews which are in progress, resource availability, we did not progress the

[78] AER, *2019 Annual Benchmarking Report, Electricity distribution network service providers*, November 2019, pp. 41–42; AER, *2020 Annual Benchmarking Report, Electricity distribution network service providers*, November 2020, pp. 51–58; AER, *2021 Annual Benchmarking Report, Electricity distribution network service providers*, November 2021, pp. 53–61.

independent review of the non-reliability weights in the PIN benchmarking. It remains an important development priority to progress and we aim to complete the review in the 2023–24 financial year.

We discuss the areas for incremental improvement and specific issues for investigation in the sections below.

8.1 Ongoing incremental improvement

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

- Continual data refinements in response to our annual review of Economic Benchmarking RIN data and data issues identified by stakeholders. For example, emergency response cost data inconsistencies[79] and whether GSL payments should be included in opex for benchmarking purposes.[80] In its submission on this year's draft report, AusNet Services suggested that the report should include sensitivity analysis showing the impact of excluding GSL payments (as well as natural disaster pass through amounts) on benchmarking results.[81] We acknowledge that it would be a useful to see the materiality of the impact of excluding GSL payments on benchmarking results; however, at this stage as the GSL data is provided as a descriptive category in the Economic Benchmarking RINs, and only some DNSPs choose to report these costs it is not clear our current data would be sufficient to do this across all DNSPs.
- Improving the way we measure the quantity of lines and cables inputs. We collect DNSP-specific voltage capacity data, measured in megavolt amperes (MVA), for lines and cable by broad voltage category and ask DNSPs to allow for operating constraints. However, DNSPs have adopted a wide range of, and in some cases, frequently changing methods to estimate the constrained MVAs. We plan to explore alternative measures to improve consistency, including 'nameplate' capacity of the installed lines and cables. To reduce the data burden on DNSPs, this information could be collected for a 'snap shot' year for each DNSP and those values applied to other years for the DNSP.
- Examining the weight allocated to the reliability output in the PIN models and whether it should be capped in some way to account for year-to-year fluctuations in exogenous factors, primarily weather, that unduly impact reliability performance and productivity growth results. Currently, the reliability output, customer minutes off-

[79] Note this issue was raised by Energy Queensland in its submission to the draft 2020 benchmarking report. Energy Queensland, *Submission to 2020 AER draft benchmarking report*, 10 November 2020, p. 5.

[80] SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2.

[81] AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–4.

supply, enters the models as a negative output and is weighted by the value of customer reliability. It is already calculated exclusive of major event days and 'excluded' outages.

- Improving, where possible, the reliability performance of the Translog econometric opex cost function models, particularly in relation to satisfying the key monotonicity property that an increase in output can only be achieved with an increase in inputs, holding other things constant. This issue is outlined in Section 5 and in a memorandum accompanying Quantonomics' 2022 benchmarking report and results.[82] We recognise that this issue has generally become more prevalent since 2018.
  - The Translog functional form is, by design, more flexible than the Cobb-Douglas form, through the addition of 'second-order' terms in the output specification.[83] The downside of this flexibility is that the monotonicity property is not necessarily satisfied for all observations in the data sample.
  - Following on from the work done by Economic Insights last year, Quantonomics has explored the potential suitability of three hybrid models, which are a hybrid of the more restrictive Cobb-Douglas and more flexible Translog functional forms. The rationale for testing hybrid models is that the monotonicity problems are likely the result of having second-order terms in the more flexible Translog form which cannot be reliably estimated by the data used. By removing some second-order terms while retaining others in this model, the alternative models tested are still more flexible than the Cobb-Douglas three-output models. The initial results indicate reduced frequency of violations of the monotonicity property over various different sample periods tested.
  - Although the performance of the three hybrid model specifications tested by Quantonomics this year show promise in relation to the monotonicity property, they also have some limitations. In particular, the 'second-order' terms in the hybrid models are not found to be consistently statistically significant across different time periods and estimation methods.
  - At this stage and with only one year of testing, we are not convinced that there is enough evidence to replace the Translog models with the hybrid models where there are violations of the monotonicity property; however, we are still open to the possibility of using these or other hybrid model specifications in future
  - We also consider any future testing of hybrid models should involve consideration of, and the likely a trade-off between:
    - The theoretical economic basis of model specification
    - Performance in relation to the monotonicity property described above

[82] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2021 DNSP Benchmarking Report*, November 2021, pp. 28–34

[83] In econometric models, first-order terms have a linear relationship to the dependent variable, and second-order terms have a quadratic relationship to the dependent variable. In addition to the Cobb Douglas model's first-order terms, the Translog model also includes quadratic and interaction terms in the outputs.

  - Statistical significance of 'second-order' terms
  - Robustness of parameter estimates for 'second-order' terms across time periods and estimation methods
  - Consistency of efficiency scores with the base Cobb-Douglas and Translog models
  - Sustained performance over time.

- Quantonomics also explored an alternative estimation method to reduce the weight given to outlying observations, which showed promise in relation to monotonicity and for the statistical significance of 'second-order' terms; however, it does not use one of the preferred modelling assumptions used to date and the consistency of efficiency scores with the base Cobb-Douglas and Translog models would need to be assessed. This alternative estimation method has recently been developed in the literature and has not been widely adopted at this stage.
- As noted in Sections 1.2 and 1.3, in response to the AER's draft of this year's report, most stakeholders suggested that the AER should give stakeholders more time to consider the latest work from Quantonomics on the reliability performance of the Translog econometric opex cost function models, possibly through a separate consultation process.[84] In response to this feedback, we are now asking stakeholders to provide submissions by Friday, 10 February 2023, so that we may consider any submissions and this issue in preparing our 2023 Annual Benchmarking Report. Jemena was the only stakeholder that considered the issue in detail and submitted that the Translog models produce unreasonable results even in the absence of monotonicity violations, and therefore should not be used for benchmarking and regulatory decision making.[85] We will consider this argument in more detail alongside further submissions we receive from other stakeholders on the reliability performance of the Translog econometric opex cost function models.

- Continuing to improve and update the quantification of material OEFs working with DNSPs. Improving the data and quantification of the vegetation management OEF will be a future focus, as discussed in Section 7, including as some DNSPs have submitted that our current approach to calculating the vegetation management OEF is not appropriate. We also intend to implement any potential incremental refinements to our approach to other OEFs where appropriate, for example Ausgrid's feedback about a data error detected in the termite OEF calculation and

[84] Evoenergy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; Ausgrid, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; Energy Queensland, *Submission to 2022 AER draft distribution benchmarking report*, 25 October 2022, p. 2; Essential Energy, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; SA Power Networks, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2; AusNet Services, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1; Energy Networks Australia, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 2.

[85] Jemena, *Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 2–6.

AusNet Services' feedback about a possible data error detected in the taxes and levies OEF calculation, as well as improvements to communicating the impact of OEFs on raw efficiency scores through an additional chart in future benchmarking reports, as suggested by AusNet Services.[86] However, at this stage it is unlikely that we will undertake a holistic review of all OEFs. We continue to see refinement of OEFs as an important area of development work.

8.2 Specific issues for investigation

In addition to the above incremental development work, consistent with last year, we consider the following key issues require specific investigation and a degree of consultation with stakeholders:

- The implications of cost allocation and capitalisation differences on the benchmarking results – in progress
- Examining whether the benchmarking needs to be updated to account for export services and if so how this would best be done – in progress
- Undertaking an independent review of the non-reliability output weights used in the PIN benchmarking
- The choice of benchmarking comparison point when making our opex efficiency assessments (as explained below)
- If and how Northern Territory DNSP Power and Water Corporation should be included in our benchmarking.

These issues are discussed briefly below.

8.2.1 Differences in cost allocation and capitalisation approaches

In recent years, we have received submissions and feedback from some stakeholders in relation to the implications of cost allocation and capitalisation differences, and ongoing changes, on the benchmarking results. It suggests that these differences are leading to differences in benchmarking results that are unrelated to the efficiency of DNSPs and that some DNSPs are disadvantaged due to their cost allocation/capitalisation decisions. Some DNSPs have put forward suggested approaches for how differences in capitalisation practices can be addressed, e.g. benchmarking on the basis of a proportion of overheads that is fixed for all DNSPs or on the basis of a common opex/totex ratio for all DNSPs.[87] We have also observed a number of changes in cost allocation methods by DNSPs since we began benchmarking.

[86] AusNet Services*, Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, pp. 1–2.

[87] For further details on stakeholder submissions, including references, see: AER*, 2020 Annual Benchmarking Report, Electricity distribution network service providers*, November 2020, pp. 83–85; AER, *Final Decision Jemena Distribution Determination 2021 to 2026, Attachment 6 Operating expenditure*, April 2021, pp. 80–85.

At the end of November 2021, we released with our 2021 Annual Benchmarking Report a consultation paper about the impact of capitalisation differences on the benchmarking results.[88] It set out options and our views on the various elements of this issue, including how capitalisation differences and their impact on benchmarking should be measured, and how material impacts (if any) on our benchmarking should be addressed.

We received submissions at the end of February 2022. We considered these and undertook further analysis and released a draft guidance note at the end of October 2022 and are currently seeking submissions to inform the final guidance note.[89]

The preferred approach in the draft guidance note to address difference in capitalisation practices is to allocate a fixed proportion of overheads expenditure to the opex series used for benchmarking purposes. To the extent that DNSPs' varying allocations of overheads drives differences between reported opex and benchmarking opex, this should remove the need to highlight the impact of using reported opex on benchmarking results, as suggested by some stakeholders.[90]

We expect to finalise the final guidance note in 2023 and will incorporate the proposed approach to address capitalisation issues into future annual benchmarking reports as appropriate.

8.2.2 Review of benchmarking modelling to account for export services

In the past we have received submissions from some stakeholders about the impact that export services, are having, or are likely to have, on DNSPs' comparative benchmark performance.[91] Further, the NER was updated in August 2021 to require the AER to consult on how it will take into account the changes in the NER relating to export services on the annual benchmarking reports by 1 July 2022.[92]

In August 2022 the AER released a consultation paper in relation to incentivising and measuring export services, which included consideration of the issues around the impact of export services on benchmarking.[93] In particular it was discussed whether the benchmarking approach needs to be updated for export services and options for how

[88] AER, *How the AER will assess the impact of capitalisation differences on our benchmarking – Guidance note – Consultation,* November 2021.

[89] AER, *How the AER will assess the impact of capitalisation differences on our benchmarking – Guidance note – Draft guidance,* October 2022.

[90] AusNet Services*, Submission to 2022 AER draft distribution benchmarking report*, 26 October 2022, p. 1.

[91] AER, *2020 Annual Benchmarking Report, Electricity distribution network service providers*, November 2020, pp. 55–57.

[92] For more details, see: https://www.aemc.gov.au/rule-changes/access-pricing-and-incentive-arrangements-distributed-energy-resources.

[93] AER, *Consultation Paper, Incentivising and measuring export service performance*, August 2022. Recognising the synergies between the three topics incorporated into this Consultation paper (incentive arrangements for export services, annual performance measurement of export services and annual benchmarking of export services) a consolidated consultation process is being undertaken, meaning the 1 July 2022 date for the benchmarking review was not met.

we could do this if required. Feedback was sought on these issues and on our proposed two-staged approach for considering options, firstly on if and how we can calculate an export services OEF for use in the AER's opex efficiency assessments and then later consulting on broader options for changing benchmarking model specifications.

The AER receiving submissions from stakeholders at the end of September 2022, which informed the publishing of a draft report in November 2022.[94] After receiving further submissions, we intend to publish a final report in early March 2023. It is proposed the outcomes of the final report will be incorporated into subsequent annual benchmarking reports for distribution as appropriate.

8.2.3 Independent review of the non-reliability output weights in the PIN benchmarking

In the 2020 Annual Benchmarking Report for distribution we made changes to the non-reliability output weights used in the PIN benchmarking to correct an error identified in how these weights had been calculated in previous years' reports.[95] Following this, and submissions from stakeholders indicating broad support, we noted in the 2021 Annual Benchmarking Report that we considered it was appropriate to undertake an independent review that would:

- Review whether the data used, and computation undertaken, under the current approach produces the correct non-reliability output weights
- Review the current approach used to produce non-reliability output weights setting out the advantages and disadvantages of this approach
- Explore whether there are any other feasible and / or improved approaches that could be used to determine the non-reliability output weights and the advantages and disadvantages the other feasible approaches.

We considered this was an appropriately targeted and manageable scope and an important piece of work. Due to competing priorities, including the other reviews in progress, resource availability, the independent review did not occur this year. It remains an important development priority to progress and we aim to complete the review in the 2023–24 financial year.

8.2.4 Benchmarking comparison point

The AER's Consumer Challenge Panel has previously advocated for a review of the selection of the benchmark comparison points that we use in our regulatory decisions.[96] In our opex decisions as a part of the revenue determinations, we draw on the efficiency scores from our econometric opex cost function models (as contained in section 5 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

[94] AER, *Draft report, Incentivising and measuring export service performance*, November 2022.

[95] AER, *2020 Annual Benchmarking Report- Electricity distribution network service providers*, November 2020, pp. 3–7.

[96] CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 13.

comparison score of 0.75 (adjusted further for OEFs as set out in section 7), which reflects the upper quartile of possible efficiency scores by DNSPs. The Consumer Challenge Panel has advocated for the 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, other uncertainties when forecasting efficient opex and quantification of OEFs. We consider that it is appropriate to be conservative while our benchmarking models and OEF assessments are maturing and the underlying data and methods are being refined as set out above. 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 that are set out above which we make to our benchmarking approaches and metrics over time.

As noted in Section 3, given the sustained opex productivity growth observed for DNSPs in recent years, we may also consider at the same time whether it would be appropriate to review our 0.5% per year opex productivity growth rate assumption for DNSPs used in regulatory decisions.

8.2.5 Power and Water Corporation benchmarking

Under section 6.27A of the NER (Northern Territory), Power and Water Corporation (‘Power and Water’) is a relevant DNSP for our annual benchmarking report. Power and Water transitioned to the NER in 2018 but has not been included in our previous annual benchmarking reports. This is because its benchmarking and regulatory data is relatively immature compared to other DNSPs in the NEM and needs to be 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 intend to work with Power and Water to examine its benchmarking data and operating environment, including its size and remoteness, to determine if benchmarking is fit for purpose in its context. This would be done separately to the process of assessing Power and Water’s base opex efficiency in its upcoming revenue determination.

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
MW	Megawatt
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
Opex	Operating expenditure
PCR	Powercor
RAB	Regulatory Asset Base
RIN	Regulatory Information Notice
SAP	SA Power Networks
TND	TasNetworks (distribution)
UED	United Energy

Glossary

Term	Description
Efficiency	A DNSP's 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 physical measures 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. In this year's annual benchmarking report, we also apply the method to time-series TFP analysis at the industry and State level and for individual DNSP to better capture large customer minutes off supply changes.
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.
OEF	Operating Environment Factor. 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 measure aggregated outputs relative to aggregated inputs using a mathematical index.
PPI	Partial Performance Indicator. PPIs are simple techniques that measure the relationship between one input and one output.
RMD	Ratcheted Maximum Demand. RMD 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 the 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 changes over time or growth rates to be compared across networks. This method was used in previous annual benchmarking reports (up to 2019) to examine productivity change over time at the DNSP level and the industry level.
VCR	Value of Customer Reliability. VCR represents a customer's willingness to pay for the reliable supply of electricity.

A References and further reading

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

Quantonomics publication

The following publication explains in detail how Quantonomics applied the economic benchmarking techniques used by the AER:

- Quantonomics, *Economic Benchmarking Results for the Australian Energy Regulator's 2022 DNSP Benchmarking Report*, November 2022

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 2021 DNSP Benchmarking Report*, November 2021
- Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 DNSP Benchmarking Report*, 13 October 2020
- Economic Insights, A*ER Memo Revised files for 2019 DNSP Economic Benchmarking Report*, 24 August 2020
- 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*, 4 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*, 14 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, Final Decision, *Jemena distribution determination 2021–26 - Attachment 6 - Operating Expenditure*, April 2021 (link)
- AER, Draft Decision, *Jemena distribution determination 2021–26 - Attachment 6 - Operating Expenditure*, September 2020 (link)
- AER, Final Decision, *AusNet Services distribution determination 2021–26 - Attachment 6 - Operating Expenditure*, April 2021 (link)
- AER, Draft Decision, *Ergon Energy distribution determination 2020–21 to 2024–25 - 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, Final Decision, *Ausgrid distribution determination 2014–15 to 2018–19,* January 2019 (link)
- AER, Final Decision, *Jemena distribution determination 2016 to 2020 - Attachment 7 - Operating Expenditure*, May 2016, p. 7–22 (link)
- AER, Final Decision, *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 techniques, as well as the output and input data used in the benchmarking techniques.

Benchmarking techniques

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

PIN. These techniques use a mathematical index to measure outputs relative to 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 can be 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 and over time,[97] when 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.

Econometric opex cost function 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 — Least Squares Econometrics (LSE) and Stochastic Frontier Analysis (SFA) – and uses two types of functional form for each model – Cobb-Douglas and Translog.

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 costs) 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:

- OEFs. 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 include five outputs (the three outputs in the econometric models plus energy delivered and reliability). The PPIs include only one output variable per indicator.

[97] There may be minor differences in MTFP and TFP growth rates for a particular firm due to differences in the sample means used in the calculations.

- Estimation technique:
  - The MTFP model uses a non-parametric method.
  - Unlike the non-parametric index-based MTFP methods, econometric opex cost function models allow for statistical noise in the data and produce confidence intervals. For the econometric models, two alternative methods of identifying firm-specific inefficiency are used. One method, LSE, uses a variant of ordinary least squares (OLS) regression, incorporating dummy variables for 12 of the 13 Australian DNSPs.[98] The estimated coefficients with these DNSP-specific dummy variables are then transformed as measures of comparative efficiency among these DNSPs.
  - The other method uses stochastic frontier analysis (SFA) that assumes an inefficiency term (with truncated normal distribution) in addition to the random error term. In the SFA models opex efficiency scores are estimated relative to the estimated frontier.
  - The econometric models also estimate two different types of functional form — Cobb-Douglas and Translog. The combination of these two estimation methods and two functional forms gives four econometric models.
- Data. The productivity index models and the PPIs use Australian data only, whereas the econometric opex models use Australian data and overseas data.

Notwithstanding the differences in the features and data requirements of each model, the opex efficiency results 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 broad similarity between the results from the opex MPFP model and the opex econometric models is particularly noteworthy, given the very different approaches. This reinforces the confidence in the results from each model.[99]

Quantonomics' 2022 report provides more detail on the econometric methodology and modelling results. The Economic Insights November 2014 report referenced in Appendix A also provides more information about each model, and the rationale supporting the choice of input and output specifications used in this report.

Benchmarking data

This section of the 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 customers 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

[98] That is, one DNSP is treated as the 'base' and the estimated coefficients on the dummy variables for other Australian DNSPs represent their systematic variation against the base. Overseas DNSPs do not have individual dummy variables, but rather a country-specific dummy variable (with Australia as the 'base country', and hence no dummy variable to avoid dummy variable trap). It does not matter which DNSP is chosen as the base since comparative efficiency measures are subsequently scaled against the DNSP with greatest efficiency.

[99] Economic Insights, *Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs*, 17 November 2014, pp. 46–47.

been selected to reflect this goal.[100]

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 measure of the scale of the DNSP and 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.[101]
- Energy delivered (MWh). Energy throughput is a measure of the amount of electricity that DNSPs deliver to their customers. This output is included only in the PIN models, not in the econometric models.
- 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 customer reliability. This output is included only in the PIN models, not in the econometric models.
- Share of undergrounding: The opex cost function econometric models also include a

[100] The 17 November 2014 Economic Insights report referenced in Appendix A details the input and output weights applied to constructing the productivity index numbers. The 9 November 2018 Economic Insights report contains further information on the updated output weights, while the 13 October 2020 Economic Insights report contains detail on a correction to these weights due to a coding error.

[101] 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.

variable for the proportion of a DNSP's total circuit length that are underground. DNSPs with more underground cables will, all else equal, face less maintenance and vegetation management costs and fewer outages.

- The November 2014 Economic Insights referenced in Appendix A 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. When the economic benchmarking program commenced, Economic Insights incorporated comparable data from electricity DNSPs in Ontario and New Zealand to increase the size of the dataset and enable more robust estimation of the opex cost function models. Sensitivity analysis of the econometric opex benchmarking results (using cost functions generated with and without the overseas data) indicated that the addition of the overseas data improved the robustness of the econometric opex models (by allowing better estimation of the opex cost function parameters) without distorting the estimation of individual DNSPs' efficiency results. Appendix A contains references to further reading on how Economic Insights incorporated overseas data into the econometric models and the sensitivity analyses. This approach with the international data continues to be used in the benchmarking work undertaken by Quantonomics to update for the 2021 data.

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. Quantonomics prepared the benchmarking results using the set of agreed benchmarking techniques.[102] We provided the DNSPs with a draft version of the benchmarking report to allow each network to provide feedback on the results before we publicly released the final benchmarking report.[103]

The complete data sets for all inputs and outputs from 2006 to 2021, along with the Basis of Preparation provided by each DNSP, are published on our website.[104]

Outputs

The techniques in this 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, is a measure

[102] The Quantonomics 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.

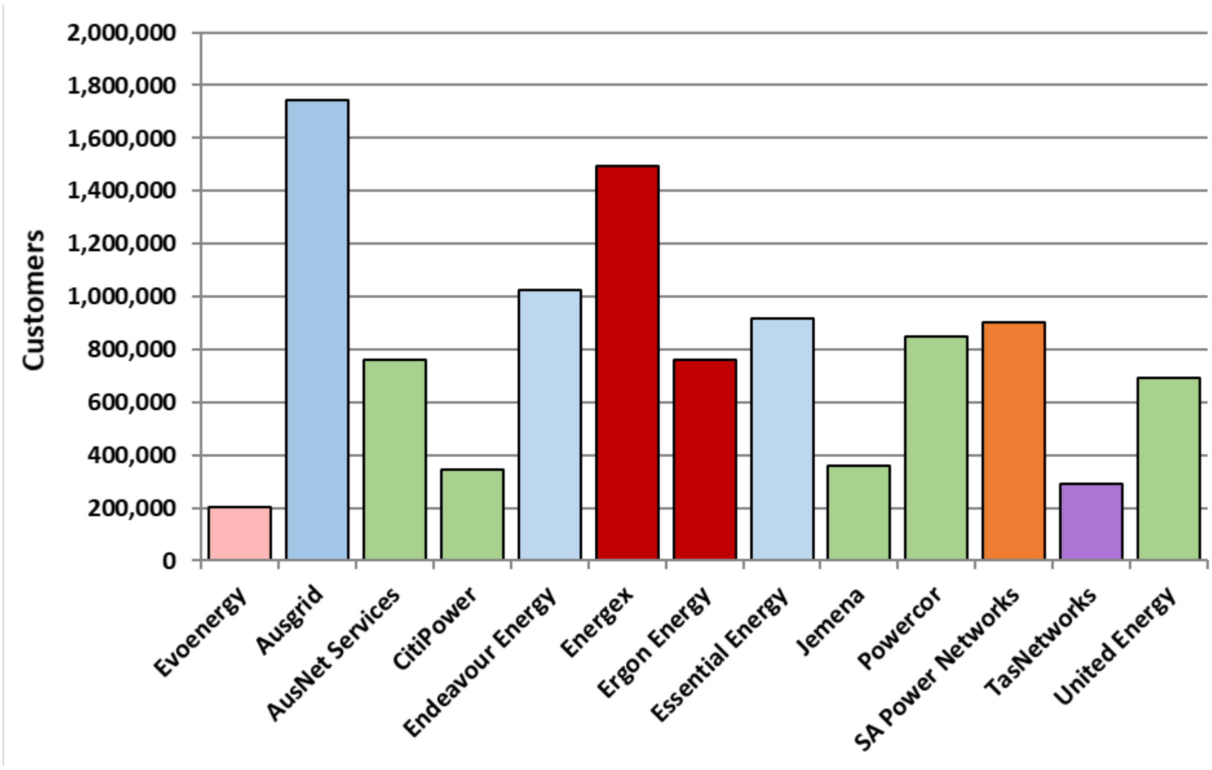
[103] NER, cll. 8.7.4(c)(1) and 8.7.4(c)(2).

[104] This dataset is available at www.aer.gov.au/networks-pipelines/performance-reporting.

of the services a DNSP provides.[105]

Figure B.1 shows the average customer numbers of each DNSP over the five-year period from 2017 to 2021.

Figure B.1 Five-year average customer numbers by DNSP (2017–2021)



Source: Economic Benchmarking RIN.

Circuit line length

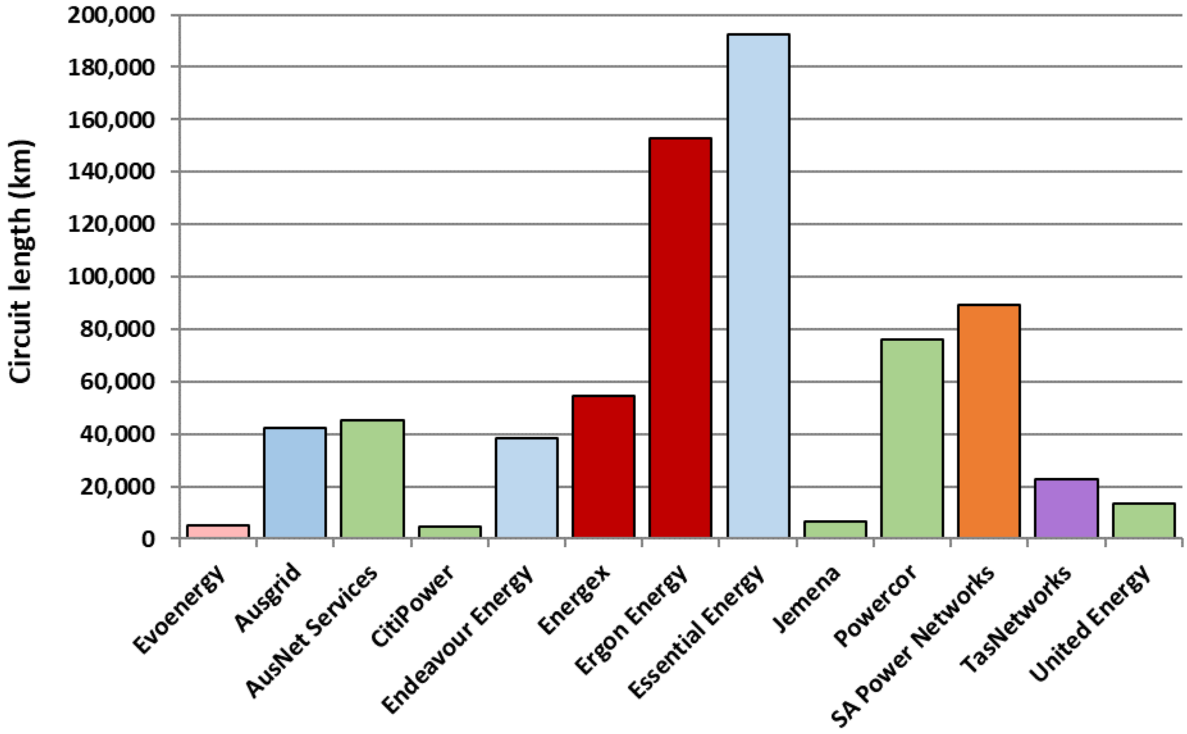
Line length reflects the distances over which DNSPs deliver electricity to their customers. To provide their customers with access to electricity, DNSPs must transport electricity from the transmission network to their customers' premises. DNSPs will typically operate networks that transport electricity 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 2017 to 2021.

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

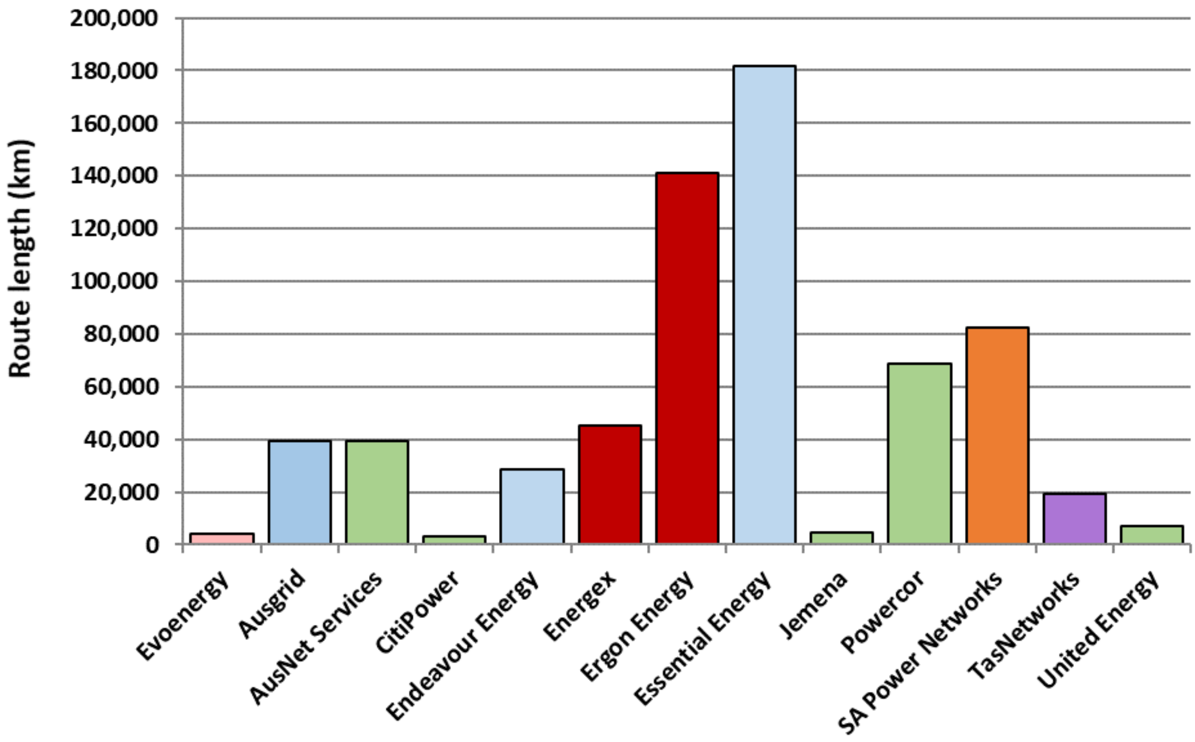
Figure B.2 Five-year average circuit line length by DNSP (2017–2021)



Source: Economic Benchmarking RIN.

For PPI metrics, we use route (rather than circuit) 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 on average over the period 2017–2021 is shorter than circuit length but there is little-to-no change in DNSP rankings. The only difference is with Ausgrid having a smaller circuit length than AusNet Services but a marginally larger route line length than AusNet Services on average over the past five years.

Figure B.3 Five-year average route line length by DNSP (2017–2021)



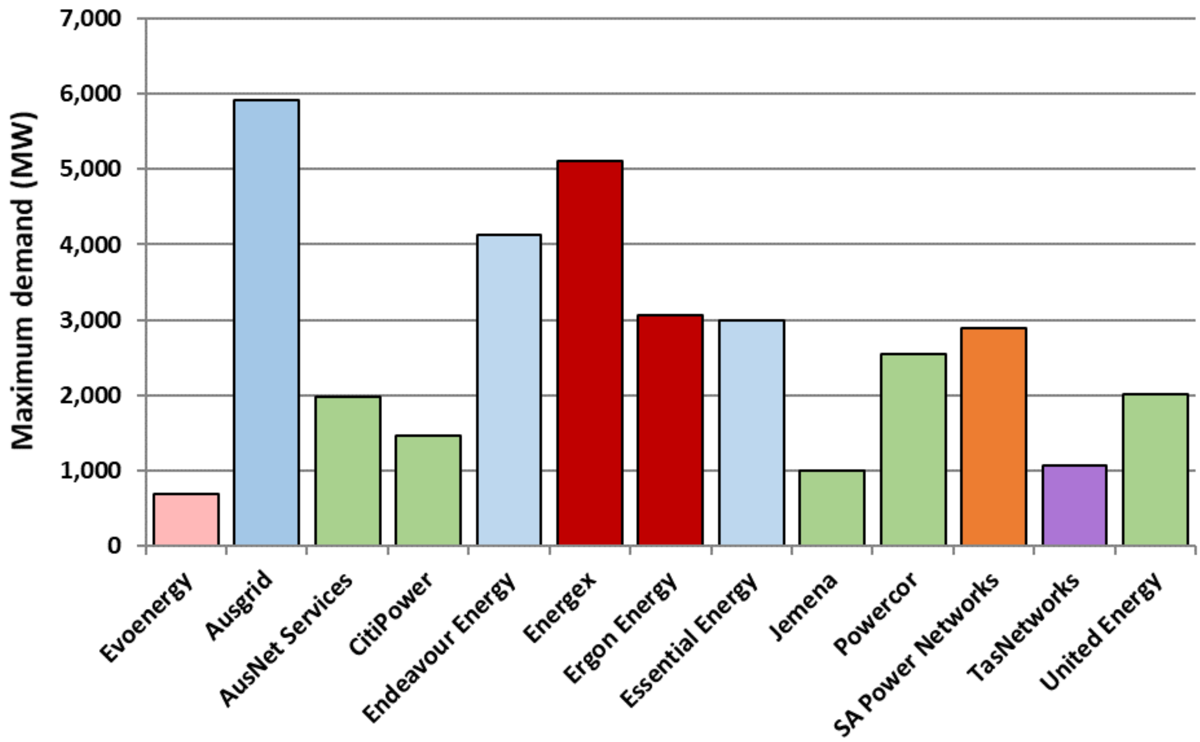
Source: Economic Benchmarking RIN.

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 megawatts (MW).

Figure B.4 shows each DNSP's maximum demand, on average, over the five years from 2017 to 2021.

Figure B.4 Five-year average maximum demand by DNSP (2017–2021)

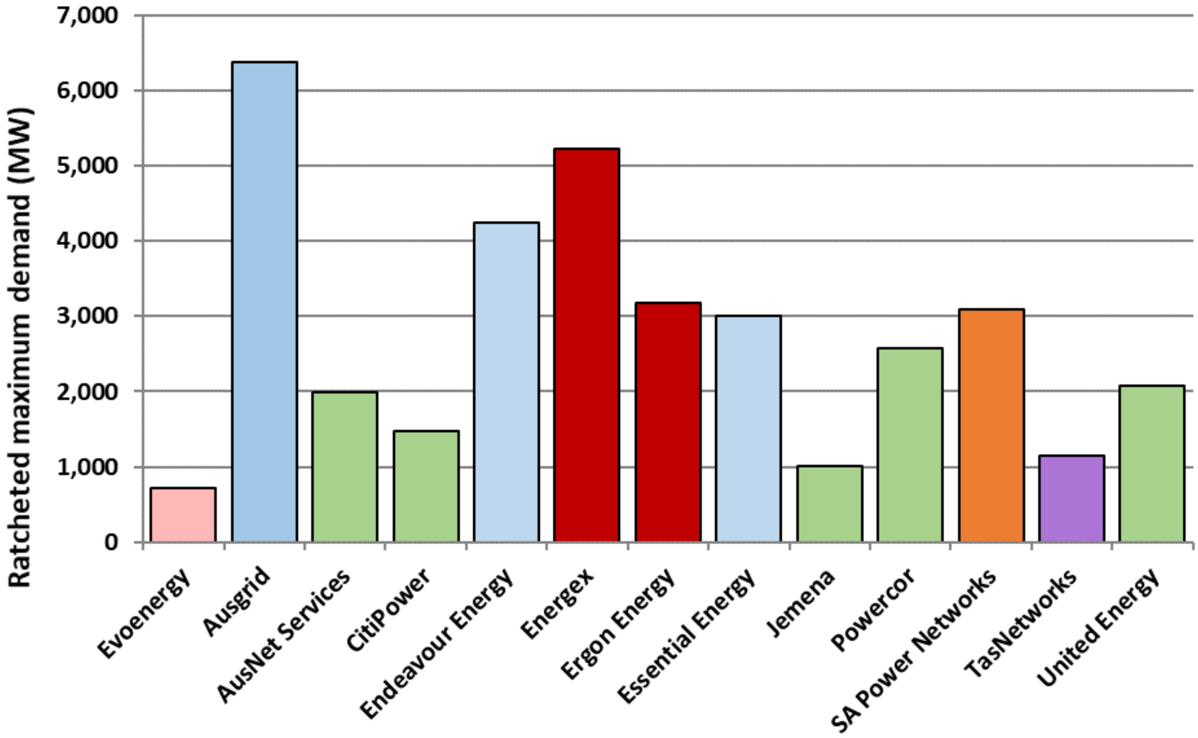


Source: Economic Benchmarking RIN.

The economic benchmarking techniques use 'ratcheted' maximum demand as an output rather than observed maximum demand. RMD 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.

Figure B.5 shows each DNSP's ratcheted maximum demand, on average, over the five years from 2017 to 2021.

Figure B.5 Five-year average ratcheted maximum demand by DNSP (2017–2021)



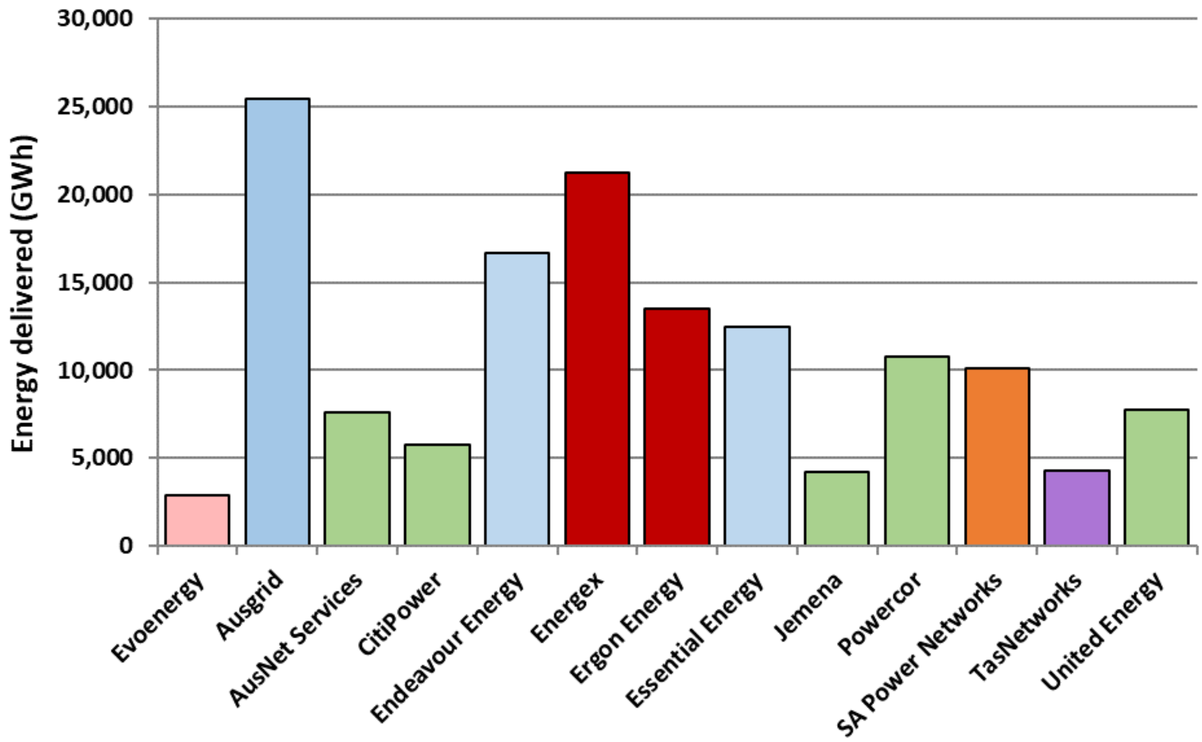
Source: Economic Benchmarking RIN.

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 major driver of costs (distribution networks are typically engineered to manage maximum demand rather than throughput) energy throughput reflects a service provided directly to customers and is a key part of what they pay for in their bills. Energy delivered is measured in Gigawatt hours (GWh).

Figure B.6 shows each DNSP's energy delivered, on average, over the five years from 2017 to 2021.

Figure B.6 Five-year average energy delivered by DNSP (2017–2021)

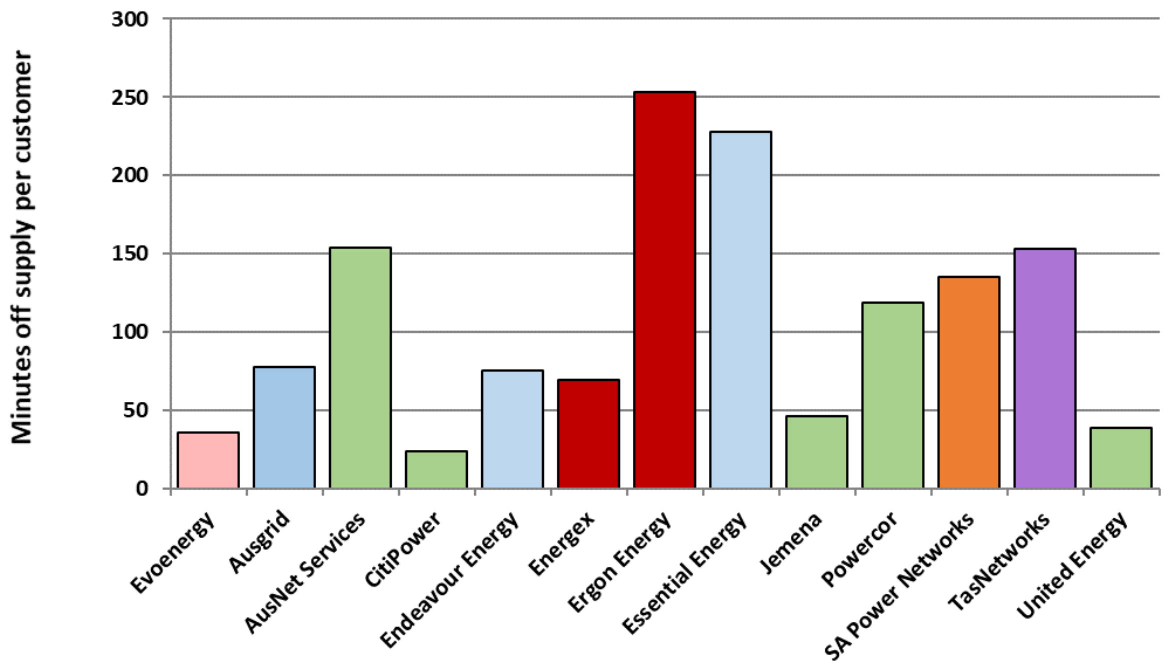


Source: Economic Benchmarking RIN.

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.7 presents for each DNSP the average annual number of minutes off-supply per customer over the 2017–2021 period, excluding the effects of major events, planned outages and transmission outages.

Figure B.7 Average annual minutes off supply per customer (2017–2021)

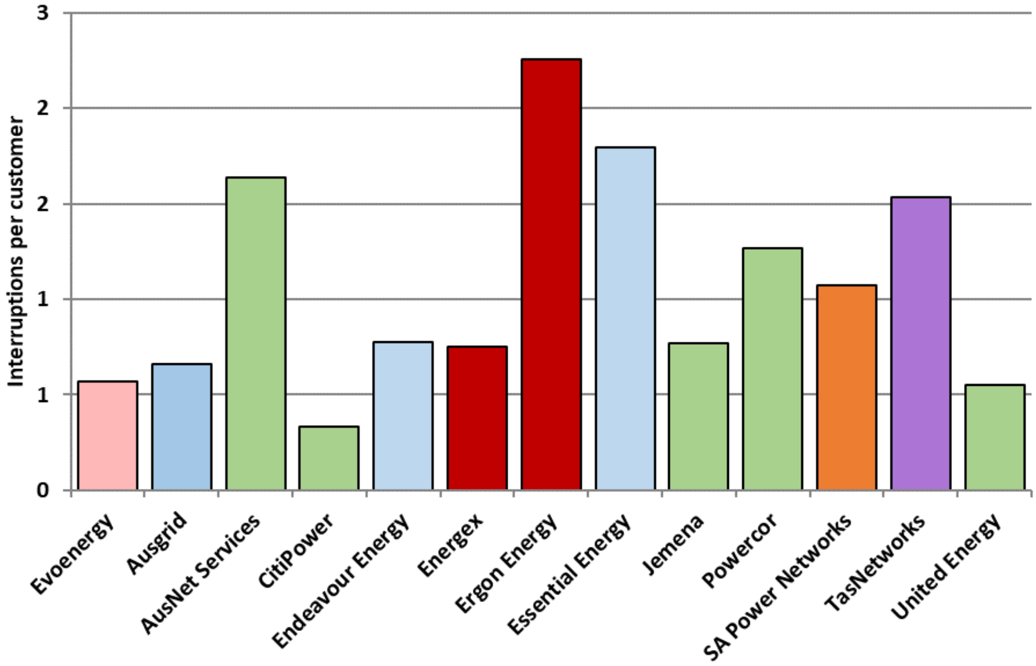


Source: Economic Benchmarking RIN.

Figure B.8 presents the average annual 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.8 Average annual number of interruptions per customer (2017–2021)



Source: Economic Benchmarking RIN.

Inputs

The inputs used in this report are capital (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 A 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,[106] we have adjusted the PPI analysis to remove assets associated with the first-stage of the two-step transformation at the zone substation 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 and is referred to as the annual user cost of capital.[107] 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.1 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.1 Average annual input costs for 2017–2021 ($m, 2021)

	Opex	Annual user cost of capital
Evoenergy (EVO)	55.5	102.5
Ausgrid (AGD)	466.4	1049.8
AusNet Services (AND)	217.0	335.1
CitiPower (CIT)	54.2	153.2
Endeavour Energy (END)	262.0	424.2
Energex (ENX)	375.2	642.6
Ergon Energy (ERG)	376.2	644.2
Essential Energy (ESS)	388.4	599.5
Jemena (JEN)	80.3	118.0
Powercor (PCR)	189.8	300.8
SA Power Networks (SAP)	259.4	446.7
TasNetworks (TND)	90.0	151.6
United Energy (UED)	122.7	213.2

Source: Economic Benchmarking RIN; AER analysis.

[106] Ausgrid, *Submission on the draft distribution benchmarking report 2016*, 14 October 2016, p. 3.

[107] To calculate the annual user cost of assets 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. The calculation of the annual user cost of capital reflects the AER’s Rate of Return Instrument 2018 for regulatory year 2021. In previous years the annual user cost of capital calculations broadly reflected the 2013 rate of return guideline. For more details, see: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/rate-of-return-instrument-2018/final-decision.