# Annual Benchmarking Report

## Electricity distribution network service providers

November 2017

AUSTRALIAN ENERGY REGULATOR

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# Contents

# Shortened forms

| Shortened form | Description |
|---|---|
| AEMC | Australian Energy Market Commission |
| AER | Australian Energy Regulator |
| ACT | ActewAGL |
| 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 |
| IEEE | Institute of Electrical and Electronics Engineers |
| JEN | Jemena Electricity Networks |
| MW | Megawatt |
| NEL | National Electricity Law |
| NEM | National Electricity Market |
| NER | National Electricity Rules |
| Opex | Operating expenditure |
| PCR | Powercor |
| RAB | Regulatory asset base |
| SAPN | SA Power Networks |
| TFP | Total factor productivity |
| TND | TasNetworks (Distribution) |
| UED | United Energy Distribution |

# Glossary

| Term | Description |
| --- | --- |
| Inputs | Inputs are the resources DNSPs use to provide services. |
| LSE | Least squares econometrics is an econometric modelling technique that uses 'line of best fit' statistical regression methods to estimate the relationship between inputs and outputs. As statistical models, LSE 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 is a PIN technique that measures the relationship between total output and one input. It allows partial productivity levels to be compared between entities (networks). |
| MTFP | Multilateral total factor productivity is a PIN technique that measures the relationship between total output and total input. It allows total productivity levels to be compared between entities (networks). |
| Network services opex | Opex for network services excludes amounts associated with metering, customer connections, street lighting, ancillary services and solar feed-in tariff payments. |
| OEFs | Operating environment factors 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 techniques determine the relationship between inputs and outputs using a mathematical index. |
| PPI | Partial performance indicator are simple techniques that measure the relationship between one input and one output. |
| Ratcheted maximum demand | Ratcheted maximum demand is the highest value of maximum demand for each DNSP, observed in the time period up to the year in question. It recognises capacity that has been used to satisfy demand and gives the DNSP credit for this capacity in subsequent years, even though annual maximum demand may be lower in subsequent years. |
| SFA | Stochastic frontier analysis is an econometric modelling technique that uses advanced statistical methods to estimate the frontier relationship between inputs and outputs. SFA models allow for economies and diseconomies of scale and directly estimate efficiency for each DNSP relative to estimated best performance. |
| TFP | Total factor productivity is a PIN technique that measures the relationship between total output and total input over time. It allows total productivity growth rates to be compared across networks but does not allow productivity levels to be compared across networks. It is used to decompose productivity change into its constituent input and output parts. |

# Executive Summary

## Benchmarking helps consumers to pay no more than necessary for the safe and reliable distribution of electricity

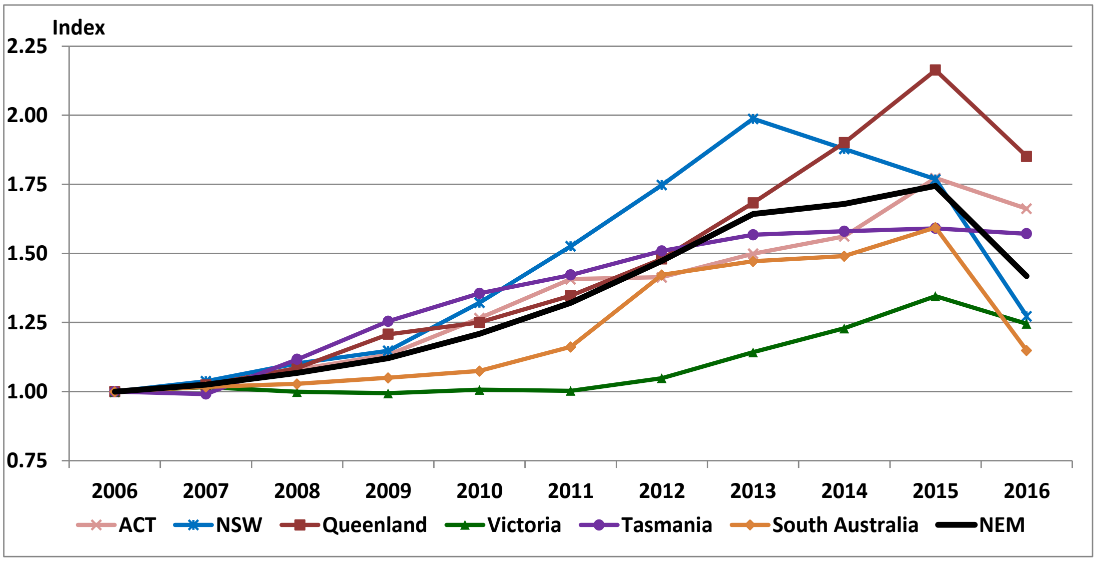
Benchmarking provides consumers with useful information about the relative efficiency of the electricity networks they rely on, helping them to better understand the performance of their networks, the drivers of network productivity and the charges that make up around 40-55 per cent of their electricity bills.

Benchmarking also provides managers and investors with information on the relative efficiency of their network businesses. Combined with incentives under the regulatory framework, this information promotes ongoing efficiency that can lead to lower network charges and retail prices. It provides the governments that set regulatory standards with information on the impact of regulation on network efficiency, charges and ultimately electricity prices. Finally, benchmarking is one of the tools the AER draws on when setting the maximum revenues networks can recover through consumers' bills.

## AER network revenue decisions (informed by benchmarking) are helping to lower network charges, putting downward pressure on consumers' bills

In the 2017 State of the Market Report, we forecast that recent AER network revenue decisions (informed by benchmarking) would result in a 13.5 per cent decline in network revenues compared with previous regulatory periods (Figure 1). We forecast that this would decrease real average residential electricity charges by between 1.9 per cent and 5.0 per cent per year over current five-year regulatory periods (assuming other components of consumers' bills remained constant).

### Figure 1 Index of network revenues from 2006 – 2016, by jurisdiction

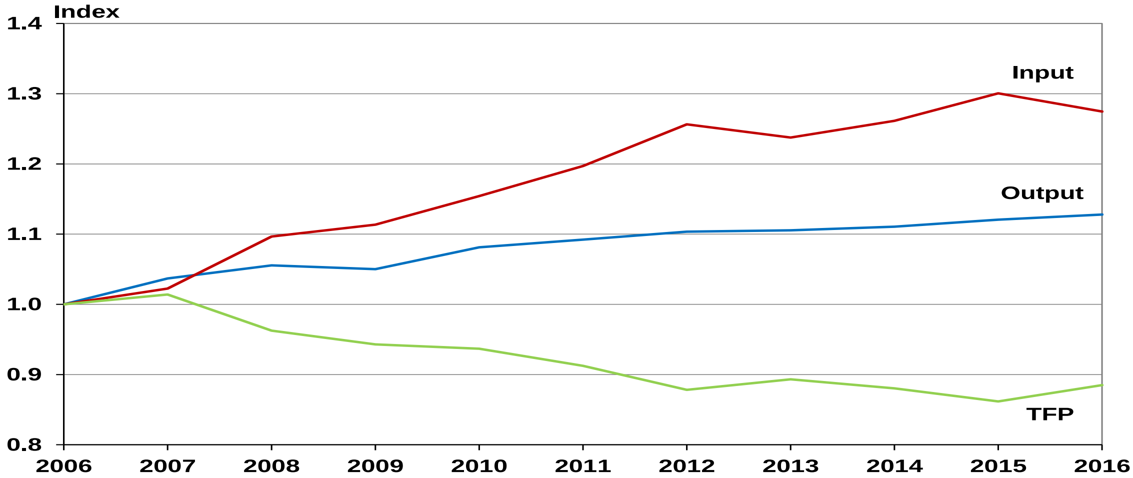



Source: AER State of the Market Report May 2017, p. 107-109, based on EBRIN data.

### Distribution network productivity is growing again

This year's benchmarking results show that over 2016, industry-wide total factor productivity (TFP) for distribution networks increased by 2.7 per cent (Figure 2). This is the highest rate of increase over the last 11 years (TFP last increased over 2013 by 1.7 per cent and fell in all other years except 2007). It is a significant improvement relative to the long-term trend over 2006-16 of a -1.2 per cent annual average decline.

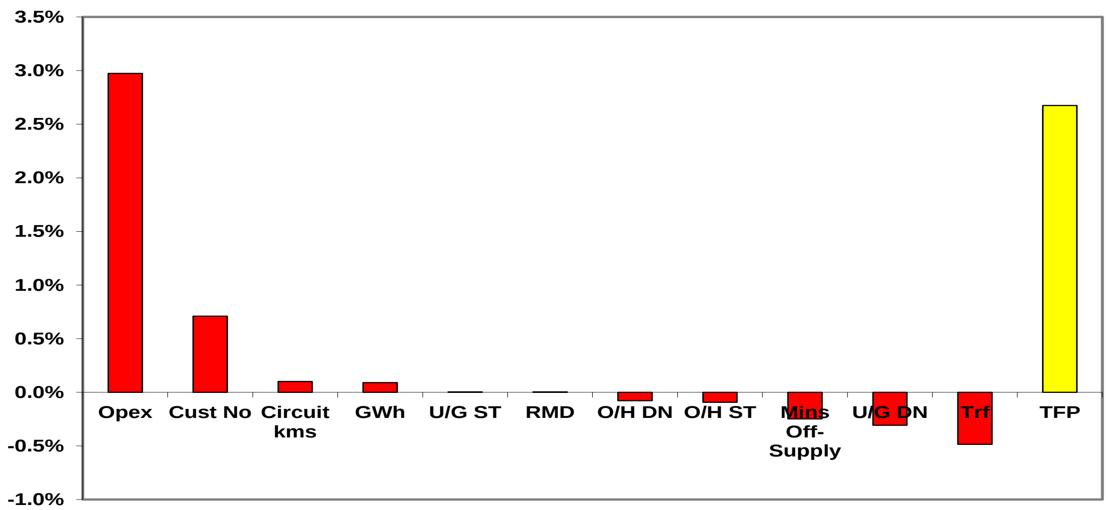
## Figure 2 DNSP industry input, output and TFP, 2006–16




### Decreasing opex spending drove productivity higher in 2016

The primary factor driving the 2.7 per cent rise in industry productivity over 2016 was a large decrease in network operational expenditures (opex) which fell 8.0 per cent. Analysis of how each network input and output contributes to productivity (Figure 3) shows the decrease in opex in 2016 added 3.0 percentage points to the rate of growth in TFP, with changes in other inputs and outputs having smaller impacts.

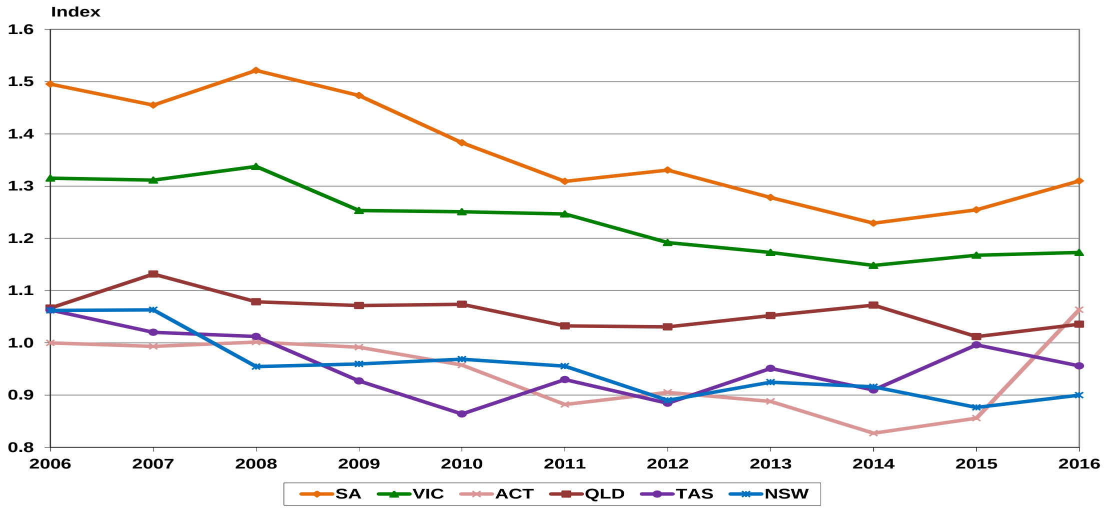
## Figure 3 Industry output and input percentage point contributions to average annual TFP growth, change from 2015 to 2016



## Victoria, South Australia and the ACT continue their recent improvements; NSW and QLD efficiency reforms are showing promise

Figure 4 shows the relative productivity ranking of each jurisdiction in the national electricity market (NEM) from 2006 to 2016 as measured by multilateral total factor productivity (MTFP). All states (except Tasmania) increased their MTFP score in 2016, with modest increases in the larger states (NSW, Queensland and Victoria) and more substantial increases in South Australia and the ACT.

### Figure 4 Multilateral total factor productivity, by jurisdiction, 2006–16




South Australia and Victoria, while showing a considerable decline in productivity up to 2014, have consistently had the highest MTFP scores over the last 11 years. Queensland has tended to benchmark in the mid-range of jurisdictions, while a large improvement in the ACT's MTFP score over the last two years has seen it move from the least productive jurisdiction in 2014 to the third most productive by 2016. NSW and Tasmania have consistently rated as among the least productive jurisdictions, although Tasmania has seen productivity increases in recent years.

## ActewAGL, Powercor, Energex, Essential Energy, AusGrid and SA Power Networks made the largest productivity gains over 2016

The productivity (MTFP) of seven of the 13 DNSPs in the NEM improved over 2016 (Table 1). The improvement in MTFP by ActewAGL (ACT), Powercor (Vic), Energex (QLD), Essential Energy and AusGrid (NSW) and SA Power Networks was particularly strong - greater than four per cent. AusNet Services, Jemena and United Energy (Vic), TasNetworks, Endeavour (NSW) and Ergon (QLD) saw decreasing MTFP over 2016.

Citipower (Vic) was the best performing DNSP in 2016 with the highest MTFP score, followed by SA Power Networks and United Energy (Vic). These three networks have consistently been the best performers over the past 11 years. Ausgrid and Essential Energy (both NSW) and Ergon (QLD) were the poorest performers over 2016. These three networks have consistently scored lowest by MTFP over the last decade.

### Table 1 Individual DNSP MTFP scores, rankings, change 2015 to 2016[1]

| DNSP | 2016 Rank | 2015 Rank | MTFP 2016 Score | MTFP 2015 Score | 2015 to 16 % change |
|---|---|---|---|---|---|
| CitiPower (Vic) | 1 | 1 | 1.50 | 1.47 | +2 |
| SA Power Networks | 2 ↑ | 3 | 1.31 | 1.26 | +4 |
| United Energy (Vic) | 3 ↓ | 2 | 1.28 | 1.30 | -2 |
| Powercor (Vic) | 4 ↑ | 5 | 1.17 | 1.10 | +6 |
| Jemena (Vic) | 5 ↓ | 4 | 1.17 | 1.19 | -2 |
| Energex (QLD) | 6 | 6 | 1.14 | 1.07 | +6 |
| ActewAGL (ACT) | 7 ↑ | 11 | 1.06 | 0.86 | +24 |
| Endeavour Energy (NSW) | 8 ↓ | 7 | 1.01 | 1.03 | -2 |
| TasNetworks | 9 | 9 | 0.96 | 1.00 | -4 |
| AusNet Services (Vic) | 10 ↓ | 8 | 0.94 | 1.01 | -7 |
| Essential Energy (NSW) | 11 ↑ | 12 | 0.89 | 0.84 | +6 |
| Ergon Energy (QLD) | 12 ↓ | 10 | 0.89 | 0.93 | -4 |
| Ausgrid (NSW) | 13 | 13 | 0.83 | 0.80 | +4 |

1 The rankings in Table 1 are indicative of relative performance as there may be other operating environment variables not captured in the MTFP model. There may be small differences between MTFP and TFP rates of change due to difference between the two methodologies. Appendix A of the 2017 Economic Insights Report contains an explanation for these differences.

## Productivity growth is accelerating and broadening to more DNSPs

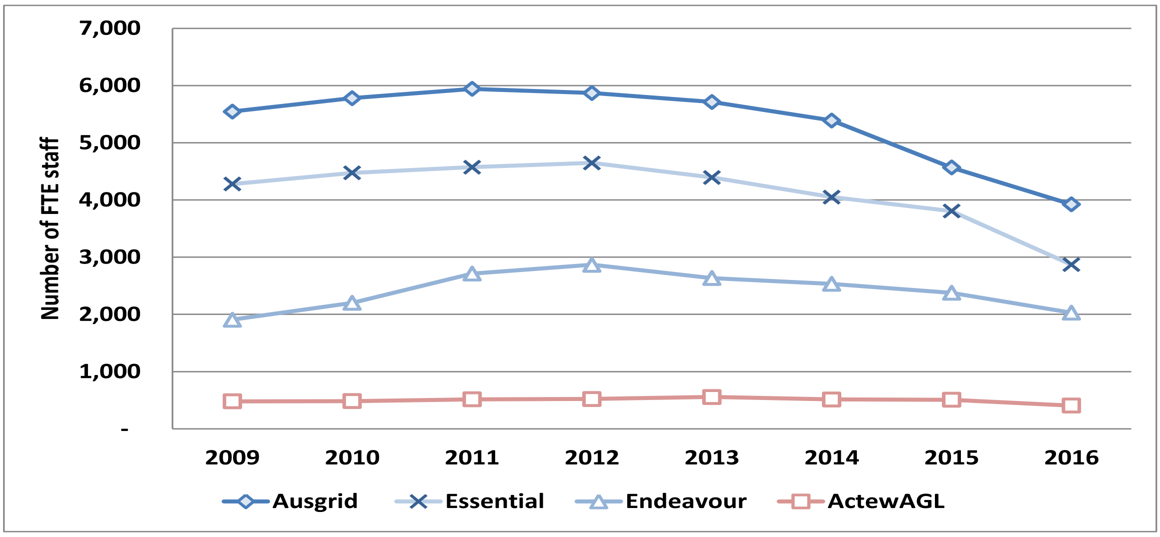
New analysis of the long-term data undertaken for this year's report shows that DNSP productivity growth returned in recent years and is accelerating. While industry-level productivity (TFP) decreased at an average annual rate of -2.2 per cent from 2006 to 2012 (primarily due to strong growth in opex and capital inputs[2]), productivity began to grow over 2012 to 2016 increasing at an average annual rate of 0.2 per cent (driven by decreasing opex and slower growth capital inputs). More recently, productivity growth has accelerated with TFP increasing by 2.7 per cent over 2016.

Productivity growth is also spreading to more DNSPs in the NEM. The number of network businesses experiencing productivity growth increased from three in 2014 to seven in 2016, while the number of jurisdictions registering productivity growth increased from one to five over the last three years.

## The current level of network redundancies point to future productivity growth

Approximately seven percent of all DNSP opex spending in 2016 was on workforce redundancy programs as network businesses improve efficiency through workforce restructuring (Figure 5). For some large DNSPs, redundancy costs accounted for up to 15 per cent of their total opex in 2016 (Table 5). As these redundancy programs wind down and labour savings are realised these networks would expect to see future productivity gains (assuming other inputs and outputs remain stable). Modelling shows that removing current redundancy costs from the 2016 data would see the reported 2.7 per cent increase in DNSP industry productivity rise to a 5.1 per cent increase. This is indicative of the impact of expected reductions in redundancy costs on future network productivity.

### Figure 5 Changes in NSW/ACT DNSP FTE staff level, 2008-9 to 2015-16




2 Transformers and underground distribution lines.

# 1 Introduction

## 1.1 Why we benchmark electricity networks?

Electricity networks are 'natural monopolies' which do not face the typical commercial pressures experienced by firms in competitive markets. 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.

Under the National Electricity Rules (NER or the rules), 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. This is done though a periodic regulatory process (known as revenue determinations or resets) which typically occur every five years. An electricity network provides the AER with a revenue proposal outlining its forecast expenditures or costs over the five year period. Following requirements set out in the NER, the AER assesses and, where necessary, amends the proposal to ensure it represents efficient expenditures/costs. Based on these cost, the AER then sets the network's revenue allowance for the five year period which is the maximum amount the network can recover from its retail customers through their electricity bills. These network revenue costs typically account for 40 to 55 per cent of the retail price of electricity.[3]

In 2012, the Australian Energy Market Commission (AEMC) amended the rules to strengthen the AER's power to assess and amend network expenditure proposals. The rule changes were made in response to concerns raised by the AER and other industry participants that restrictions in the NER had resulted in inefficient increases in capital and operating expenditure allowances of NSPs and higher charges for consumers.[4]

The rule changes required the AER to develop a benchmarking program to measure the relative efficiency of all electricity networks in the national electricity market (NEM) and to have regard to the benchmarking results when assessing capital expenditure (capex) and operational expenditure (opex) allowances for network businesses.[5] The new rules also required the AER to publish the benchmarking results in an annual benchmarking report.[6]

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3 See section 2.3 for a detailed description of the revenue determination process.

4 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 (AEMC Rule Determination), p. vii.

5 The benchmarking presented in this report is one of a number of factors we consider when making our revenue determinations. For a determination, we examine the efficiency of an individual DNSP's forecast opex and capex. In this report we primarily examine the efficiency of distribution networks overall. Though the efficiency of networks as a whole is relevant to our determinations, we also undertake further analysis when reviewing opex and capex forecasts.. (see: NER cll 6.5.6(e)(4) & 6.5.7(e)(4)).

6 NER 6.27(a) &(c).

***National Electricity Rules reporting requirement***

6.27 Annual Benchmarking Report

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

The aims of the 2012 rule changes were to reduce inefficient capital and operational network expenditures, which had been a significant factor in higher network charges, so that electricity consumers did not pay more than necessary for reliable energy supplies. The changes also aimed to provide consumers with useful information about the relative performance of their electricity NSP to help them participate in regulatory determinations and other interactions with their NSP.[7]

This is the fourth benchmarking report for distribution network service providers (DNSPs). The previous three benchmarking reports can be found on the AER's website at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2016

## 1.2 What is in this year's report?

Consistent with the rules, this report describes the relative efficiency of each DNSP in the NEM for the 2016 reporting period (box 1). It also examines longer term trends and changes in network efficiency from 2006 to 2016 and identifies the key drivers behind those trends and changes.

**Box 1: What is a distribution network service provider?**

The electricity industry in Australia is divided into four parts — generation, transmission, distribution and retail.

As electricity generators (i.e. coal, gas, hydro, wind etc.) are usually located near fuel sources and often long distances from electricity consumers, extensive networks of poles and wires are required to transport power from the generators to end use consumers. These networks include:

- High voltage transmission lines operated by transmission network service providers which transport electricity from generators to distribution networks in urban and regional areas.
- Transformers, poles and wires operated by distribution network service providers (DNSPs) which convert electricity from the high voltage network into medium and low voltages and transport electricity to residential and business consumers.

Appendix D presents a map showing service areas for each of the thirteen DNSPs operating in the national electricity market.

7 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 (AEMC Rule Determination), p. vii-viii.

Chapter two describes the AER's approach to benchmarking electricity networks (including the techniques, methodology and data we use), the regulatory framework applying to electricity networks, the role benchmarking plays within that framework, and the benefits benchmarking can generate for consumers and the economy generally.[8] The chapter also outlines some recent developments in the use of benchmarking and the AER's program of continual improvement.

Chapter three presents total factor productivity (TFP) results at the industry level and multilateral total factor productivity (MTFP) results for jurisdictions and individual DNSPs. All results are reported for the period 2006 to 2016 and for the reporting period of 2016. TFP results are primarily used to measure industry-level productivity and to decompose changes in industry and individual DNSP productivity into its input and output components (chapter four). MTFP is the primary technique we use to measure and compare the relative productivity and efficiency of jurisdictions and individual DNSPs under the NER reporting requirement. We also report supplementary partial productivity measures for each DNSP, including opex and capital multilateral partial factor productivity (MPFP) and opex econometrics modelling. Supplementary partial productivity indicators (PPIs) are reported in appendix C.

Chapter four interprets the benchmarking results. For the first time, this year's report includes input/output analysis of the benchmarking data to determine what changes in network inputs and outputs are driving the productivity trends at the industry, jurisdiction and individual DNSP level. The chapter also summarises some of the key changes in state and territory operating factors over 2006-16 which can explain the observed changes in inputs and outputs, and examines the impact network redundancy costs can have on current and future network productivity.

A complete set of the benchmarking results and analysis at the industry, jurisdiction and individual DNSP level used to inform chapters three and four is available online.[9]

## 1.3 How was this report produced?

The benchmarking techniques presented in this report and the AER's approach to applying benchmarking in network revenue determinations are the result of a development program undertaken over 2011 to 2013 by AER staff in conjunction with our expert consultants at Economic Insights.[10] The development program included extensive reviews and assessments of best practice approaches used by regulators internationally, the development of a set proposed benchmarking techniques,

8 A fuller description of the benchmarking methodologies and data on the inputs and outputs used can be found in the Economic Insights papers listed in Appendix A.

9 See Annual Benchmarking Report 2017: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2017

10 The AER's Expenditure Forecast Assessment Guidelines 2013 outline how benchmarking is used by the AER in network revenue determinations. See: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/expenditure-forecast-assessment-guideline-2013

methodologies and data sets, and rounds of consultation with network businesses, consumer groups and the broader public.[11]

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). This data was verified by the DNSP’s chief executive officer and independently audited. We separately tested and validated the data provided by the networks. Economic Insights prepared the benchmarking results using the set of agreed benchmarking techniques.[12] We provided the DNSPs with a draft version of the benchmarking report to allow each network to provide feedback on the results before this final benchmarking report was publicly released.[13]

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11 Appendix A lists Economic Insights publications which explain how it developed and applied the economic benchmarking techniques we use, and ACCC/AER publications which provide a comprehensive overview of overseas benchmarking approaches reviewed by the AER.

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

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

# 2 Electricity network benchmarking and its uses

This chapter describes the AER's approach to benchmarking distribution network service providers (DNSPs) and the benefits it can provide to electricity consumers. It also gives an update on recent developments in the area including work underway as part of the AER's program to continually improve our benchmarking toolkit.

## 2.1 What is benchmarking?

Productivity benchmarking is a quantitative or data driven approach used widely by governments and businesses around the world to measure how productive (or efficient) firms are at producing outputs compared with their peers. Broadly, this is done by using standardised statistical techniques to compare the quantity of input(s) a firm uses to produce a quantity of output(s), and then compare the firm's relative performance with other firms.

The benchmarking in this report uses several techniques (described below) to measure DNSP productivity and efficiency by comparing the combination of inputs electricity networks use (such as capital and labour) to provide various services (outputs) to their customers (such as the quantity of electricity consumed). 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.[14] A more productive network is likely to be relatively more efficient and have lower costs compared with less productive networks (controlling for its operating environments and the prices it pays for its inputs).

This report presents results from three types of 'top-down' benchmarking techniques.[15] Each technique uses a different method for relating outputs to inputs to measure and compare DNSP efficiency (see Appendix A for further details on each technique):

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[14] Cost efficiency (also known as productive efficiency) is made up of technical efficiency and allocative efficiency. Technical efficiency is an engineering concept and means that an input cannot be further reduced to produce the given quantity of output without increasing the use of another input, Allocative efficiency requires inputs to be used in the proportions that would minimise cost given prevailing input prices. In simple terms, technical efficiency is about getting to the efficient frontier while allocative efficiency is about getting to the right point on the frontier. Another type of efficiency, dynamic efficiency, is achieved when DNSPs are technically and allocatively efficient over time. Measuring cost efficiency helps us determine efficient prices/revenues for services. Measuring cost efficiency over time provides an insight into the dynamic efficiency of DNSPs.

[15] Top down techniques measure a network's efficiency overall, taking into account any synergies and trade-offs that may exists between input components. Alternative bottom up benchmarking techniques are more resource intensive in that they examine each input component separately then aggregated them to form a total input. Bottom up techniques do not take into account potential efficiency trade-offs between input components of a DNSP's operations. This is particularly the case with opex. It is should be recognised that in some cases, a bottom up assessment can be useful for capex where a discrete number of projects can be clearly identified. Most regulators overseas use top down economic benchmarking techniques rather than bottom up benchmarking techniques. See

- **Productivity index numbers (PIN)**. These techniques use a mathematical index to determine the relationship between outputs and inputs:
    - Total factor productivity (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 for different periods of time for the one entity. It allows total productivity growth rates to be compared across networks but does not allow productivity levels to be compared across networks. It is used to decompose productivity change into its constituent input and output parts.
    - Multilateral total factor productivity (MTFP) relates total inputs to total outputs and provides a measure of overall network efficiency relative to other networks. It thus allows total productivity levels to be compared between networks.[16] It is applied to combined time-series, cross-section (or 'panel') data.
    - Multilateral partial factor productivity (MPFP) is a partial efficiency measure which uses the same output specification as MTFP but separately examines the productivity of opex and capital against total output. It allows partial productivity levels to be compared between networks.
- **Econometric opex cost function models**. These model the relationship between opex (as the input) and outputs and so also measure partial efficiency. The report presents two types of econometric opex cost function models — least squares econometrics (LSE) and stochastic frontier analysis (SFA).

**Partial performance indicators (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) used to produce one unit of a given output (such as total customer numbers, megawatts of maximum electricity demand or kilometres of circuit line length).

MTFP, as the measure of overall network efficiency, is the primary indicator we use to measure and compare the relative efficiency of DNSPs for this report. The various partial efficiency measures (including capital and opex MPFP, the econometric opex models and PPIs) provide alternative measures of comparative performance and are used as supporting efficiency indicators.[17] Partial efficiency metrics provide information

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Appendix A for more detail on the use of top down and bottom up benchmarking techniques by international utility regulators.

16 There may be minor differences in MTFP and TFP growth rates for a particular firm due to differences in the properties of the indices. The Economic Insights Report – Economic Benchmarking Results for the Australian Energy Regulator's 2017 TNSP Benchmarking Report, November 2017 contains a description of TFP and MTFP methodologies.

17 While, in some cases, the best and worst performers on a supporting metric rank similarly to those on MTFP because they measure different aspects of efficiency they will not be the same as they are for MTFP.

about a network's relative efficiency at using specific inputs and so are particularly useful for understanding which components of a network's production process are more or less efficient compared with other networks.

## 2.2 What data is used?

The inputs and outputs used in the benchmarking techniques for this report are described in Box 2 below. Inputs include a mix of the infrastructure assets needed to distribute electricity to end users and the network opex to run and maintain the network. DNSPs primarily exist to provide customers with access to a safe and reliable supply of electricity and a range of outputs have been selected to reflect this goal.[18]

**Box 2: 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 subtransmission (33kV and above) lines

  - underground distribution cables

  - underground subtransmission (below 33kV) cables

  - transformers and other capital

- Operating expenditure (opex) is expenditure needed to operate and maintain a network. Opex is an immediate input into providing services and is fully consumed within the reporting year.

**Outputs**

- Customer numbers. The number of customers is a significant driver of the services a DNSP must provide. We measure the number of customers as the number of active connections on a network, represented by each energised national metering identifier. It is given a 45.8 per cent weight of gross revenue.

- Circuit line length. Line length reflects the distances over which DNSPs deliver electricity to their customers. (23.8 per cent weight)

- 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.[19] (17.6 per cent weight)

[18] The November 2014 Economic Insights referenced in Appendix A details the input and output weights applied to constructing the productivity index numbers.

[19] 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

- Energy delivered (MWh). Energy throughput is a measure of the amount of electricity that DNSPs deliver to their customers. (12.8 per cent weight)
- Reliability (Minutes off-supply). Reliability measures the extent to which networks are able to maintain a continuous supply of electricity. Minutes off-supply enters as a negative output and is weighted by the value of consumer reliability.

The November 2014 Economic Insights referenced in Appendix A details the rationale for the choice of these input and output and the weights applied.

The complete data sets for all inputs and outputs from 2006 to 2016, along with the Basis of Preparation provided by each DNSP, are published on our website.[20]

The econometric modelling differs from the other benchmarking techniques in that it uses Australian and overseas data. The data intensive nature of the econometric techniques means that sufficiently robust results cannot be produced with Australian DNSP data alone. Economic Insights incorporated comparable data from electricity DNSPs in Ontario and New Zealand to increase the size of the dataset and enable robust estimation of the opex cost function models. Sensitivity analysis of the econometric benchmarking results (using costs functions generated with and without the overseas data) indicates that the addition of the overseas data improves the robustness of the econometric model (by allowing better estimation of the opex cost function parameters) without distorting the estimation of individual DNSPs efficiency results. Section 3.1 and Appendix A contains references to further reading on how Economic Insights incorporated overseas data into the econometric models and the sensitivity analyses.

## 2.3 Network revenue determinations and the role of benchmarking

Under the National Electricity Law (NEL) and the National Electricity Rules (NER or Rules), the AER regulates the revenues from providing network services.

### 2.3.1 The regulatory framework

Network services are ‘natural’ monopolies with little scope in any given location for a competitor to duplicate the network efficiently. Monopoly businesses do not have an incentive to set prices at an efficient level because there is no competitive discipline on their decisions. They do not need to consider how and whether or not rivals will respond to their prices. Without regulation, the resulting market power would lead to higher prices and probably inefficient investment.

the DNSP credit for this capacity in subsequent years, even though annual maximum demand may be lower in subsequent years.]

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

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. Network revenues are paid by electricity consumers through their electricity bills and typically account for 40 to 55 per cent of the retail cost of electricity. Consequently, AER revenue determinations have a significant impact on electricity networks as well as electricity consumers.

The AER applies incentive-based regulation across all energy networks we regulate—consistent with the NER. Broadly speaking, incentive regulation is designed to align the commercial goals of the business to the goals of the NEO.[21]

The AER determines the revenues that an efficient and prudent business would require at the start of each five-year regulatory period. The business is then given financial rewards when it improves its efficiency and spends less than the forecast during the regulatory period—while maintaining or improving its service standards. If the business spends less than the forecast it will still earn revenue to cover the total forecast amount. Hence it can 'keep the difference' between the forecast and its actual expenditure until the end of the regulatory control period. Conversely, if its spending exceeds the forecast, it must carry the difference itself until the end of the period.

The AER determines network revenues through a 'propose-respond' framework (box 3).[22] Network businesses propose the expenditure they believe they need to make 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.[23]

An AER determination does not set network expenditures or costs but establishes a cap on the maximum revenue that a network can recover from its customers during the regulatory control period.[24] Consequently, a network can decide how best to use this revenue in providing distribution services and fulfilling their obligations. This provides an ongoing incentive for networks to operate more efficiently and at 'least cost' to consumers. It also provides incentives for the network operator to innovate and invest

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21 The National Electricity Objective (as stated in the National Electricity Law (NEL section 7)) is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to – price, quality, safety, reliability, and security of supply of electricity; and the reliability, safety and security of the national electricity system. NEL section 7

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

23 Efficient costs, broadly defined, are costs that best contribute to the achievement of the National Electricity Objective (NEO), which is 'to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: price, quality, safety, reliability and security of supply of electricity; and the reliability, safety and security of the national electricity system' (see s.7 of the National Electricity Law).

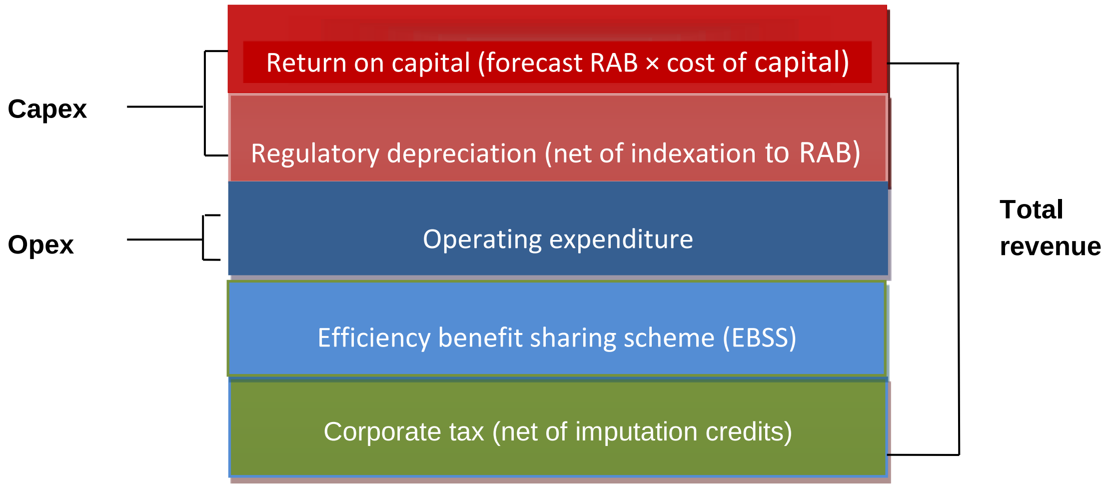
24 Except for the ACT, where an average revenue cap (revenue yield) links revenue to volumes of electricity sold).

in response to changes in consumer needs and technology which is consistent with economic efficiency principles.

**Box 3: Three stages of the revenue determination process**

1. Network businesses submit a network expenditure proposal to the AER for a coming regulatory control period, including forecast costs for each of the building blocks of their network expenditure (Figure 6).[25] The proposals include data and information to support the estimates of needed expenditure.

## Figure 6 The building block approach for determining total revenue




2. The AER assesses the proposal against relevant criteria and tests in the NER and using the assessment methods and tools developed as part of our Better Regulation Guidelines. Network efficiency benchmarking is one of these assessment tools (see below).

3. Where a network business' proposed expenditure for a building block meets the criteria and tests specified under the NER, the AER accepts the proposal. Where the AER is not satisfied that the relevant regulatory criteria and tests are met, the AER cannot accept the proposal and must estimate an amount it believes reasonably reflects the regulatory requirements. Benchmarking can also inform these AER estimates. The AER must also explain its reasons for each of its constituent decisions.[26]

### 2.3.2 The uses of benchmarking

The NER requires the AER to have regard to network benchmarking results when assessing and amending network capex and opex expenditures, and to publish the benchmarking results in this annual benchmarking report.[27]

The AEMC added these requirements to the NER in 2012 to strengthen the AER's power to assess and amend network expenditure proposals in response to concerns

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25 NER Schedule 6.1

26 NER 6.12.1 and 6.12.2.

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

(raised by the AER and other industry participants) that restrictions in the rules had resulted in inefficient increases in network expenditure allowances and higher charges for consumers. The stated aims of these rule changes were to:

- reduce inefficient capital and operational network expenditures so that electricity consumers would not pay more than necessary for reliable energy supplies
- to provide consumers with useful information about the relative performance of their electricity NSP to help them participate in regulatory determinations and other interactions with their NSP.[28]

The AER uses benchmarking in various ways to inform our assessments of network expenditure proposals. We use it as a measure of the relative efficiency of network opex, capex and total expenditures and changes in the efficiency of these expenditures over time. This gives us an additional source of information on the efficiency of historical network opex and capex expenditures and the appropriateness of using them in forecasts. We also use benchmarking to understand the drivers of trends in network efficiency over time and changes in these trends. As we have done in this year's report, this can help us understand why network productivity is increasing or decreasing and where best to target our expenditure reviews.[29]

The benchmarking results also provide network owners and investors, governments and electricity consumers with useful information on the relative performance of the electricity networks they own, invest in, regulate or use. Network owners, managers and investors can use the benchmarking results to better understand the relative efficiency of network business. 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 which 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 provide information to measure the success of the regulatory regime over time.

Finally, benchmarking provides consumers with accessible information about the relative efficiency of the electricity networks they rely on. The breakdown of inputs and outputs driving network productivity in particular, allow consumers to better understand what factors are driving network efficiency and the network charges which make up 50 to 55 per cent of their electricity bills. This helps to inform their participation in our regulatory processes and broader debates about energy policy and regulation.

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[28] AEMC final rule determination 2012, p. viii.

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

Each benchmarking technique cannot readily incorporate every possible exogenous factor that may affect a DNSP's costs. Therefore, the performance measures are reflective of, but do not precisely represent, the underlying efficiency of DNSPs. For this benchmarking report, our approach is to derive raw efficiency and productivity results and where possible, explain drivers for the performance differences and changes.

### 2.3.3 Why do we care about network charges?

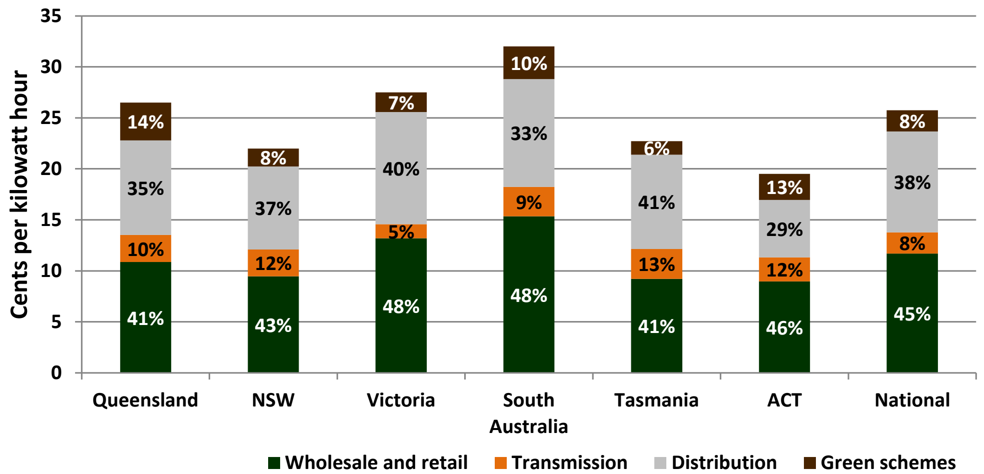
Consumers pay electricity transmission and distribution network charges through their retail electricity bills. In total, these charges account for 40 per cent and 55 per cent of what consumers pay (with distribution charges making up around 30 to 40 per cent and transmission charges accounting for 5 to 13 per cent (box 4).

**Box 4: Electricity network costs and retail electricity prices**

Retail electricity bills cover the costs of generating, transporting and retailing electricity, as well as various regulatory programs. A typical electricity retail bill (Figure 7) includes:

- network costs for the transmission and distribution of electricity across poles and wires (around 40-55 per cent of a bill) (under the NER, the AER regulates this component of network charges to cover the efficient costs of building and operating electricity networks and to provide a commercial return to the network owner on their invested capital)
- wholesale costs for generating the electricity and retail costs to cover selling and billing electricity to retail consumers (around 40–50 per cent of a bill)
- regulatory costs for renewable generation and energy efficiency (such as the renewable energy target and solar PV feed-in tariffs) (around 5–13 per cent of a bill).[30]

Figure 7 Network revenue as a proportion of retail electricity bills, 2016

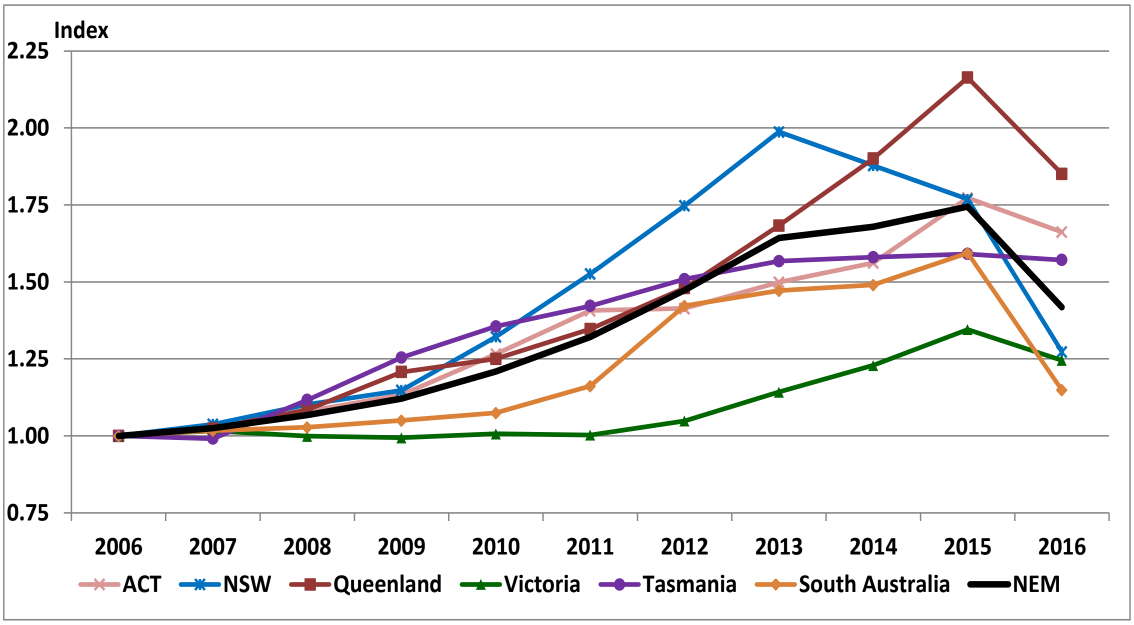



Source: AMEC, 2016 residential electricity price trends, final report.

[30] AEMC, 2016 residential electricity price trends, fact sheet.

Over the last 11 years, electricity network revenues (paid for by electricity consumers through network charges in their bills) have risen substantially.[31] Figure 8 shows the indexed change in total transmission and distribution network revenues in each jurisdiction in the NEM over 2006 to 2016. New South Wales and Queensland have experienced the largest increase in network costs, while Victoria has had the lowest growth. The increase in network costs coincided with the large increases in retail electricity prices seen across the NEM over 2007 to 2013.[32]

### Figure 8 Index of network revenues, 2006 – 2016, by state and territory




Source: AER economic benchmarking Regulatory Information Notice responses

Figure 8 also shows that network revenues began to peak in 2013 (first in NSW then progressively in other jurisdictions over 2014 and 2015) and by 2016 had fallen in all jurisdictions in the NEM. NSW has seen the largest decline to date with significant falls also in Queensland and South Australia.

The AER's 2017 State of the Market report estimated the potential impact on retail electricity charges of decreases in network revenues flowing from recent AER network revenue determinations. We forecast that network revenues in the current round of AER decisions should fall by an average 13.5 per cent across the NEM (compared with revenues in previous decisions) (Figure 9). Amongst DNSPs seeing revenue reductions, decreases ranged from 15 per cent (for SA Power Networks) to 36 per cent (for ActewAGL).[33]

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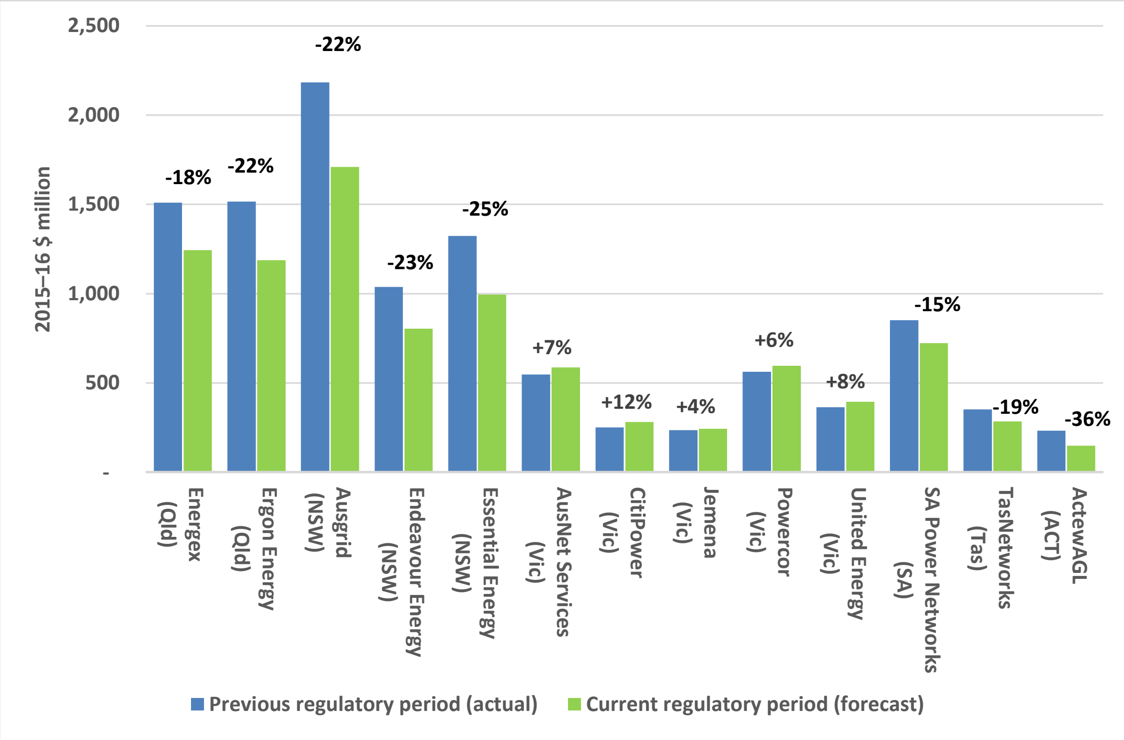
[31] ACCC 2017, ACCC Retail Electricity Pricing Inquiry: Preliminary Report, https://www.accc.gov.au/publications/accc-retail-electricity-pricing-inquiry-preliminary-report

[32] AER State of the Market Report 2017, p. 135.

[33] The AER revenue determinations for DNSPs in QLD (Ergon and Energex), NSW (Ausgrid, Essential and Endeavour) and the ACT (ActewAGL) were the first to use the updated approach to benchmarking established

## Figure 9 Forecast change in electricity network revenues from previous to current regulatory period, by DNSP



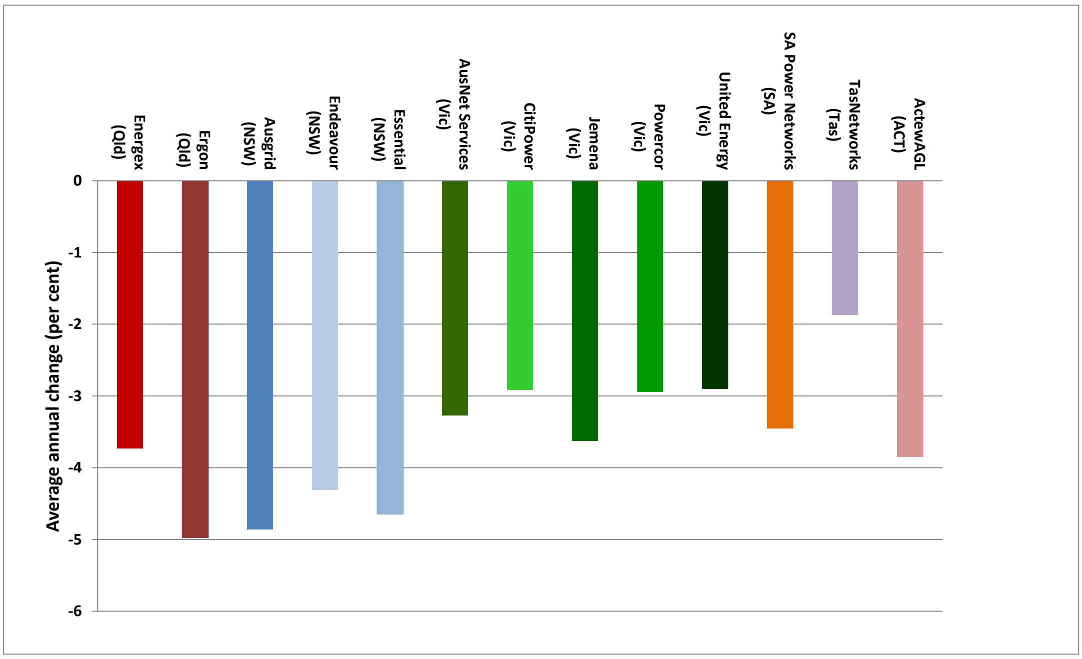

Note: Percentages are the revenue change across the regulatory periods. The AER revenue determinations for DNSPs in QLD (Ergon and Energex), NSW (Ausgrid, Essential and Endeavour) and the ACT (ActewAGL) were the first to use the updated approach to benchmarking established under the 2012 NER rule change (section 1.1) which made benchmarking a 'critical exercise in assessing the efficiency of a NSP and approving its capital expenditure and operating expenditure allowances'.
Source: AER regulatory determinations.

Further, we estimated that these decreases in network revenues would lead to real average decreases in retail electricity charges of between 1.9 and 5 per cent in each year of the current five-year regulatory periods (Figure 10).[34] The largest decreases are forecast to accrue to customers of DNSPs in the ACT, NSW and Queensland. These reductions in the network cost component of retail electricity bills should help to cushion some of the effects of rises in wholesale prices and other components of customer energy costs.

under the 2012 NER rule change (section 1.1) which made benchmarking a 'critical exercise in assessing the efficiency of a NSP and approving its capital expenditure and operating expenditure allowances'.

34 The forecast decreases represent the impact on real average annual electricity charges for a typical residential customer in a given jurisdiction in the current regulatory period. The forecasts assume full pass through of lower revenues to network charges and no change in other components of retail bills (such as wholesale costs and a retailer's profit margins).

### Figure 10 Forecast impact of AER decisions on residential electricity charges (average annual % decline), by DNSP




Notes: Real average annual impact on electricity charges for a typical residential customer in that jurisdiction in the current regulatory period. The data accounts for the impact of decisions by the Australian Competition Tribunal. The estimates are based on information available at the time of the decisions, and may change due to factors such as annual updates to capital costs. They also do not account for changes in other components of a retailer bill, such as wholesale costs and a retailer’s profit margins. Outcomes will vary among customers, depending on energy use and network tariff structures.
Sources: AER regulatory determinations and final decisions on access arrangements.

## 2.4 Ongoing development work in benchmarking

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

We have refined two areas of our benchmarking methodology over 2017.

Firstly over 2017, the AER ran a public review of aspects of the benchmarking models used to measure and compare TNSP efficiency. The review was undertaken in consultation with industry participants and considered issues raised about the specifications of the TNSP benchmarking models. The process included public consultation on an issues paper, an industry stakeholder roundtable, and further consultation on a positions paper. As a result of this process, we have updated the TNSP benchmarking techniques and used the new approach to generate the benchmarking results for this year's TNSP report. More information on the TNSP benchmarking review can be found in this year's TNSP benchmarking report.[35]

Secondly, the AER began a process of reviewing the differences in operating environment factors (OEFs) between DNSPs. The AER has previously considered operating environments in detail within its regulatory determinations. This review seeks to refine the AER’s understanding of the most material operating environment factors driving differences in estimated productivity and operating efficiency between DNSPs. The AER will consult with industry and other interested stakeholders on issues being examined over the coming months.

In May 2017, the Full Federal Court (the Court) ruled on the AER's appeal of a 2016 Australian Competition Tribunal (Tribunal) decision on revenue determinations made for NSW and ACT electricity distribution networks covering the current regulatory control period.[36] The Court affirmed the Tribunal's position that while it was open to us to use benchmarking to make conclusions on the relative efficiencies of DNSPs and to not accept the distributors’ opex forecasts, we had relied too heavily on the results of a single benchmarking model to derive alternative opex forecasts.[37] We are considering these decisions, as well as feedback provided in submission to the draft of this report, as part of our ongoing benchmarking development program.[38]

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35 All documents related to the Review of TNSP Benchmarking can be found at the AER's Benchmarking Report web page: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2017

36 On 26 February 2016, the Tribunal found that it was open to us not to accept the distributors’ opex forecasts, but had a number of concerns with how we derived our alternative opex forecasts. In particular, the Tribunal considered that we relied too heavily on the results of a single benchmarking model to derive our alternative opex forecasts.

37 Australian Energy Regulator v Australian Competition Tribunal (No 2) [2017] FCAFC 79.

38 Submissions to this report are available on line at the AER's Benchmarking Report web page: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2017

# 3 Benchmarking results

**Key points**

- Industry-wide productivity, as measured by total factor productivity (TFP), increased by 2.7 per cent over 2016.[39]
- The primary factors driving increased DNSP productivity over 2016 were a large decrease in network operational expenditures (opex), which fell 8.0 per cent, and slower growth in capital inputs (transformers and underground lines).
- This is the highest rate of DNSP productivity growth over the last 11 years (TFP last increased over 2013 by 1.7 per cent and fell in all other years except 2007). It is a significant improvement relative to the long-term trend over 2006-16 of a -1.2 per cent annual average decline in productivity.
- All jurisdictions (apart from Tasmania) increased productivity over 2016 (as measured by multilateral total factor productivity or MTFP) with modest increases in the larger states (NSW, Queensland and Victoria) and more substantial increases in South Australia and the ACT.
- Seven of the 13 DNSPs in the NEM improved their productivity levels (MTFP) over 2016.
    - The improvement in MTFP by ActewAGL (ACT), Powercor (Vic), Essential Energy and AusGrid (NSW), SA Power Networks and Energex (QLD) was particularly strong at 4 per cent or more.
    - AusNet Services, Jemena and United Energy (Vic), TasNetworks, Endeavour (NSW) and Ergon (QLD) all saw decreasing MTFP.
- Citipower (Vic) was the best performing DNSP over 2016 by MTFP score followed by SA Power Networks and United Energy (Vic). These three networks have consistently been the best performers over the past 11 years.
- Ausgrid and Essential Energy (NSW) and Ergon (QLD) were the worst performers over 2016. These three networks have consistently scored lowest by MTFP over the past 11 years.

This chapter presents the TFP and MTFP results at the industry, jurisdiction and individual DNSP levels for the periods 2006 to 2016 and for the latest reporting period of 2016. Note that per cent changes in TFP or MTFP over 2016 refer to the percentage change in TFP/MTFP scores between the calendar years 2015 and 2016. In this report, this can be referred to as a 'change over 2016' or 'a change over 2015-16'.

TFP results are primarily used to measure industry-level productivity and in the input/output analysis in chapter four which decompose changes in industry and

[39] The 2.7 per cent increase in TFP over 2016 refers to the percentage change in productivity scores between the calendar years 2015 and 2016. In this report, this change is referred to as 'a change over 2016' or 'a change over 2015-16'.

individual DNSP productivity into its input and output components. MTFP is the primary technique we use to measure and compare the relative productivity and efficiency of jurisdictions and individual DNSPs under the NER reporting requirement.[40]

We also report in this chapter supplementary partial productivity measures for each DNSP (including opex and capital MPFP and opex econometrics modelling) to check and augment the MTFP measures. Additional supplementary partial productivity indicators (PPIs) are reported in appendix C.

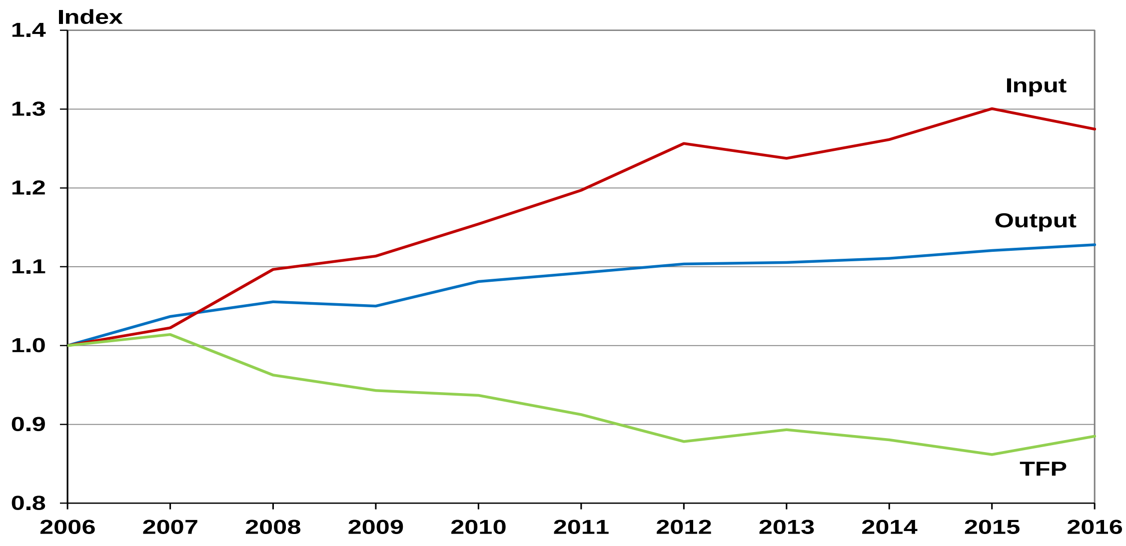
The full benchmarking results (including for each individual DNSP in the NEM) can be found in the documents listed in Appendix A which are available on the AER Benchmarking website.[41]

## 3.1 Total factor productivity results

### 3.1.1 Industry-wide TFP results

Industry-wide productivity, as measured by total factor productivity (TFP), increased by 2.7 per cent over 2015-16 (Figure 11).[42] This is the highest rate of increase over the last 11 years and only the third increase in industry-wide productivity since 2006. The increase in productivity is a significant departure from the long-term trend of decreasing network productivity, measured as a -1.2 per cent average annual decrease from 2006 to 2016.

**Figure 11 Industry input, output and TFP indices, 2006–16**




[40] There may be small differences between MTFP and TFP rates of change due to difference between the two methodologies. Appendix A of the 2017 Economic Insights Report contains an explanation for these differences.

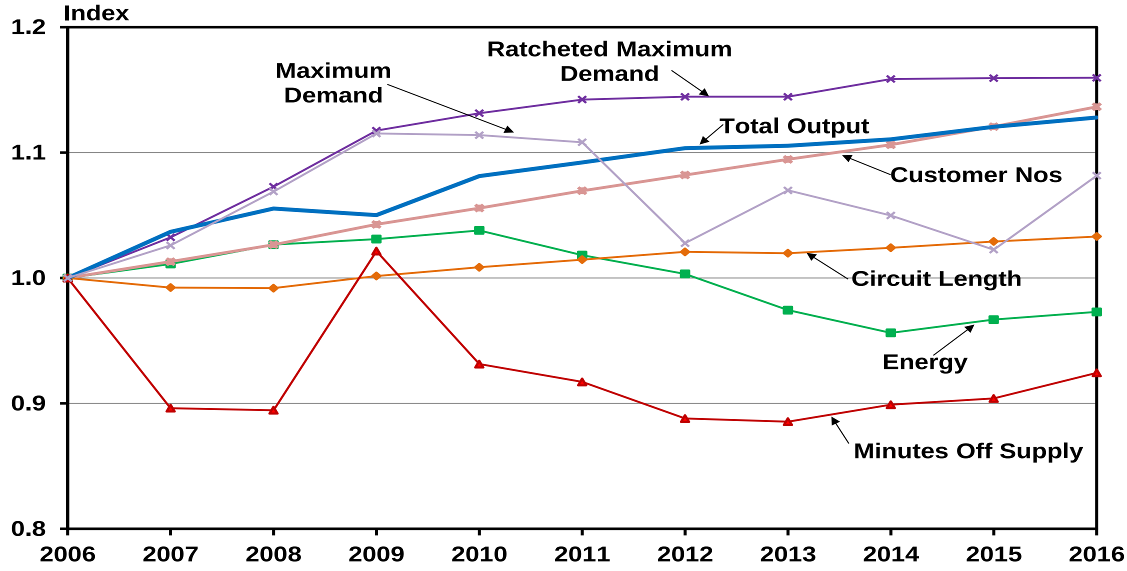
[41] See: Annual Benchmarking Report 2017: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-report-2017

[42] This refers to the change in TFP score between the calendar year 2015 and 2016.

### *Total outputs*

The main contributor to the steady growth in total output has been the increase in customer numbers. Customer numbers increased at a steady rate over the past 11 years, with an overall increase of almost 14 per cent (Figure 12). Customer numbers have the greatest impact on total output with a weighting of 53 per cent.

## Figure 12 Industry distribution output quantity indexes, 2006–2016




Circuit length has experienced only a modest increase (up three per cent) over the past 11 years, with a slight decrease from 2006 to 2008, followed by a modest increase between 2008 and 2016. This suggests very little growth in the network over the past 11 years, despite the increase in customer numbers.

Following strong growth in ratcheted maximum demand from 2006 to 2011, an increase of almost 12 per cent, it has shown only a moderate increase since. This corresponds with the strong growth in maximum demand, which peaked in 2009, followed by a levelling off between 2009 and 2011, then a sharp decline in 2012. It has been quite volatile since, but, despite strong growth in 2015-16, maximum demand remains well below the 2009 peak.

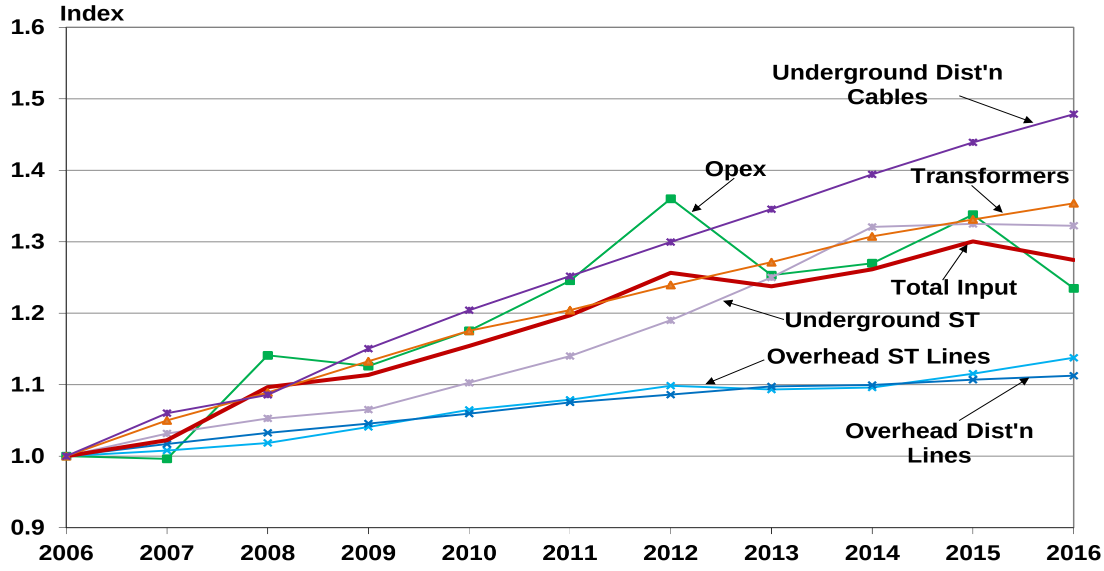
Energy supply initially rose moderately from 2006 to 2010, but then noticeably decreased between 2010 and 2014 - down 8 per cent. This is likely the result of increased awareness of energy consumption and a shift to more energy efficient appliances over this period. However, it has since experienced a modest increase in 2015 and 2016, suggesting consumers have taken up most of the easy options to improve their energy efficiency.

Network reliability, as measured by minutes off supply (which has a negative impact on total output), fell sharply in 2007 and has remained at a relatively similar level over the observed period. The exception was 2008-09, with a very sharp increase in minutes off supply. This impacted total output, which experienced a modest decrease in 2009.

### *Total inputs*

The strongest growth in inputs over the past decade has been in operational expenditure (opex) (Figure 13). Opex is the largest contributor to total inputs, with an average share of total costs of 38 per cent.

## Figure 13 Industry distribution input quantity indexes, 2006–2016




Opex grew very strongly between 2007 and 2012, increasing 37 per cent over this five-year period. Sharp increases in opex in 2007-08 (15 per cent) and 2011-12 (9 per cent) were the main contributors to this increase. There was a sharp decrease in opex in 2012-13 (down 8 per cent) and little change in overall opex since as increases in 2013-14 and 2014-15 were offset by a decrease (8 per cent) in 2015-16. A number of DNSPs have restructured their operations since 2012, contributing to the moderation and decline in opex spending observed since then. It remains to be seen as to whether current levels of opex can be maintained into the future.

Transformers have also experienced strong and steady growth over the past 11 years, increasing by 35 per cent. Transformers are the second largest contributor to total input (after opex) with a weighting of 29 per cent, thus this growth is a notable contribution to increase in total inputs. Increasing the number of transformers on the existing network allows the DNSPs to accommodate the ongoing increase in customer numbers with a lesser increase in overall network length.

There has also been strong growth in underground distribution cables and to a lesser extent, underground sub-transmission cables. However, the underground network is a small component of the overall network, so this growth has relatively little impact on total input costs.  The overhead distribution and sub-transmission networks are more extensive and have a greater impact on total input costs. These have experienced modest growth over the past decade, increasing by 11 per cent and 14 per cent respectively.

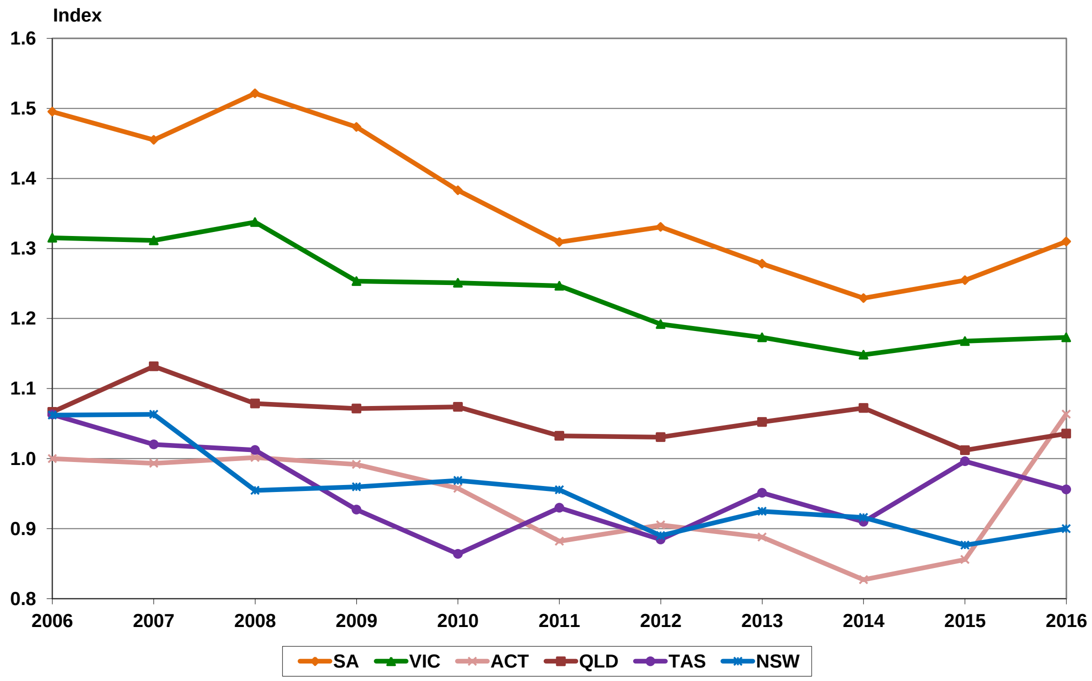
### 3.1.2 State and territory MTFP results

The change in MTFP over time at the jurisdictional level is presented in Figure 14. MTFP, as the measure of overall network efficiency, is the primary indicator we use to measure and compare the relative efficiency of DNSPs for this report. Changes in a network's MTFP score over time is also a useful indicator of how the business' efficiency changes overtime.

South Australia and Victoria are the best performing states by MTFP score in 2016 and have consistently had the highest productivity scores over the last eleven years. Queensland has consistently benchmarked in the mid-range of jurisdictions over the last eleven years and has continued to do so in 2016. NSW, Tasmanian and the ACT results consistently rated them as the three least productive jurisdictions from 2009 to 2015. The ACT has made a significant improvement in its MTFP score over the last two years rising from sixth (the least productive jurisdiction) to the third most productive.

All states (except Tasmania) increased their MTFP scores from 2015 to 2016, driving the overall improvement at the industry level. A modest increase in MTFP in the larger states (NSW, Queensland and Victoria) and more substantive increase in South Australia and the ACT, drove the overall improvement in industry-level MTFP in 2016.

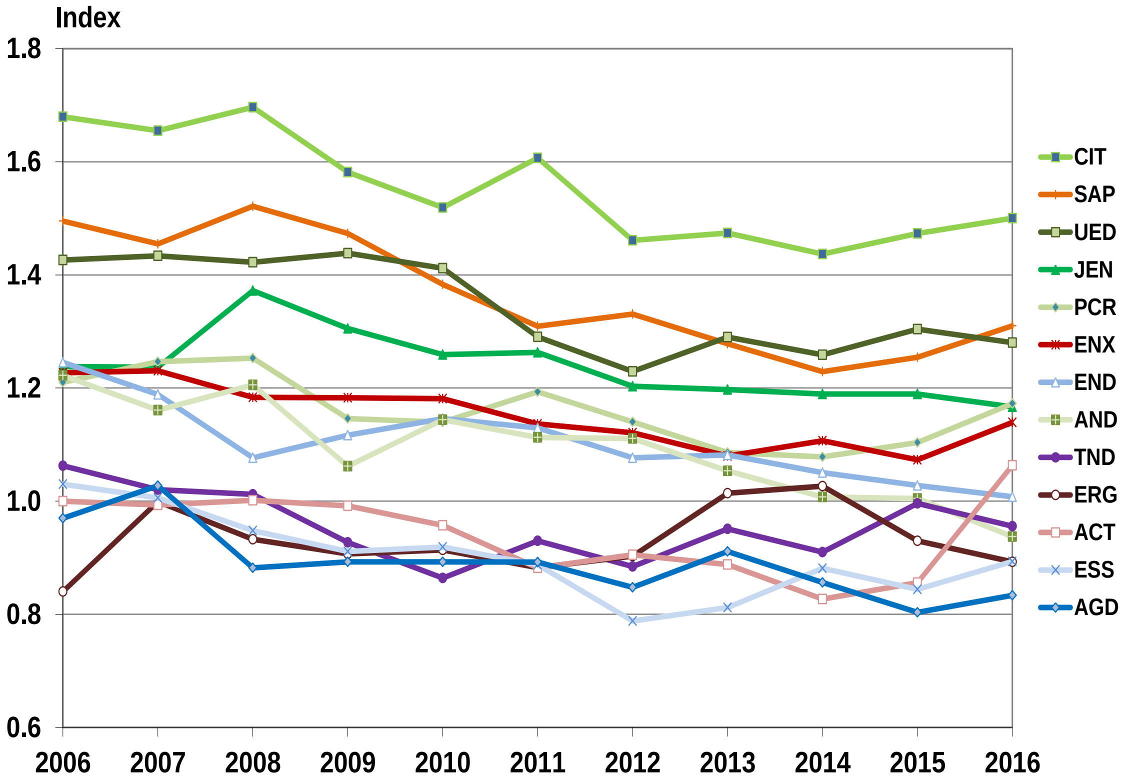
**Figure 14 MTFP by state and territory, 2006–16**



### 3.1.3 Individual DNSP MTFP results

The MTFP results for each DNSP from 2006 to 2016 are presented in Figure 15. Generally, the individual MTFP results follow the same general trend of their home states, as described above (Figure 15).

**Figure 15 MTFP by individual DNSP, 2006–16**




The MTFP of seven of the 13 DNSPs in the NEM improved from 2015 to 2016. The improvement in MTFP by ActewAGL (ACT), Powercor (Vic), Essential Energy (NSW), SA Power Networks and Energex (QLD) was particularly strong - greater than four per cent. The exceptions, with decreasing MTFP, were TasNetworks, AusNet Services, Jemena, United Energy (all three Vic), Endeavour (NSW) and Ergon (QLD).

In 2016, Citipower (Vic) was the best performing DNSP, with the highest MTFP index, followed by SA Power Networks and United Energy (Vic). These three networks have consistently been the best performers by MTFP score over the past 11 years. NSW and Queensland DNSPs - Ausgrid, Essential Energy and Ergon - were the poorest performers over 2016. These three networks have consistently scored lowest by MTFP over the last 11 years.

ActewAGL (ACT) shifted from a bottom-level performer in previous years to a mid-level performer in 2016 following a sharp increase in MTFP since 2014. Ausnet Services (Vic) and Endeavour Energy (NSW) have seen their MTFP score fall from a mid-level range in 2010 to a bottom-level range by 2016, following steady declines in recent years. TasNetworks' MTFP score fell from 2006 to 2010 to become the worst performer by 2010. The network's MTFP score has since trended upward rising to the top of the bottom-level grouping by 2016.[43]

The MTFP results in Figure 15 are only indicative of the DNSPs' relative performance. Operating environment factors (OEFs), which are beyond a DNSP's control and may not be captured in the MTFP model, can affect a DNSP's costs and benchmarking performance.

### 3.1.4 Observations for 2016

In line with our reporting requirement, Table 2 shows the relative efficiency (productivity rankings by MTFP) for all DNSPs in the NEM for 2015 and 2016 and the change in rankings between the two years.[44]

There was a modest shift in the relative rankings between 2015 and 2016.

- CitiPower (Vic) continued to be the best performing DNSP remaining in first place.
- A 4 per cent increase in SA Power Networks' MTFP score saw it move from 3rd to 2nd at the expense of United Energy (whose MTFP declined by 2 per cent).
- ActewAGL (ACT) leapt up the table from 11th to 7th place due to very strong MTFP growth over 2016 (see section 4.2.2).
- Several NSPs fell in the rankings, including Endeavour (NSW) (from 7th to 8th with a 2 per cent fall in MTFP), Ergon Energy (QLD) (from 10th to 12th with a 4 per cent decline) and AusNet Services (Vic) (from 8th to 10th due to a 7 per cent decline).
- TasNetworks remained in 9th place despite a 4 per cent decline in its MTFP score.
- Essential Energy (NSW) rose from 12th to 11th place with a 6 per cent increase in its MTFP score.
- Ausgrid (NSW) remained in 13th place despite improving its MTFP scores by 4 per cent.

As noted for Figure 15, the rankings in table 2 are only indicative of the DNSPs' relative performance as some OEFs may be not captured in the MTFP model and this can affect a DNSP's costs and benchmarking performance.

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[43] TasNetworks, however, could be considered an outlier compared to its peers in terms of system structure, which influences its MTFP score to some extent. Compared to other DNSPs, TasNetworks operates substantially less high voltage subtransmission assets and has a comparatively high proportion of lower voltage lines. Therefore, Economic Insights advises that some caution is required in interpreting TasNetworks' MTFP score, given its comparatively unusual system structure.

[44] NER, 6.27.

### Table 2 Individual DNSP MTFP rankings and scores, 2015 to 2016

| DNSP | 2016 Rank | 2015 Rank | MTFP 2016 Score | MTFP 2015 Score | 2015 to 16 change (%) |
|---|---|---|---|---|---|
| CitiPower (Vic) | 1 | 1 | 1.50 | 1.47 | +2 |
| SA Power Networks | 2 ↑ | 3 | 1.31 | 1.26 | +4 |
| United Energy (Vic) | 3 ↓ | 2 | 1.28 | 1.30 | -2 |
| Powercor (Vic) | 4 ↑ | 5 | 1.17 | 1.10 | +6 |
| Jemena (Vic) | 5 ↓ | 4 | 1.17 | 1.19 | -2 |
| Energex (QLD) | 6 | 6 | 1.14 | 1.07 | +6 |
| ActewAGL (ACT) | 7 ↑ | 11 | 1.06 | 0.86 | +24 |
| Endeavour Energy (NSW) | 8 ↓ | 7 | 1.01 | 1.03 | -2 |
| TasNetworks | 9 | 9 | 0.96 | 1.00 | -4 |
| AusNet Services (Vic) | 10 ↓ | 8 | 0.94 | 1.01 | -7 |
| Essential Energy (NSW) | 11 ↑ | 12 | 0.89 | 0.84 | +6 |
| Ergon Energy (QLD) | 12 ↓ | 10 | 0.89 | 0.93 | -4 |
| Ausgrid (NSW) | 13 | 13 | 0.83 | 0.80 | +4 |

Note: 1. All scores are calibrated relative to the 2006 ActewAGL score which is set equal to one.

2. In the 2015 benchmarking report, we amended ActewAGL's historic data to be consistent with the cost allocation method (CAM) we approved in 2013. The CAM put in place since June 2013 brings ActewAGL more in line with other DNSPs' capitalisation policy. To provide a consistent time series, ActewAGL back cast its historical data consistent with the approved CAM. This has resulted in lower opex reported for ActewAGL in the years 2006 to 2014. Therefore, ActewAGL's 2006 to 2014 performance improves relative to what it was previously and to other DNSPs.

3. We continue to set ActewAGL's new score for 2006 equal to one. Because all other DNSPs' scores are calibrated relative to this observation, they now receive lower scores. Importantly, the relativities between all other DNSPs remain the same. It is only the relationship between each of the other distributors and ActewAGL that has changed.

4. The rankings in Table 1 are indicative of relative performance as there may be other operating environment variables not captured in the MTFP model. There may be small differences between MTFP and TFP rates of change (between table 1,2 and 3) due to difference between the two methodologies. Appendix A of the 2017 Economic Insights Report contains an explanation for these differences.

### 3.1.5 Network commentary on the 2016 MTFP results

Energy Queensland attributed the decrease in Energex's opex in recent years (which was the primary driver of the 6 per cent improvement in its MTFP score from 2015 to 2016) to greater efficiencies in its customer service operations and vegetation management contracting, and a continuing decline in redundancy costs (which they expect to continue into 2017). Energex also attributed improved reliability (which also contributed to its increase in MTFP from 2015 to 2016) to improvements in the resilience of its network in recent years and moderate weather conditions experienced over 2015 and 2016.[45]

Energy Queensland also submitted that Ergon's lower MTFP scores in 2015 and 2016 were due to increased opex from higher vegetation management and storm related costs, and corporate restructuring costs including redundancies. Ergon noted that the workforce restructuring was in response to the AER's 2015-20 Final Determination and the formation of Energy Queensland in 2015-16. Ergon also attributed lower MTFP scores in 2015 and 2016 to lower reliability outputs due to storm events.[46]

AusNet Services (Victoria) attributed the seven per cent decline in its MTFP score from 2015 to 2016 to higher redundancy costs from workforce restructuring and adverse weather events in October 2016, which resulted in high GSL payments and a decrease in the reliability output in the MTFP model. AusNet also noted that it expects to see improvements in its benchmarking results in the 2018 benchmarking report and over the remainder of this regulatory period as a result of ongoing efficiency programs.[47]

United Energy (Victoria) submitted that the increase in its opex over 2015-16 (which was the primary driver of the 2 per cent decline in its MTFP score over the period) was due to increased maintenance and vegetation management expenditure and the reallocation of IT costs from metering to standard control services as approved in the AER's 2016-2020 final determination.[48]

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45 EnergyQLD submission, p. 7.

46 EnergyQLD submission, p.6-7

47 AusNet submission, p. 1.

48 United Energy, pers. comms. 11/10/2017

## 3.2 Results from supporting benchmarking techniques

A range of supplementary measures are used to assist in interpreting the MTFP results, including capital and opex multilateral partial factor productivity (MPFP), econometric opex modelling and partial performance indicators (PPIs). The MPFP and econometric opex modelling methods and results are presented below, while the PPIs are reported in Appendix C.

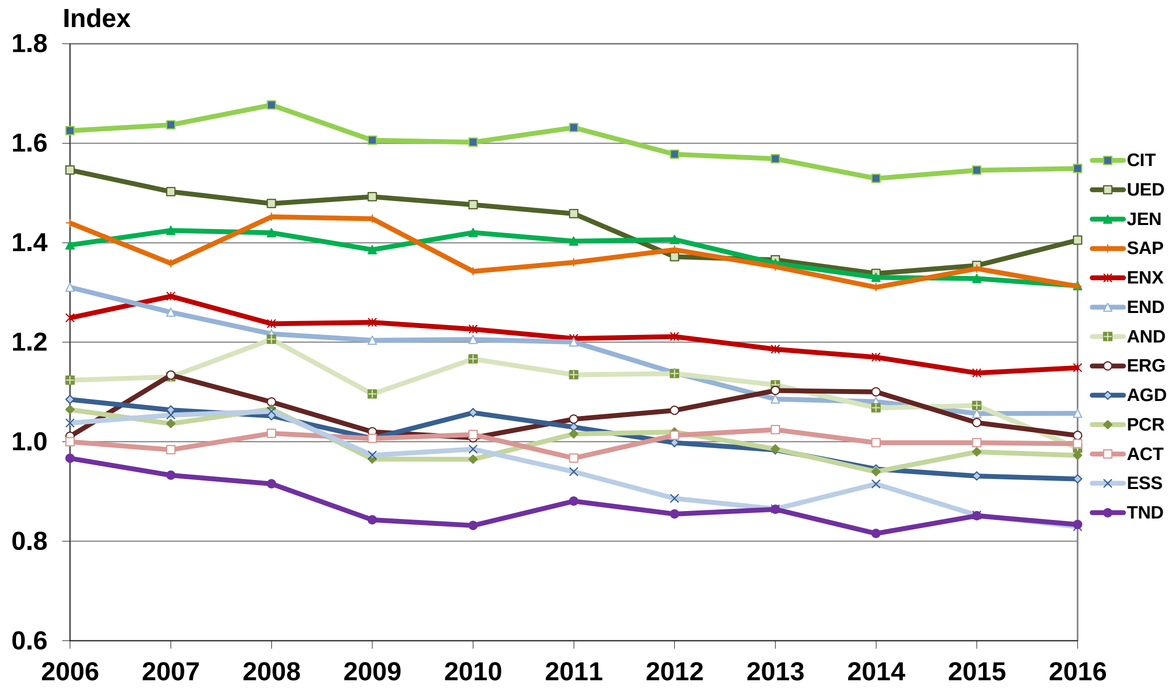
### 3.2.1 Multilateral partial factor productivity

The multilateral partial factor productivity (MPFP) techniques assist in interpreting the MTFP results by examining the contribution of capital and operational expenditure to overall productivity in isolation. This 'partial' approach uses the same output specification as MTFP but provides more detail on the contribution of the individual components of capital and opex to changes in productivity.

Capital MPFP considers the productivity of the DNSP's use of overhead lines and underground cables (split into distribution and subtransmission voltages) and transformers.

The trend in capital productivity and ranking of the individual DNSPs follows a relatively similar trend to that of the MTFP (Figure 16). Overall, there has been a moderate decline in capital productivity since 2006. The capital productivity ranking of the DNSPs and the pattern of change is broadly similar to their MTFP ranking and trends. However, the difference in capital productivity between the DNSPs is somewhat narrower and the magnitude of the change is smaller.

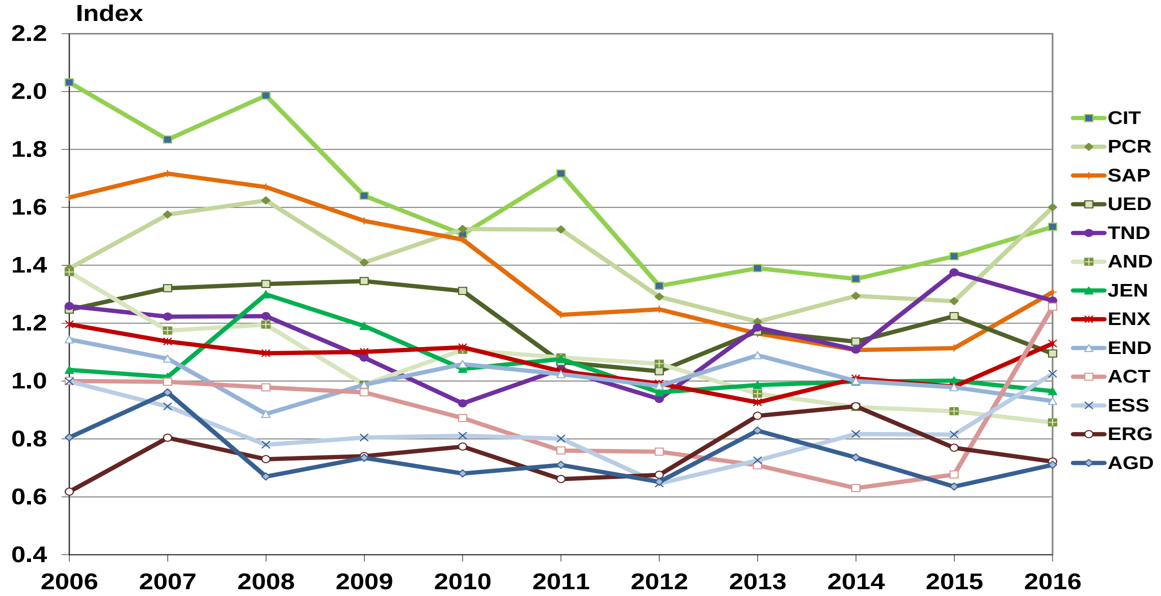
**Figure 16 Capital multilateral partial factor productivity (MPFP), 2006–16**



The capital MPFP of most DNSPs decreased slightly in 2016, which contrast with the trend in MTFP. The only providers showing an improvement in capital productivity in 2016 were Citipower, United Energy, Energex, and Endeavour. This suggests that opex had greater influence over total factor productivity in 2016.

Opex MPFP for all DNSPs over the 2006-2016 period is presented in Figure 17. This tends to be more volatile than capital MPFP, with the magnitude of change and the variation between the DNSPs being greater. Overall, opex has been the main driver of the productivity improvement observed in recent years.

### Figure 17 Opex multilateral partial factor productivity (MPFP), 2006–16




ActewAGL experienced an exceptional 86 per cent increase in its opex productivity from 2015 to 2016 (which drove the 26 per cent rise in its MTFP score the same year). Other DNSPs with a notable improvement in opex MPFP include Essential Energy (26 per cent), Powercor (25 per cent), SA Power Networks (17 per cent), Energex (15 per cent), Ausgrid (12 per cent) and Citipower (7 per cent). Opex productivity of four DNSPs decreased in 2016. The decline in opex productivity was notable for United Energy (-11 per cent), TasNetworks (-7 per cent) and Ergon (-6 per cent).

CitiPower and SA Power Networks perform well on both the opex and capital MPFP, being in the top four of both measures. However, the ranking of the other DNSPs changes somewhat under the two MPFP results, reflecting differing input combinations. For example, Powercor is in the bottom four performers in terms of capital productivity, but is the top performer in 2016 in terms of opex MPFP. TasNetworks is the lowest performer in terms of capital productivity, but is a top-four performer in terms of opex MPFP. While, historically ActewAGL and Essential Energy have been bottom four performers in both capital and opex MPFP, following a significant improvement in opex productivity in 2016, they have improved their position to now be mid-level performers in terms of opex MPFP, but remain relatively low-level performers on capital productivity.

### 3.2.2 Econometric opex modelling

This section presents the results of the three econometric models:

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

These models provide a measure of the efficiency of opex and were developed as part of our assessment of the efficiency of DNSPs' opex proposals in recent distribution determinations. Each model uses the same specification, to compare opex as the input to multiple outputs (customer numbers, circuit length and ratcheted maximum demand). The econometric results are only indicative of the DNSPs' relative performance. Operating environment factors (OEFs) not captured in the econometric model can affect a DNSP's benchmarking performance and its relative performance. Consequently, the raw results can be adjusted to account for additional OEF differences not otherwise accounted for in the models.

There are several important differences across the various models. The three econometric models include allowance for the key network density differences and the degree of undergrounding. Whereas the opex MPFP model includes allowance for the key network density differences, but not the degree of undergrounding. The econometric models include three outputs whereas the opex MPFP model includes five outputs (the same three as the opex cost function models plus energy delivered and reliability). The econometric models use parametric methods whereas the opex MPFP model uses a non–parametric method.

The LSE opex cost function models use least squares (line of best fit) estimation whereas the SFA model uses frontier estimation methods. The LSE opex cost function models include allowance for heteroskedasticity and autocorrelation whereas the SFA model does not.

The results from the three econometric models and the opex MPFP model are presented in Figure 18. These are the average efficiency scores for the 2006–16 period.[49] A score of 1.0 is the highest possible score.

Citipower and Powercor have the highest efficiency scores on the majority of metrics. ActewAGL, Ausgrid, and Ergon Energy have the lowest scores.

More detail on the econometric methodology and modelling results is presented in the Economic Insights report.[50]

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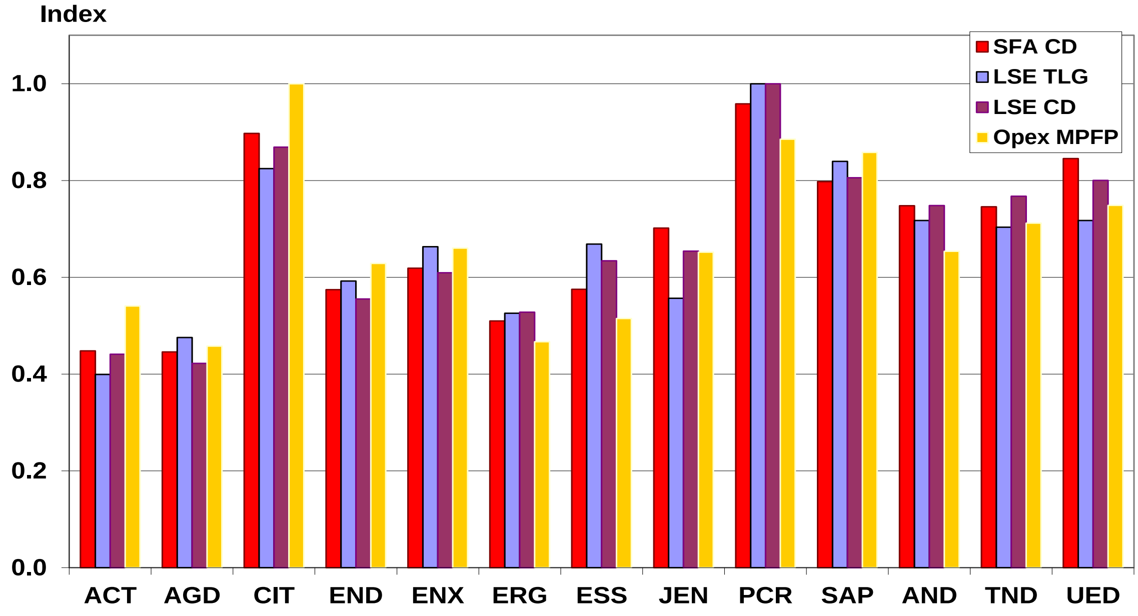
[49] This reviews performance in the longer term and facilitates the estimation of the impact of technological change.

[50] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking Report*, August 2017, pp. 18-21.

### Figure 18 DNSP opex cost efficiency scores, (2006–16 average)




Despite the differences in the model features, Figure 18 shows that the opex efficiency scores produced by the four models are broadly consistent with each other (although there is some variation in individual DNSP results and the relative rankings of DNSPs).

The similarity between the results from the opex MPFP model and the econometric models is particularly noteworthy, given the very different approaches. Opex MPFP is a productivity index number (PIN) technique[51] that uses Australian data only whereas the three econometric models use Australian data and overseas data.

In recent distribution determinations, we have used the Cobb-Douglas SFA model as our preferred technique for forming a view about efficient total opex. When we do this, we make three adjustments to the above ‘raw’ score of the DNSP we are assessing by:

- applying an adjustment for operating environment factors (OEFs) that are beyond the DNSP’s control and not already accounted for in the model
- comparing the DNSP’s efficiency score to a target efficiency score (previously we have used the top quartile of possible scores) to provide an error margin for potential data or modelling issues
- conducting a ‘roll forward’ process to transform the period average efficiency results to an opex amount for a particular year.

Appendix A contains references to determinations where we have used the Cobb-Douglas SFA model to form a view on efficient total opex.

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51 PIN techniques determine the relationship between inputs and outputs using an index.

# 4 Interpreting the benchmarking results

**Key points**

- For the first time, this year's report includes analysis of the benchmarking data over the longer term to provide more information on how changes to network inputs and outputs drive productivity trends. A full set of this analysis for each jurisdiction and individual DNSPs is available in the Economic Insights Report on the AER's benchmarking website.
- Over 2006-12, industry-wide productivity (TFP) declined at an average annual rate of 2.2 per cent primarily due to:
  - strong growth in industry opex spending (which increased at an average annual rate of 5 per cent)
  - strong growth in capital inputs (transformers and underground distribution cables).
- Over 2012-16, industry-wide productivity stabilized and increased at an average annual rate of 0.2 per cent primarily due to:
  - a decrease in network opex spending (which fell at an annualised rate of 2.5 per cent over the period)
  - slower growth in capital inputs (transformers and underground distribution cables).
- Between 2015 and 2016, the industry rate of productivity growth accelerated relative to earlier years increasing by 2.7 per cent. The increase was primarily due to a large decrease in opex in 2016 (down 8.0 per cent) and continued moderation in the growth of capital inputs.
- Broadly, almost all DNSPs in the NEM experienced similar productivity trends over 2006-16 to those observed at the industry level, although the timing, magnitude and consistency of the changes varies by DNSP.
- Redundancy costs associated with workforce restructuring accounted for around 7 percent of total industry opex in 2016. As these redundancy costs drop out of the opex data and ongoing workforce savings are realised, the productivity results of networks undertaking workforce restructuring should improve (assuming other opex expenditures remain stable).

This chapter describes some of the key drivers of changes to network productivity reported in chapter three. We do this by describing the contribution network inputs and outputs make to changes in total factor productivity (TFP) at the industry level over 2006 to 2016. The chapter then discusses how operating factors (such as changes to network regulations) and network management practices (such as labour redundancy programs) can help explain why the changes to inputs and outputs are happening.

## Calculating input and output contributions to changes in TFP

To calculate the contribution each input and output makes to a given change in TFP requires us to consider the quantity change in each of the five outputs and six inputs used in our benchmarking as well as the weights placed on each in forming the total output and total input indexes (box 2). Appendix A includes a link to the methodology that allows us to decompose a given productivity change into its input and output components.

This is the first time Economic Insights has calculated input and output contributions to TFP changes for use in the benchmarking report. This type of analysis is valuable because it allows us to identify productivity trends and see more clearly what is driving these trends and breaks in trends over time. The analysis has been done for the industry as a whole and at the jurisdiction and individual DNSP level. The full set of analysis can be found in the Economic Insights report and related spread sheets online. This chapter presents only the key findings on the input and output changes driving TFP.

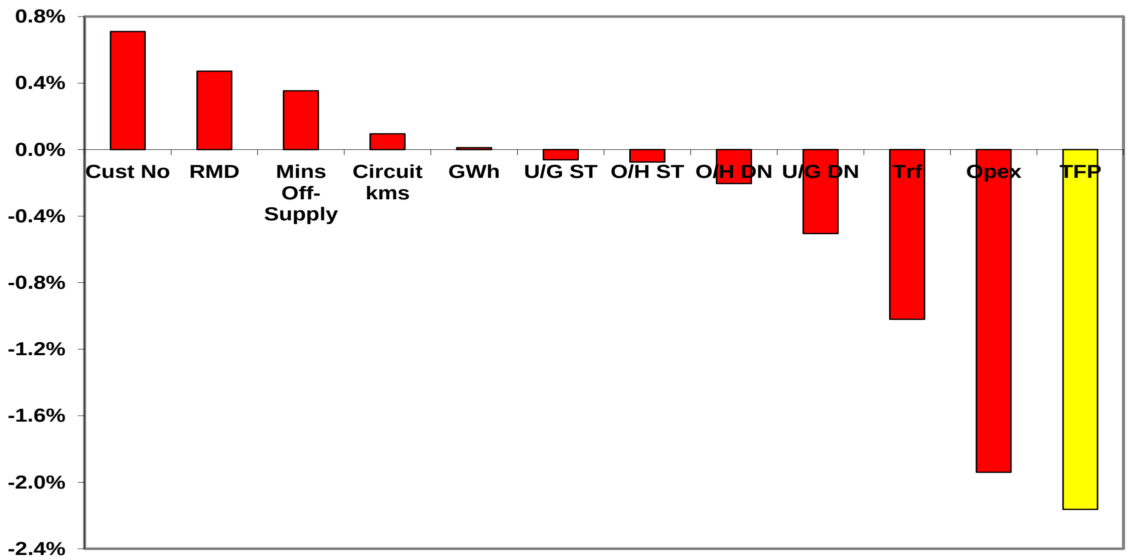
## 4.1 Input and output drivers behind industry-wide TFP

The input and output analysis of the benchmarking data revealed two distinct trends in industry-wide productivity over the last decade.

- Over 2006-12, industry-wide productivity (TFP) declined at an average annual rate of 2.2 per cent.
- Over 2012-16, industry-wide productivity stabilized and began to grow, increasing at an average annual rate of 0.2 per cent over the period (data for 2016 shows this trend strengthening as industry-wide growth in TFP accelerated to 2.7 per cent).

To understand the drivers of the decline in TFP over 2006 to 2012, we decomposed the change in TFP over this period into its input and output contributions. The contributions of each output and each input (the red bars) to the average annual rate of TFP change (the yellow bar) are shown in Figure 19. Over 2006-12, TFP declined at an average annual rate of –2.2 per cent. The contributions of each output and input to this average annual change in TFP appear from the most positive on the left to most negative on the right. If all the positive and negative contributions in Figure 19 are added together, the sum will equal the TFP change or average annual growth rate for the period.

### Figure 19 DNSP output and input percentage point contributions to average annual TFP change, 2006–2012



The figure shows that over 2006-12, the largest contributing factors to the 2.2 percent average annual decline in TFP were:

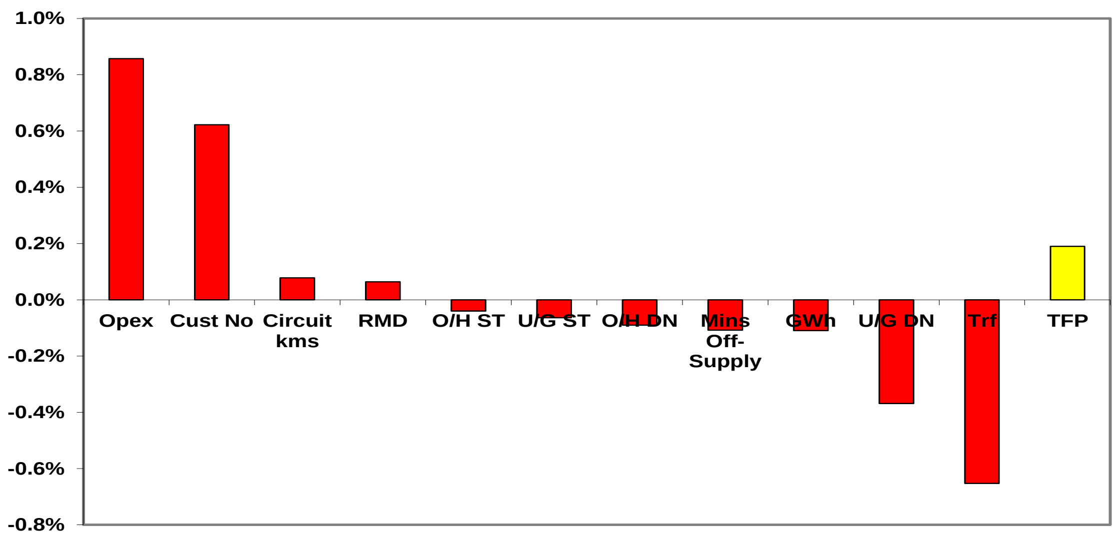
- growth in network opex spending which contributed -1.9 percentage points (ppts) to the negative TFP growth rate
- growth in capital inputs (transformers and underground distribution cables) which contributed -1.5 ppts combined (or -1.0 and -0.5 ppts respectively) to the rate of decline in TFP.

The negative impact on TFP from these inputs was partially offset by the positive contribution from the increase in customer numbers (which added 0.7 ppts to average annual TFP) and the growth in ratcheted maximum demand (which added 0.5 ppts) over the period.

These results reflect the rapid increase in industry-wide opex from 2006 to its peak in 2012 (growing at an average annual rate of 5 per cent). This likely reflects factors such as network responses to meet higher reliability standards in NSW and Queensland, responses to the Victorian Black Saturday bushfires and the differing levels of commercial discipline between government owned and privately owned networks under the regulatory framework. A fuller discussion of drivers of network inputs at the jurisdictional level can be found in section 4.2.

We also decomposed the change in TFP over 2012 to 2016 into its input and output contributions (Figure 20) to see what changes in inputs and outputs drove the stabilization and marginal rise in TFP over more recent years.

### Figure 20 DNSP output and input percentage point contributions to average annual TFP change, 2012–2016




Over 2012 to 2016, TFP increased at an average annual rate of +0.2 per cent. The largest contributing factors driving this turnaround were:

- the decrease in network opex which contributed 0.9 ppts to average annual TFP growth rate over the period (compared with the -1.9 ppts contribution over 2006-12)

- slower growth in capital inputs (transformers and underground distribution cables) which subtracted 1.0 ppt combined (compare with -1.5 ppts over 2006-12).

Growth in customer numbers continued to be one of the largest factors contributing to TFP growth over the period adding 0.6 ppts to the TFP growth rate (down slightly from 0.7 ppts over 2006-12).

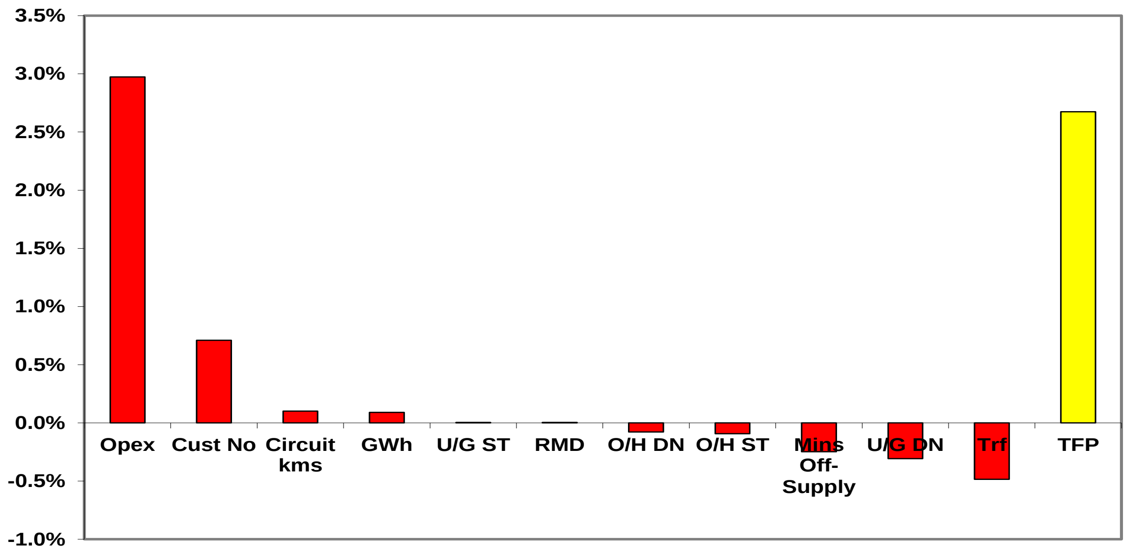
These results show that the most significant factor driving the turnaround in TFP was the change in the contribution of opex, which switched from being the most negative contributor up to 2012 to being the most positive after 2012. Opex, which grew at an average annual rate of 5 percent over 2006-12, decreased at an average annual rate of –2.5 per cent over 2012-16. A slowdown in the rate of growth in capital inputs (particularly transformers) was the second largest explanatory factor.

Drivers of the turnaround in opex performance are likely to include factors such as a moderation in network spending designed to meet increased reliability standards introduced in previous years in NSW and Queensland, and AER determinations (informed by these benchmarking results) which reduced network proposed opex.

The turnaround in TFP after 2012 would have been even greater if not for reductions in the contributions from some outputs. Ratcheted maximum's demand's (RMD's) contribution to average annual TFP change fell from 0.5 to 0.1 ppts over the two periods and the reliability contribution (CMOS) fell from 0.4 to –0.1 ppts as RMD flattened out and reliability performance declined somewhat. Further reductions in energy throughput turned its contribution to average annual TFP change from being marginally positive to –0.1 ppts. The rate of growth in TFP would also have been higher if redundancy costs were not counted in opex. This issue is discussed further in section 4.2 and 4.3.

In line with our reporting requirement, we also decomposed the input and output contributions to TFP over the most recent 12 months for 2016 (figure 21).

### Figure 21 DNSP output and input percentage point contributions to average annual TFP change, 2015–2016



The largest contributing factor driving the observed 2.7 per cent rise in TFP was a large reduction in opex (down 8 per cent in 2016) which contributed 3 ppts to the increase in TFP. As with previous years, an increase in capital inputs made a negative contribution to the TFP change (with transformers subtracting 0.5 ppts and underground transmissions 0.3 ppts), while rising customer numbers a positive one (adding 0.7 ppts).

These results indicate that the general drivers of the turnaround in TFP noted above - decreasing opex and lower growth in capital inputs driving TFP growth - not only held but strengthened over the last 12 months.

## 4.2 Input and output drivers at the jurisdiction level

Networks in a given jurisdiction generally face similar regulatory and environmental factors. Changes in these factors in a state or territory can explain changes in inputs, outputs and productivity results for networks in the same jurisdiction. This section compares the trends in industry-wide TFP identified in section 4.1 with trends observed in each jurisdiction and describes some of the factors which help explain observed differences. To help us do this, we have summarised key industry-level and jurisdictional results from our input and output analysis in table 3.[52]

Table 3 allows us to compare the average annual changes in TFP over three periods (2006-12, 2012-2016 and from 2015 to 2016), and the percentage point contributions to TFP changes from opex and capital inputs (transformers and underground distribution inputs) across the jurisdictions. We chose to focus on these three inputs as a review of the complete results for all DNSPs showed that they were the top three contributors to changes in TFP for almost every network in each time period.

The next two sections, referring to the table three below and the two periods 2006-12 and 2012-16, will describe annual changes in TFP and the percentage point contributions to TFP changes from opex and capital inputs across the jurisdictions. The full input-output analysis of TFP for each jurisdiction and individual DNSPs is available in the Economic Insights report and related spread sheets on the AER's benchmarking website.

52 There may be small differences between MTFP and TFP rates of change (between tables 1,2 and 3) due to difference between the two methodologies. Appendix A of the 2017 Economic Insights Report contains an explanation for these differences.

## Table 3: Component contributions to TFP growth rate, by jurisdiction, 2006 to 2016

| | 2006-2012 | | | 2012-2016 | | | 2016 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Av annual change in TFP (%) | Opex contribution to TFP (ppts) | Capital inputs contribution to TFP[53] (ppts) | Av annual change in TFP (%) | Opex contribution to TFP (ppts) | Capital inputs contribution to TFP (ppts) | Change in TFP (%) | Opex contribution to TFP (ppts) | Capital inputs contribution to TFP (ppts) |
| **Industry** | **-2.2** | **-1.9** | **-1.5** | **0.2** | **0.9** | **-1.0** | **2.7** | **3.0** | **-0.8** |
| NSW | -3.5 | -2.4 | -1.6 | 0.6 | 1.2 | -1.0 | 3.8 | 4.0 | -0.7 |
| QLD | -0.5 | -1.5 | -1.7 | -0.1 | 0.6 | -1.2 | 1.5 | 1.1 | -1.0 |
| Victoria | -1.6 | -1.8 | -1.3 | -0.7 | -0.0 | -0.9 | 0.3 | 1.0 | -0.8 |
| SA | -1.7 | -2.1 | -1.9 | -0.8 | 0.5 | -0.9 | 7.6 | 6.5 | -0.7 |
| Tasmania | -3.1 | -2.1 | -1.2 | 2.4 | 2.5 | -0.5 | -2.8 | -2.2 | -0.3 |
| ACT | -1.9 | -2.5 | -1.1 | 4.5 | 4.1 | -0.8 | 22.8 | 22.6 | -0.5 |

[53] Capital inputs = the percentage point contribution to average annual TFP growth rate from transformers (TRF) and underground distribution (UGD) inputs. In almost all cases, these were the two largest negative contributors to average annual TFP growth rates for all DNSP in each time period. There may be small differences between MTFP and TFP rates of change (between tables 1,2 and 3) due to differences between the two methodologies. Appendix A of the 2017 Economic Insights Report contains an explanation for these differences.

### 4.2.1 Industry trend 2006-12: Increasing opex and capital inputs drove productivity down

Section 4.1 found that over 2006-12 industry-wide TFP decreased at an average annual rate of -2.2 per cent driven primarily by strong growth in opex and capital inputs (transformers and underground distribution cables). Broadly, data in Table 3 shows that all jurisdictions experienced a decline in TFP over 2006-12 (all have negative average annual TFP growth rates). It also shows that, as with the industry-wide results, the decline in TFP was driven primarily by strong growth in opex and secondarily by growth in capital inputs (all opex and capital input contributions to TFP are negative and the negative contributions from opex are greater than that from capital inputs).[54] In spite of this common trend of declining productivity, there is substantial variation in the magnitude and drivers of the declines across the jurisdictions.

***Higher reliability and design standards drove down productivity in NSW***

NSW saw the largest declines in network productivity over 2006-12 with TFP declining at an average annual rate of 3.5 per cent over the seven years. This was driven by very high growth in opex (which contributed -2.4 ppts to the rate of decline in TFP compared with the industry opex contribution of -1.9 ppts) and increases in capital inputs which contributed a further -1.6 ppts.

A significant driver of increased capital inputs and opex in NSW from 2006-12 was spending by NSW DNSPs to meet 2005 and 2007 changes to mandatory licence conditions which set higher reliability and design standards and network planning requirements.[55] Work commissioned by the AER to review DNSP programs to comply with the new licence conditions found that, 'changes to licence conditions … placed considerable pressure on DNSPs to deliver a significant volume of capital works in the years leading up to and during the 2009-14 regulatory period'.[56]

***Higher reliability and design standards also impacted TFP in Queensland***

Queensland had the lowest rate of decline in TFP over 2006-12 (decreasing at an average annual rate of -0.5 percent). Strong growth in opex and capital inputs (transformers and underground distribution cables) contributed -1.5 ppts and -1.7 ppts to the rate of TFP decline. This negative effect was mostly offset by strong growth in outputs (improvements in reliability added 1.1 ppts to TFP while increased customer numbers added 1.0 ppts and ratcheted maximum demand another 0.7 ppts).

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54 Except for Tasmania which is the only jurisdiction in which growth in capital inputs provided a greater negative contribution (-4.2 ppts) to the TFP rate of decline than opex (-2.0 ppts).

55 Minister For Energy and Utilities, Design, Reliability And Performance Licence Conditions For Distribution Network Service Providers, 1 August 2005, and Ian Macdonald, MLC Minister for Energy, Design, Reliability And Performance Licence Conditions For Distribution Network Service Providers, December 2007.

56 Deloitte Access Economics, NSW Distribution Network Service Providers Labour Analysis, Final Addendum to 2014 Report , April 2015, p.2.

A significant component of the build-up in Queensland capital inputs and opex from 2006-12 can be attributed to spending to meet increased reliability standards set by the introduction of the N-1 security standard, the Minimum Service Standard (MSS) and Guaranteed Service Level (GSL) requirements. These new requirements came from recommendations by the Electricity Distribution and Service Delivery (EDSD) review panel in 2004 following extended network outages due to storms and extreme heat events in 2004.[57]

***Growth in Tasmanian opex drove rapid declines in productivity to 2010***

Tasmanian TFP decreased by 3.1 per cent annually over 2006-12. This decline was driven mainly by rapid growth in opex from 2008 to 2012 (contributing 2.1 ppts to the 3.1 per cent rate of decline) and growth in capital inputs (which subtracted 1.2 ppt from the TFP rate over the period). The rise in these inputs drove productivity lower such that by 2010 TasNetworks was the least productive network under our TFP measure.

***Rapid growth in ACT and SA opex to 2014 drove TFP declines***

The ACT and South Australia (as with Tasmania, NSW above) also experienced large negative contributions to network productivity from strong growth in opex spending.

From 2006-12, ACT network productivity declined at an average annual rate of -1.9 per cent primarily driven by strong growth in opex, which contributed -2.5 ppts to the rate of decline. ACT opex spending continued to grow up to 2014 and was the primary driver of declining productivity to that year.

ActewAGL proposed various factors driving this opex spending, including:

- increased vegetation management costs from two very wet years in 2010-11 and 2011-12
- increased costs to meet compliance and reporting requirements and the introduction in 2007 of the Energy Industry Levy
- business overheads and restructuring costs (including spending on IT systems and structural change and safety improvement costs).[58]

South Australia saw productivity decrease at an average annual rate of -1.7 per cent over 2006-12 driven primarily by growth in opex (which contributed -2.1 ppts annually to the rate of decline in productivity over the period). South Australian opex continued to grow steadily up to 2015 driving down network productivity.

SA Power Networks identified various factors contributing to rapid increases in their opex spending between 2010 and 2015, including:

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[57] Queensland Competition Authority, Discussion Paper - Review of Minimum Service Standards and Guaranteed Service Levels to apply in Queensland from 1 July 2015, August 2013, p.17.

[58] ActewAGL, Regulatory Proposal, 2015-19 Subsequent regulatory control period, Distribution services provided by the ActewAGL Distribution electricity network in the Australian Capital Territory, June 2014, pp.213 and 215-218.

- weather related factors (including vegetation management costs doubling after the breaking of the 'millennium drought' in 2010 and a quadrupling in reliability guaranteed service level payments over 2010-2015 to compensate customers for loss of supply from an increase in major weather events)
- new regulatory requirements (including the 2011 establishment of the solar feed-in scheme which SA Power Networks was required to administer and the start in 2013 of the National Energy Customer Framework).[59]

***Vegetation and maintenance spending drove Victorian productivity lower***

Victoria network TFP declined at an average annual rate of -1.6 per cent annually from 2006 to 2012. Growth in Victorian opex was the major contributor to the decrease in productivity (subtracting -1.8 ppts from the state's TFP growth rate). A major driver of increased opex in Victoria from 2011 to 2013 was an increase in vegetation management work needed after heavy rains in 2010 and 2011 and to meet new regulatory requirements under the Electrical Safety (Electric Line Clearance) Regulations 2010 following the Black Saturday bushfires in 2009. Victorian DNSPs also reported a moderate increase in maintenance expenditure driven by increases in other regulatory obligations following the Black Saturday bushfires.[60]

### 4.2.2 Industry trend 2012-16: Decreasing opex and slower growth in capital inputs turns productivity positive

Section 4.1 found industry-level productivity (TFP) grew over 2012 to 2016 at an average annual rate of 0.2 percent a year, driven primarily by decreasing opex and slower growth in capital inputs.

In line with this industry-wide trend, the data in table 3 shows that each jurisdiction experienced a similar shift toward productivity growth over 2012-16, although the timing and magnitude of the change varies significantly. Specifically, this shift can be seen in the change in the jurisdictional results from negative TFP growth rates over 2006-12 to positive TFP growth rates over 2012-16 and for 2016.[61] Also consistent with industry-wide trends; the improvement in TFP in each jurisdiction is driven primarily by reductions in opex and a moderation in the growth of network capital inputs. This can be seen in table 3 in the switch in opex contribution numbers for each jurisdiction from negative to positive between the 2006-12 and 2012-16 periods.[62] The moderation in

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[59] SA Power Networks, SAPN Regulatory Proposal 2015-2020, October 2014, p.42 and 55.

[60] AER, Final Decision AusNet Services Distribution Determination 2016-20 -Attachment 7 - Operating Expenditure, May 2016, pp. 7-34 to 7-37 and 2106 BMR.

[61] ACT and NSW recorded positive TFP growth rates for 2012-16 and 2015-16. SA, Victoria and Queensland all recorded negative average annual TFP growth rates for 2012-16 but positive TFP rates for 2016. Tasmania recorded a positive TFP growth rate over 2012-16 but a negative rate in 2015-16.

[62] Victoria is the exception showing an opex contribution of -0.1 ppts over 2012-16. This is an improvement compared to 2006-12 when increasing opex contributed -1.8 ppts to the average annual TFP growth rate of - 1.6 per cent.

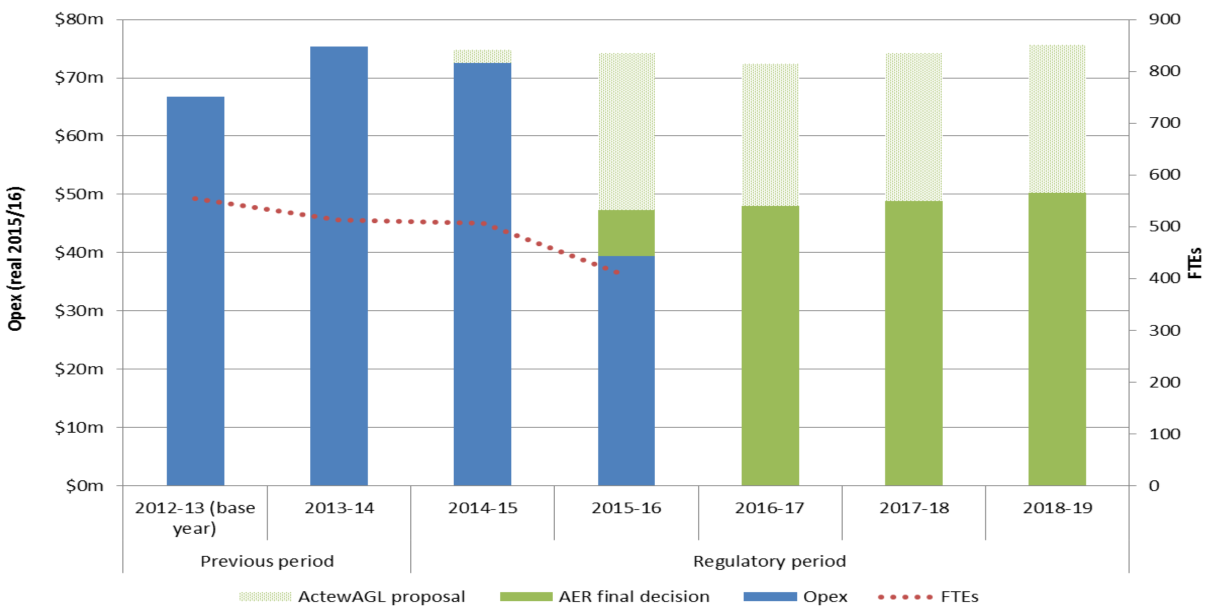
the negative contribution of capital inputs on TFP can be seen in the decrease in the magnitude of the (still negative) capital contribution numbers between the 2006-12 and 2012-16 periods.

***Decreasing redundancy costs in 2016 boost the ACT's productivity***

The ACT had the highest average annual growth in TFP over 2012-16 at 4.5 per cent. This was primarily driven by decreasing opex spending (which added 4.1 ppts to the TFP rate). However, these results (calculated over 2012-16) obscure a dramatic turnaround in TFP in 2014. While industry-wide opex peaked in 2012, ACT opex continued to grow strongly to 2014. It declined slightly in 2015 then fell precipitously in 2016.[63] The ACT's results in table 3 show this. TFP increased by 22.8 per cent in 2016 driven almost completely by a decrease in opex (which contributed 22.6 ppts to the TFP change). On an alternative measure, ActewAGL increased its opex PFP result by an exceptional 86 per cent between 2015 and 2016.

The extent of the ACT' s (ActewAGL's ) productivity improvement over the last two years is driven by a reduction in the labour redundancy cost component of its opex. Figure 22 shows the extent of the decrease in its opex from 2015 to 2016 (a decrease from $73.6 million to $40.6 million) with the decline coming from  a combination of falling redundancy costs and lower wage costs as staffing levels declined.

## Figure 22 ActewAGL actual opex, AER forecast opex, and ActewAGL proposed opex for 2014-19, including movements in FTEs




Source: AER final decision; Category Analysis RIN; ActewAGL response to information request

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63 Economic Insights report, 'Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking Report 31 October 2017, Figure 4.3, p. 23

If redundancy payments were excluded from opex, the trajectory of the ACT's productivity improvement would have been more even over 2014 to 2016 as earlier TFP results would be higher and the rise in TFP in 2016 not as steep. The impact of labour redundancy costs on opex and TFP is discussed further in section 4.3.

It is of note that after the large decline in ActewAGL's opex spending between 2015 and 2016, actual opex for the current period is significantly lower than ActewAGL's proposed opex for the period and lower than the level approved by the AER in our final distribution determination for the 2015-16 to 2018-19 period (Figure 22). ActewAGL has stated that the sharp fall in opex 'has been driven by the uncertainty as to the outcome of the prolonged appeal process in respect of the AER's opex decision in its Final Decision, ActewAGL distribution determination 2015-16 to 2018-19 (2015 determination), rather than an efficient and prudent program for maintenance of its distribution network.'[64]

***Lower opex in 2016 boosts SA productivity***

South Australia follows a similar but less extreme trajectory to that of the ACT in terms of opex and TFP. South Australian opex spending grew strongly from 2007 to 2015 while TFP declined over the period. A large decrease in opex in 2015 produced an uptick in TFP.[65] Data in table 3 shows TFP increased by 7.6 per cent in 2016 with opex contributing 6.5 ppts to this change.

The 2016 decline in South Australian opex and the improvement in TFP was likely driven in part by the AER's 2015 final decision on SA Power Networks' network determination for the 2015-20 regulatory period. In the decision the AER did not accept SA Power Networks' revised forecast total opex of $1.422 billion dollars and made a final decision of $1.251 billion.[66] SA Power Networks appealed the AER's decision and in October 2016 our determination was upheld in its entirety.[67] SA Power Networks has appealed the determination to the Federal Court.

SA Power Networks submitted that the improved productivity result of the last two years was largely driven by reliability improvements and lower emergency response expenditure and guarantee service level payments due to more moderate weather.[68]

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64 ActewAGL, Expenditure Forecasting Methodology 2019-2024, June 2017, p.12.

65 Economic Insights report 'Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking', 31 October 2017, Figure 4.19, p. 43

66 AER, Final Decision SA Power Networks determination 2015-20 - Attachment 7 - Operating expenditure, October 2015, pp. 7-38 to 7-47.

67 http://www.judgments.fedcourt.gov.au/judgments/Judgments/tribunals/acompt/2016/2016acompt0011#_Ref465074000

68 SA Power Networks submission, p.2.

### *NSW network efficiency reforms reduce opex in 2013*

In NSW (as with the industry-wide results) network opex peaked in 2012 and over 2012-16 reductions in opex spending drove TFP higher.[69] Decreasing opex added 1.2 ppts to the TFP growth rate (of 0.6 per cent) while lower growth in capital inputs subtracted -1.0 ppts from TFP growth (compared with -1.6 ppts over 2006-12). The trend in NSW of productivity growth driven by falling opex and slower growth in capital inputs strengthened over 2016 as TFP increased by 3.8 per cent with declining opex contributing 4.0 ppts towards the rate of growth.

The 2012 peak in NSW opex levels coincided with the NSW Government's implementation of a restructuring plan for state DNSPs overseen by Networks NSW. Improved labour productivity 'was a major focus of the reform program, [as was the] development of a new operating model and umbrella structure across the three organisations [to] enable labour cost reductions.'[70] Networks NSW emphasised increased efficiency as a goal of the reform plans, noting that, 'A strategic framework and seven strategic plans have been developed by NNSW to deliver on its key objectives of safety, reliability and affordability in an aligned and cost effective manner.'[71]

Opex of the three NSW DNSPs rose over 2014 and 2015 in part due to increased redundancy costs (see section 4.3). However, there was a decline in overall NSW opex spending (and an uptick in TFP) in 2016 as some of the benefits of ongoing redundancy programs were realised. The AER's 2015 final determinations for the NSW DNSPs (which set revenue allowances substantially below proposed levels) was also a likely driver of the recent decline in NSW opex spending.[72]

### *QLD network reforms drove lower opex in 2013*

The Queensland data shows a similar turnaround trend in TFP to NSW but less acute in magnitude and later in timing (table 3). Queensland saw its rate of TFP decline decrease from an average annual -0.5 per cent over 2006-12 to -0.1 per cent over 2012-16 then turn positive over 2016 (increasing by 1.5 percent).  As with other networks, declining opex was the biggest single contributor to this trend.

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69 Economic Insights report 'Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking', 31 October 2017, Figure 4.9, p. 31

70 Networks NSW, Delivering efficiencies for our Customers, May 2014, pp.6-7.

71 Ibid.

72 AER, Final decision Ausgrid distribution determination, Attachment 7 Operating Expenditure, April 2015. NSW DNSPs appealed the AER's 2015 determinations to the Australian Competition Tribunal and the AER sequentially appealed the Tribunal's decision to the Federal Court. In May 2017, the Federal Court remitted the decisions (including the approach the AER used to determine efficient opex) back to the AER to remake the decisions (section 2.4).

The decline in Queensland opex from 2012 to 2014 coincided with a government review of the drivers of network costs.[73] In 2012, the state Government instituted a freeze on the standard residential tariff and established the Independent Review Panel (IRP) on Network Costs to develop options to address the impact of rising network costs on electricity prices in Queensland. The Panel found, 'The capital programs and operating costs of the government owned corporations have increased sharply and unsustainably in response to prescriptive system design standards, such as the N-1 security standard and the Minimum Service Standards imposed by Government. …These standards were originally introduced to improve the reliability of the network but have driven excessive costs and resulted in a degree of over-engineering of the networks.'[74]

In May 2013, the IRP found that through a series of reforms, Energex and Ergon could together achieve an estimated $1.4 billion reduction in operational costs over the 2015−20 regulatory control period. The IRP made 45 recommendations, including 18 focused on overhead expenses and operational efficiencies. As a result of these reviews, Energex and Ergon Energy regulatory proposals to the AER in 2015 included a series of efficiency adjustments to base opex and over the forecast period, including FTE reductions.[75]

A second decline in Queensland opex spending more recently over 2015 to 2016 coincided with the AER's final determinations for the QLD DNSPs. The AER decisions set revenue allowances including for opex substantially below the DNSP's proposed levels.[76]

### *Victoria returns to positive TFP growth in 2015 and 2016*

Victorian data also shows a similar turnaround trend in TFP to NSW but less acute in magnitude and later in timing (table 3). Victorian TFP declined at a lower rate over 2006-12 compared with NSW (TFP declined by 1.6 per cent annually for Victoria compared with 3.5 per cent for NSW). The data also shows the switch from negative to positive TFP growth happened later in Victoria and was of a lesser magnitude compare with NSW. NSW recorded positive TFP growth over 2012-16 of 0.6 per cent annually whereas Victoria recorded improved but still negative TFP growth rate of -0.7 per cent. By 2016, Victoria recorded positive TFP growth of 0.3 per cent, albeit substantially less than the NSW TFP growth rate of 3.8 per cent.

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73 Economic Insights report 'Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking', 31 October 2017, Figure 4.14, p. 37

74 Independent Review Panel, Electricity Network Costs Review Final Report , December 2012, pp. iv - vi.

75 AER, Final Decision Ergon Energy preliminary determination 2015-20 - Attachment 7 - Operating expenditure, October 2015, p. 7-51 to 7- 53

76 AER, Final Decision Ergon Energy preliminary determination 2015-20 - Attachment 7 - Operating expenditure, October 2015, p. 7-51 to 7- 53.

***Tasmanian reduced input use from 2012***

Tasmania also broadly followed industry-wide trends, with opex peaking in 2012, although the decline in TFP halted earlier than in most other jurisdictions (in 2010 rather than the industry-wide bottom in 2012).[77] The turnaround in Tasmania's TFP growth rates between 2006-12 and 2012-16 was one of the largest of any jurisdiction (average annual TFP switched from a -3.1 per cent annual decline to a 2.4 per cent average annual increase). This was driven by a decrease in opex (which switched from subtracting -2.1 ppts from TFP growth to adding 2.4 ppts over the two periods), and a decline in the growth rate of capital inputs (which went from subtracting -1.2 ppts from TFP growth to just -0.5 ppts between the two periods).

TasNetworks noted that a large part of its recent improvement was due to a focus on achieving operational efficiencies over and above overhead savings from its merger with TasNetworks Transmission. TasNetworks included the following excerpt from its 2015 annual report referring to the 2014–15 financial year: 'We focussed on generating operational efficiencies and were successful in reducing the recurrent cost base of the business by $25.9 million in addition to the initial $8 million of cost reductions achieved on the establishment of our business.' [78]

## 4.3 Impact of reform costs on productivity results

The reduction in industry-wide opex since 2012 has been accompanied by increased levels of redundancy payments as some DNSPs have restructured to improve efficiency and reduce staffing levels. In NSW, DNSP workforce numbers have been declining for several years as part of ongoing reforms under Networks NSW and in response to partial privatisation of Ausgrid and Endeavour. More recently, workforce reductions continued in response to the AER's 2015 final determinations which substantially reduced network opex revenue allowances.

Figure 23 shows changes in full time equivalent (FTE) staff over time at the three NSW DNSPs and ActewAGL.

As noted in section 4.2, redundancy payments are counted as opex for the AER's economic benchmarking. In the year redundancy costs are expensed, a DNSP's opex input rises, decreasing their TFP and opex PFP results. In subsequent years, assuming other inputs and outputs remain constant, opex should decrease by the amount of the redundancy costs plus the labour costs savings from reduced staffing levels. This cycle lowers productivity initially and produces a productivity uplift later as costs pass through the opex data. This effect explains part of the very large improvement in ActewAGL's TFP and opex PFP in 2016 (section 4.1).

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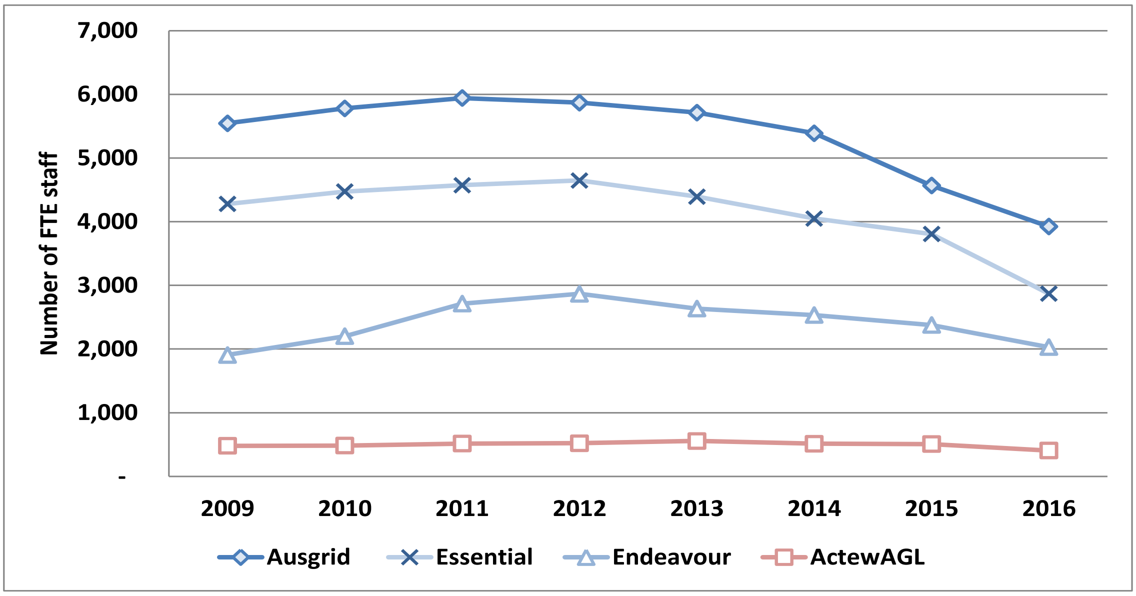
[77] Economic Insights report 'Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking', 31 October 2017, Figure 4.27, p. 53

[78] TasNetworks, 'TasNetworks response to 2017 AER draft benchmarking report for distribution networks', 11 October 2017, p.4.

## Figure 23 NSW/ACT DNSP FTE staff level, 2008-9 to 2015-16




Source: Industry data.

Some DNSPs have expressed concern that redundancy payments are an 'abnormal' expense or a 'cost of reform' that should be excluded from the opex data for the purposes of benchmarking.[79]

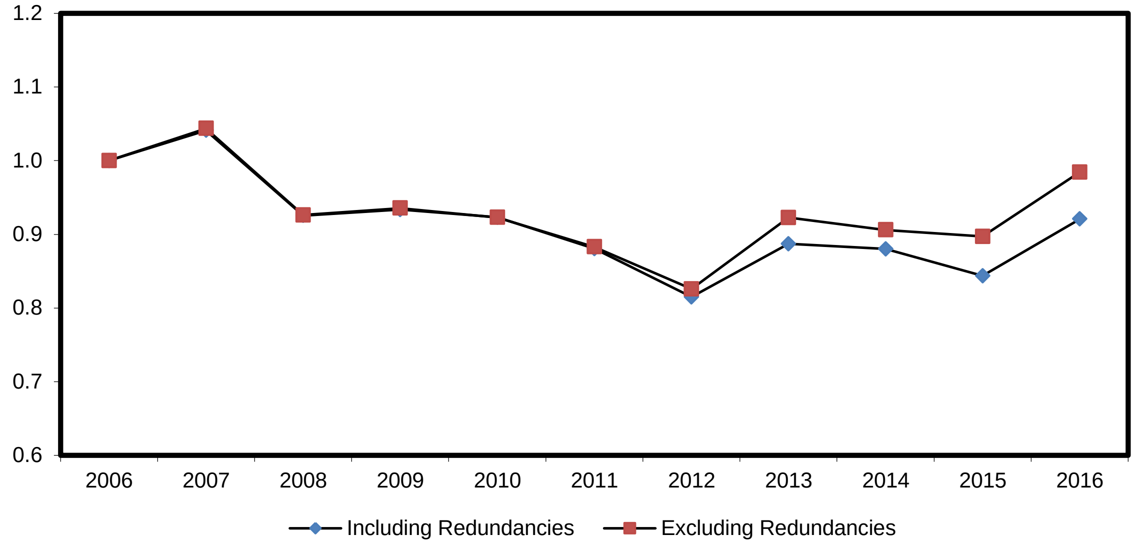
To quantify the size of the impact of redundancy costs on benchmarking, the AER requested redundancy cost data from all DNSPs for 2006 to 2016 and calculated TFP and opex PFP results with and without redundancy costs. Results at the industry, jurisdiction and individual DNSP levels can be found on line in the Economic Insights report. This section describes the effect of excluding redundancy data on the industry-wide benchmarking results for TFP and opex PFP. Results for individual DNSP's would follow a similar pattern, although the timing and magnitude of the effects will depend on their individual redundancy programs.

### Excluding current redundancy costs boosts the 2016 productivity results

DNSP data reveals that redundancy payments at the industry level were a marginal proportion of opex prior to 2012 but have steadily risen since then to account for around 7 per cent of industry opex by 2016. Figure 24 shows the impact of excluding redundancy payments from industry wide opex PFP from 2006 to 2016. As expected, excluding these costs increases opex PFP, with the size of the gap increasing from 2012 onwards as redundancy costs rise. Excluding redundancy costs from the 2016 industry opex data increases the opex PFP result by around 7 per cent (from 0.92 to 0.98).

[79] For example, see Ausgrid's 2916 submission to the Benchmarking Report.

## Figure 24 Industry opex PFP redundancy payments in/out, 2006–16




A similar pattern of growing divergence from 2012 holds for industry-wide TFP results when redundancy costs are removed. For 2016, removing redundancy costs from industry-wide opex increases the industry TFP result from 0.885 to 0.906 (by around 2.4 per cent), increasing the change in TFP over 2016 from the reported 2.7 per cent increase to a 5.1 per cent rise.

### Current redundancy costs point to future productivity gains

A number of DNSPs have reported incurring significant redundancy costs over 2016 at levels above the industry average of seven per cent of total opex (Table 4).

### Table 4: NSW DNSPs with ongoing redundancy cost, 2014 to 2016

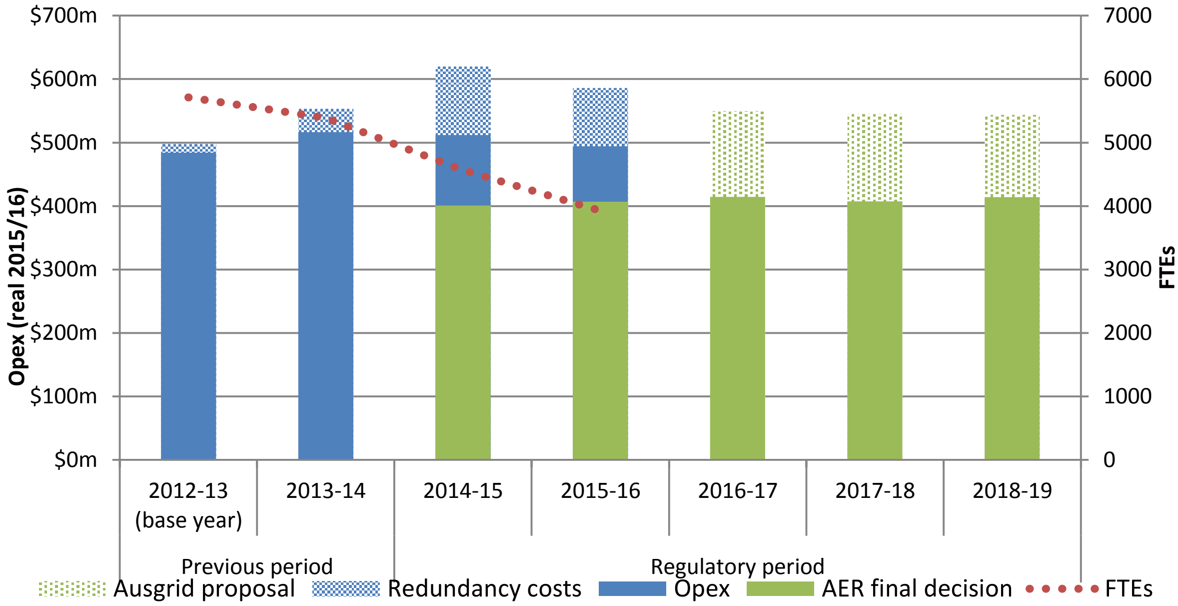
| DNSP | Costs ($,000) | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| **AGD** | Network services opex | 539 570 | 647 228 | 588 179 |
| | Total redundancy | 24 518 | 107 185 | 91 933 |
| | **% of opex** | **4.5** | **16.6** | **15.6** |
| **END** | opex | 258 322 | 270 954 | 311 821 |
| | redundancy | 5 926 | 13 191 | 29 736 |
| | **% of total** | **2.3** | **4.9** | **9.5** |

Source: Industry data.

As these redundancy costs wash out of network opex data and lower labour costs are realised these DNSPs should experience a significant uplift in their productivity results (assuming other inputs and outputs remain constant). The size of the uplift for a DNSP would depend on the level of redundancy costs incurred and labour costs saved relative to their opex.

Figure 25 below provides an example of the potential magnitude of future productivity uplift for the NSW DNSP Ausgrid. Ausgrid has reduced its workforce numbers by around 30 per cent since 2012-13 and incurred large redundancy costs as it pays benefits to departing employees (amounting to $92 million or 16 per cent of total opex in 2015-16). Removing redundancy costs from Ausgrid's 2016 benchmarking data (while holding all other inputs and outputs constant) increases their 2016 TFP score from .842 to .889 (by 5.6 per cent), and increases the rate of change in their TFP between 2015 to 2016 from 3.3 per cent to approximately 9.1 per cent.

### Figure 25 Ausgrid actual opex, AER forecast opex, and Ausgrid proposed opex for 2014-19, including movements in FTEs




Source: 2015 AER final decision; Category Analysis RIN; Ausgrid response to information request

Note: Actual opex has been normalised by excluding metering and ancillary costs prior to 2014-15 and removing the cost pass-through for the 2014-15 storms.

# A References and further reading

This benchmarking report is informed by several sources. These include ACCC/AER research and expert advice provided by Economic Insights.

## Economic Insights publications

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

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

## ACCC/AER publications

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

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

## AER distribution determinations

The AER uses economic benchmarking to inform its regulatory determination decisions. A full list of these decisions to date can be found on the AER's website: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements

# B Inputs and outputs

This appendix contains further information on the outputs and inputs used in the benchmarking techniques. The November 2014 Economic Insights report referenced in Appendix A explains the rationale supporting the choice of input and output specifications used in this report.

## B.1 Outputs

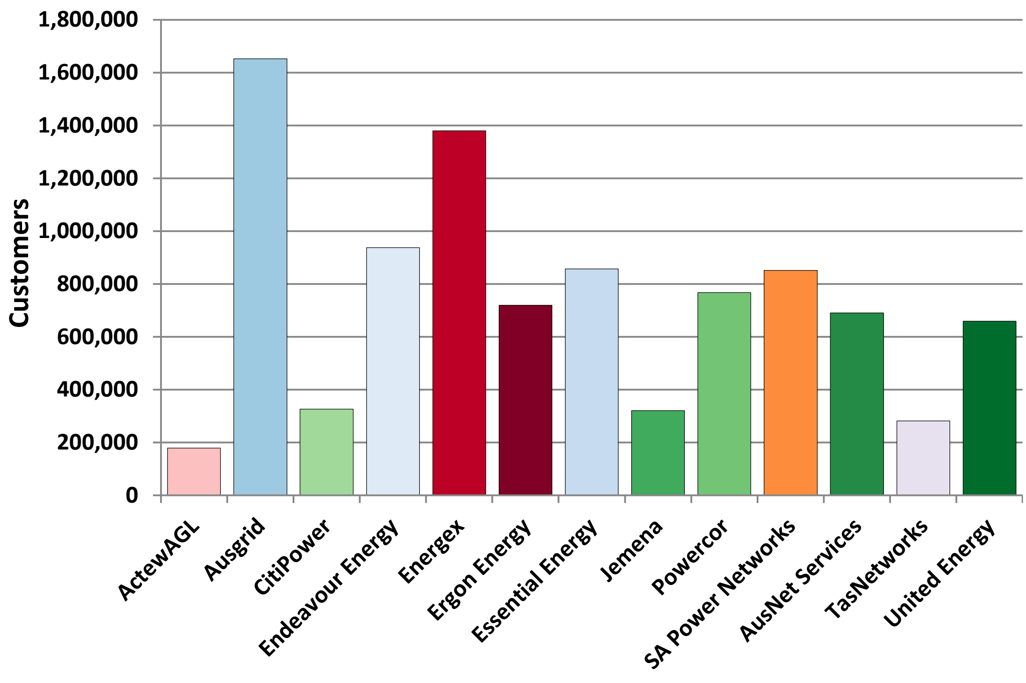
The techniques in the report measure output using some or all of customer numbers, circuit line length, maximum demand, energy throughput and reliability.

### B.1.1 Customer numbers

The primary function of a distribution network is providing its customers with access to electricity. Regardless of how much electricity a customer consumes, infrastructure is required to connect every customer to the network. The number of customers, therefore, reflects a significant driver of the services a DNSP provides. We measure the number of customers as the number of active connections on a network, represented by each energised national metering identifier.

Figure 26 shows the average customer numbers of each DNSP over the five year period from 2012 to 2016. We use an average to mitigate the effect of one-off changes in a particular year. Five years is the length of a typical regulatory period.

**Figure 26 Five year average customer numbers by DNSP (2012–16)**



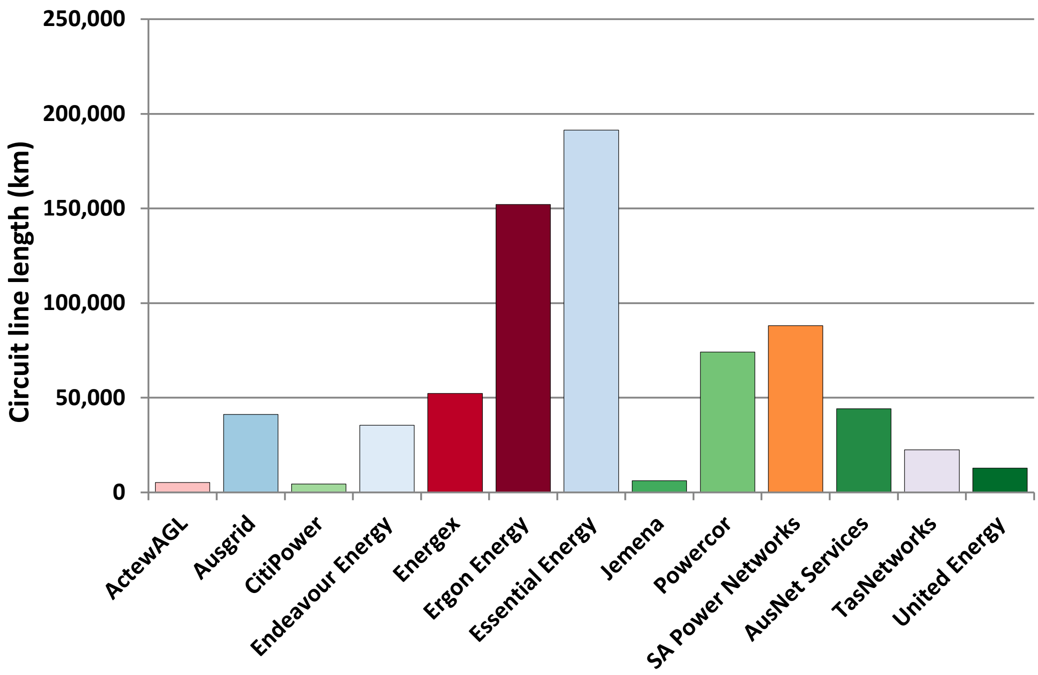
## B.1.2 Circuit line length

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 this report, line length is measured in terms of the length of 'circuit' or the length of 'route'. Route length is the distance between a DNSP's poles. Circuit length is the length of lines in service, where a double circuit line counts as twice the length. Circuit and route length can differ because distributors may run multiple lines on the same route.

In economic benchmarking metrics and PPI metrics, we use circuit length because, in addition to measuring network size, it also approximates the line length dimension of system capacity. System capacity represents the amount of network a DNSP must install and maintain to supply consumers with the quantity of electricity demanded at the places where they are located. Figure 27 shows each DNSP's circuit length, on average, over the five years from 2012 to 2016.

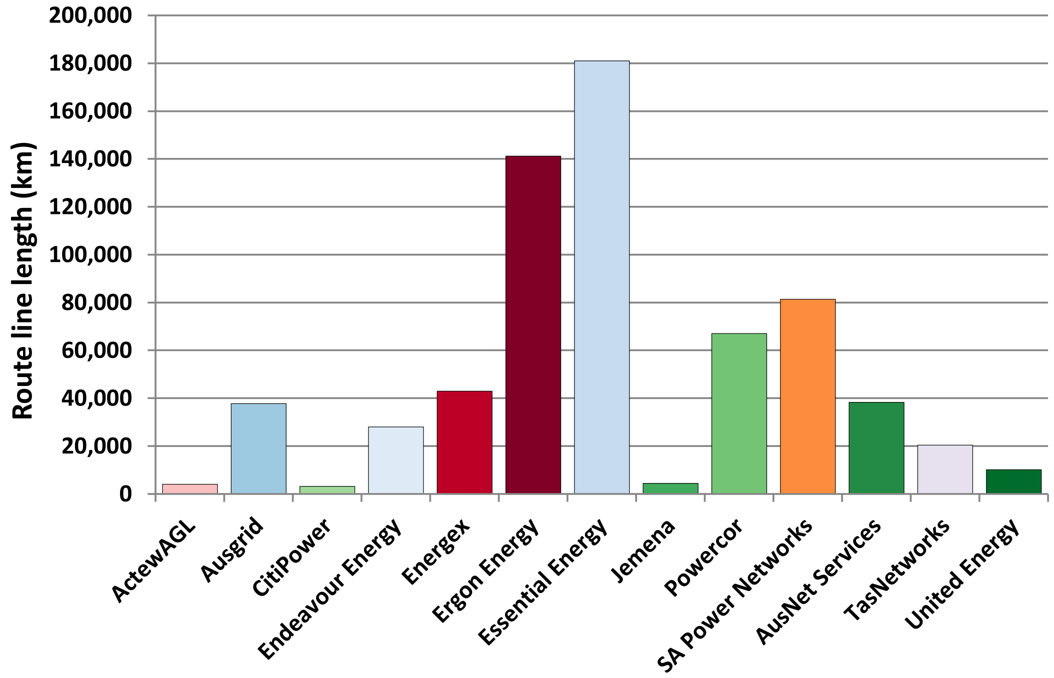
### Figure 27 Five year average circuit line length by DNSP (2012–16)




For PPI metrics, we use route length to calculate customer density (measured as customers per km of line length) because it is a measure of network size. For this purpose, route length is a measure of a DNSP's physical network footprint because it does not count multiple circuits on the same route. Figure 28 demonstrates that, for all

DNSPs, route length is shorter than circuit length but there is no change in DNSP ranking between the two line length measures.

**Figure 28 Five year average route line length by DNSP (2012–16)**




## B.1.3 Maximum demand and energy throughput

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.

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

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

Table 5 presents maximum demand and energy delivered for each of the DNSPs, on average, for the five years between 2012 and 2016.

### Table 5 Maximum demand and energy throughput (2012–16 average)

| | Maximum demand (MW) | Energy throughput (MWh) |
|---|---|---|
| ActewAGL (ACT) | 693 | 2,871,402 |
| Ausgrid (AGD) | 5,659 | 26,490,798 |
| AusNet Services (AND) | 1,877 | 7,557,905 |
| CitiPower (CIT) | 1,373 | 5,961,412 |
| Endeavour Energy (END) | 3,651 | 16,183,271 |
| Energex (ENX) | 4,678 | 21,079,133 |
| Ergon Energy (ERG) | 3,124 | 13,661,402 |
| Essential Energy (ESS) | 2,713 | 12,151,630 |
| Jemena (JEN) | 949 | 4,230,686 |
| Powercor (PCR) | 2,415 | 10,600,461 |
| SA Power Networks (SAP) | 2,848 | 10,665,511 |
| TasNetworks (TND) | 1,047 | 4,221,291 |
| United Energy (UED) | 1,965 | 7,869,031 |

## B.1.4 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 29 presents the average number of minutes off supply per customer, excluding the effects of major events, planned outages and transmission outages.

## Figure 29 Average minutes off supply per customer (2012–2016)

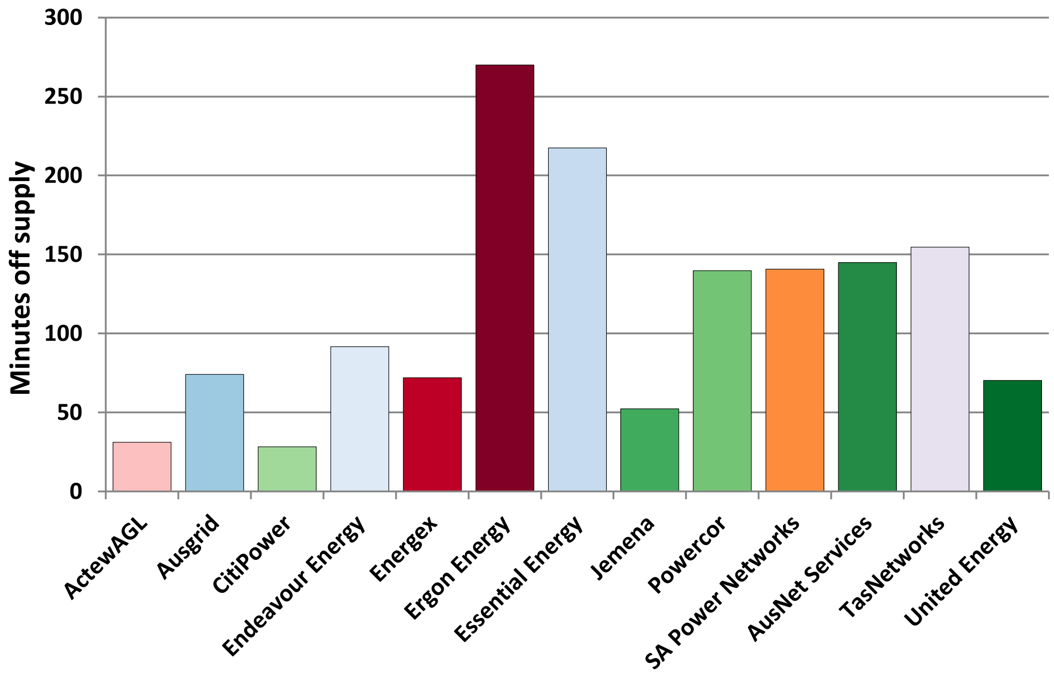
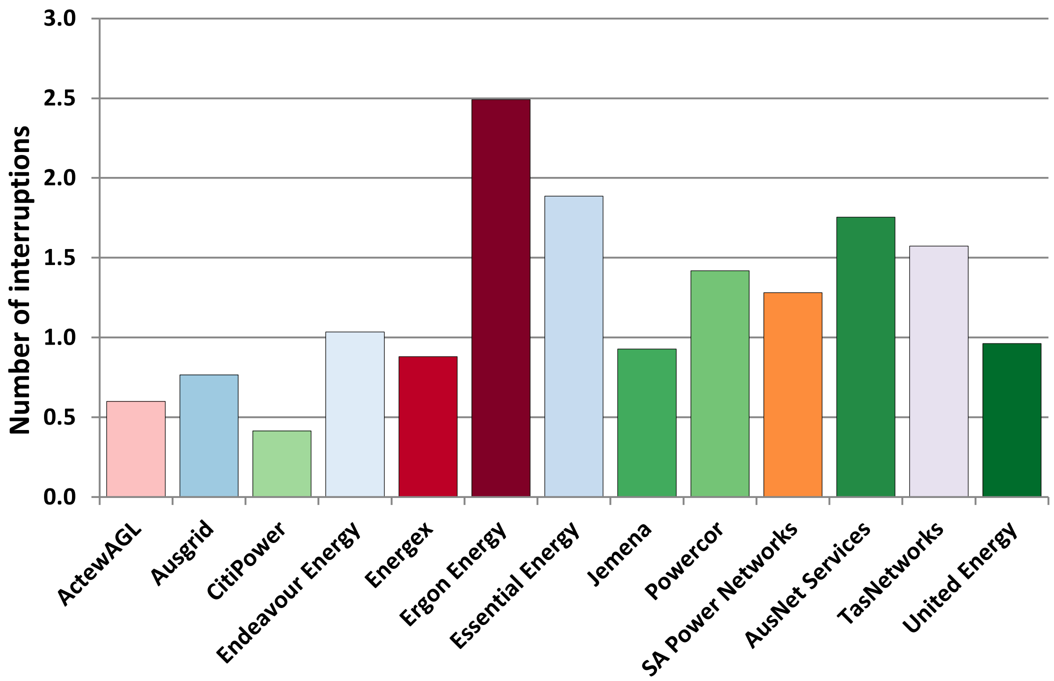



Figure 30 presents the average number of interruptions to supply per customer, excluding the effects of major events, planned outages and transmission outages. There are other measurements of reliability but the frequency and duration of interruptions to supply per customer are the Institute of Electrical and Electronics Engineers (IEEE) standard measures for DNSPs.

## Figure 30 Average number of interruptions per customer (2012–2016)



## B.2 Inputs

The inputs used in this report are physical 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 analysis we use measures of the capital stock or physical assets DNSPs use to provide services and invest in to replace, upgrade or expand their network. Using physical values for capital inputs has the advantage of best reflecting the physical depreciation profile of DNSP assets. Our MTFP analysis uses five physical measures of capital inputs: the capacity of transformers, overhead lines above 33kV, overhead lines below 33kV, underground cables above 33kV and underground cables below 33kV. The MTFP analysis also uses 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.

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 analysis, and in response to a submission by Ausgrid,[80] 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.[81] 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.

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

81 To calculate asset costs relevant to PPIs, MTFP and Capital MPFP, 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. See: AER, *Final decision, Jemena distribution determination 2016 to 2020 Attachment 3 – Rate of return*, May 2016 and AER, *Final decision*, *Jemena distribution determination 2016 to 2020 Attachment 4 – value of imputation credits*, May 2016. These include a market risk premium of 6.5 per cent, and a risk free rate based on the yield of ten year CGS (noting we use a 365 day averaging period for each year in the benchmarking report). For this benchmarking report, we choose to continue to use our the previous approach used in previous benchmarking reports that use the Bloomberg BBB fair value curve (365 day averaging period) to calculate the debt risk premium. The AER's present approach averages ten year maturity BBB yields from the RBA and Bloomberg (appropriately extrapolated out to ten years where necessary). However, historical data going back to 2006 is not available for the RBA curve. Given this, we have continued to rely solely on estimates based on the Bloomberg fair value curve data. Where relevant, the tax component uses gamma of 0.4.

Table 6 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 6 Average annual costs for network inputs for 2012–16 ($m, 2016)

| | Opex | RAB | Depreciation | Asset cost |
|---|---|---|---|---|
| ActewAGL (ACT) | 66.91 | 879 | 50.29 | 88.13 |
| Ausgrid (AGD) | 595.16 | 13,164 | 475.15 | 1,041.78 |
| AusNet Services (AND) | 198.23 | 3,132 | 143.90 | 278.72 |
| CitiPower (CIT) | 57.78 | 1,377 | 68.90 | 128.18 |
| Endeavour Energy (END) | 274.54 | 4,745 | 208.82 | 413.06 |
| Energex (ENX) | 386.53 | 7,606 | 297.12 | 624.51 |
| Ergon Energy (ERG) | 363.43 | 7,367 | 315.60 | 632.70 |
| Essential Energy (ESS) | 407.76 | 6,647 | 290.27 | 576.39 |
| Jemena (JEN) | 75.46 | 959 | 60.78 | 102.07 |
| Powercor (PCR) | 193.01 | 2,556 | 130.36 | 240.38 |
| SA Power Networks (SAP) | 236.15 | 3,491 | 212.17 | 362.45 |
| TasNetworks (TND) | 76.81 | 1,474 | 77.72 | 141.18 |
| United Energy (UED) | 130.04 | 1,880 | 111.63 | 192.55 |

Note: Data for the Victorian distributors is for calendar years whereas the data for the other DNSPs is for financial years. RAB values are the average of opening and closing values.

# C Results for partial performance indicators

Partial performance indicator (PPI) techniques compare one input to one output. This contrasts with the MTFP, MPFP and Econometric techniques that relate inputs to multiple outputs. PPIs measure the average amount of input that is used to produce one unit of the chosen output.

## C.1 Partial performance indicators by DNSP

PPIs provide a simple visual representation of input costs relative to a particular output. The PPIs used here support the MTFP analysis, providing a general indication of comparative performance of the DNSPs in delivering a specific output. While PPIs don't take into account the interrelationships between outputs, they are informative when used in conjunction with other benchmarking techniques (such as MTFP).

The DNSPs' total cost (opex and asset cost[82]) is the main input used in this analysis. It is compared with a number of outputs, including customer numbers, maximum demand and circuit line length. The analysis also compares total costs per customer with unplanned minutes off supply per customer, to provide a 'per customer' reliability metric.[83]

We note that on a 'per customer' metric, large rural DNSPs will perform poorly relative to DNSPs in suburban and metropolitan areas. Typically, the longer and sparser a DNSP's network, the more assets it must operate and maintain per customer. The 'per MW' metric exhibits a similar pattern. Conversely, on 'per km' metrics, large rural DNSPs will perform better because their costs are spread over a longer network. Where possible the PPIs are plotted against customer density, to enable readers to visualise and account for these effects when interpreting the results.[84]

The PPIs in this section of the report measure average costs from 2012 to 2016. Using a five year average mitigates against the effect of one-off changes in opex or assets in a particular year. Also, five years is the length of a typical regulatory period.

### *Total cost per customer*

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82 Asset cost is the sum of annual depreciation and return on investment. 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.

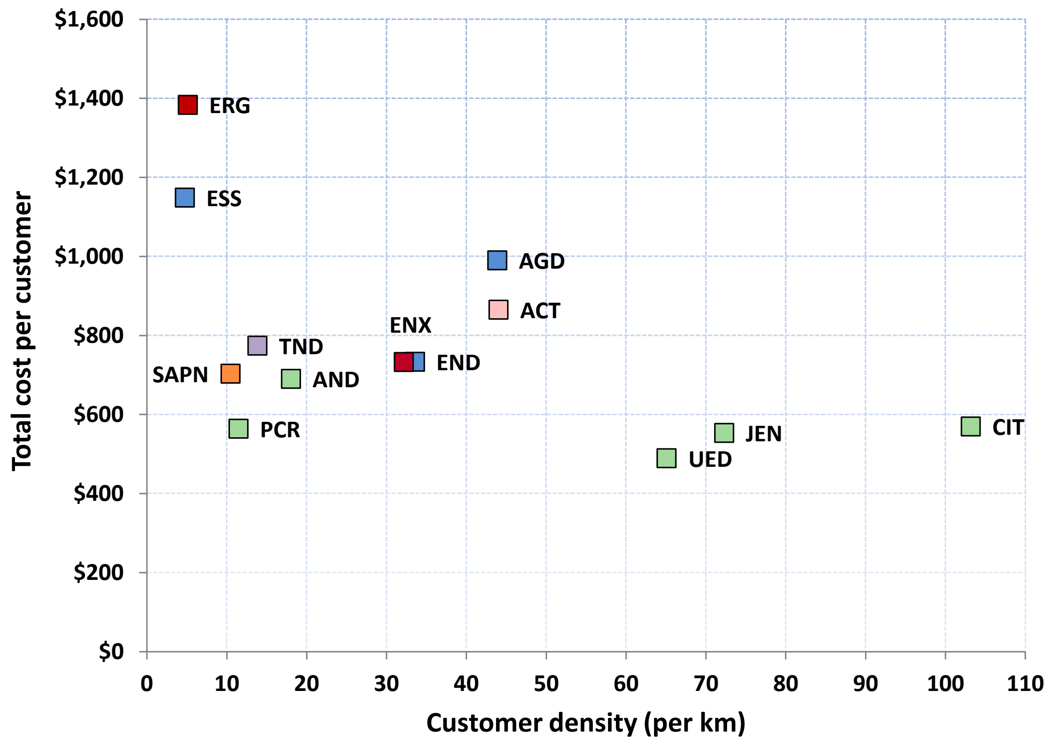
83 The outputs we consider are similar to those used in the MTFP and MPFP benchmarking techniques. However, we do not specifically consider energy delivered as it is likely to be highly correlated with customer numbers and maximum demand, and is a less significant driver of the DNSPs' costs.

84 We measure customer density as the number of customers per km of route line length (see Appendix B).

Customer numbers are arguably the most significant output DNSPs provide because the number of customers connected to the network drives the demand and the infrastructure required to meet that demand.[85]

Figure 31 shows total cost per customer on the vertical axis and customer density on the horizontal axis.

## Figure 31 Total cost per customer ($2016) against customer density (average 2012–16)




Melbourne metropolitan DNSPs (Citipower, Jemina and United Energy), those with the highest customer density, have and the lowest cost per customer. However, it is notable that Powercor (a regional Victorian DNSPs with low customer density), also has low total costs per customer relative to the DNSPs in other states.

Regional DNSPs in Queensland and NSW (Ergon Energy and Essential Energy) operate with very low customer density. Not surprisingly, they have also the highest total cost per customer. However, the magnitude of their costs per customer, relative to the regional Victorian, South Australian and Tasmanian DNSPs which also have relatively low customer density, is much greater than expected – almost double that of

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

other DNSPs in Victoria, South Australia and Tasmania, which also have relatively low customer density.

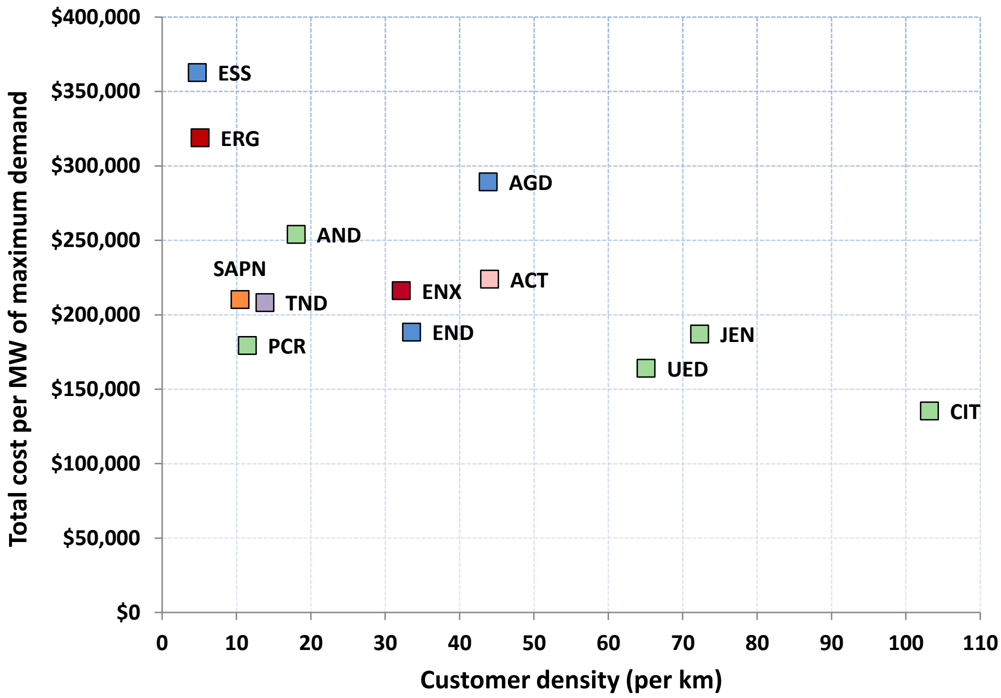
It is also noteworthy that Ausgrid and ActewAGL, which operate in a mixed metropolitan-urban area, have higher total costs per customer than other DNSPs operating with lower customer density (regional Victorian, South Australian and Tasmanian DNSP's). Generally, given their comparatively higher customer densities, Ausgrid and ActewAGL would be expected to be positioned lower on the chart.

### *Total cost per MW of maximum demand*

To ensure they are able to meet peak demand, DNSPs install assets to meet maximum demand. Maximum demand is also an indirect driver of opex, as installed assets require maintenance (opex). Similar to total cost per customer, the measure of total cost per MW of maximum demand favours DNSPs with higher customer density. However, the spread of results tends to be narrower than that of the other metrics.

Figure 32 shows total cost per MW of maximum demand and customer density.

**Figure 32 Total cost per MW of maximum demand ($2016) against customer density (average 2012–16)**




Victorian DNSPs (excluding AusNet Services) and Endeavour Energy perform the best in their combined use of opex and assets to meet maximum demand. They spend the least per MW of maximum demand, despite their differing customer densities.

Region NSW and Queensland networks Essential Energy and Energex, with very low customer density, again have the highest total costs, relatively to maximum demand.

However, the magnitude of their total cost per MW of maximum demand, more than double that of regional Victorian DNSP Powercor, suggests that the low customer density only partially explains their higher total cost.

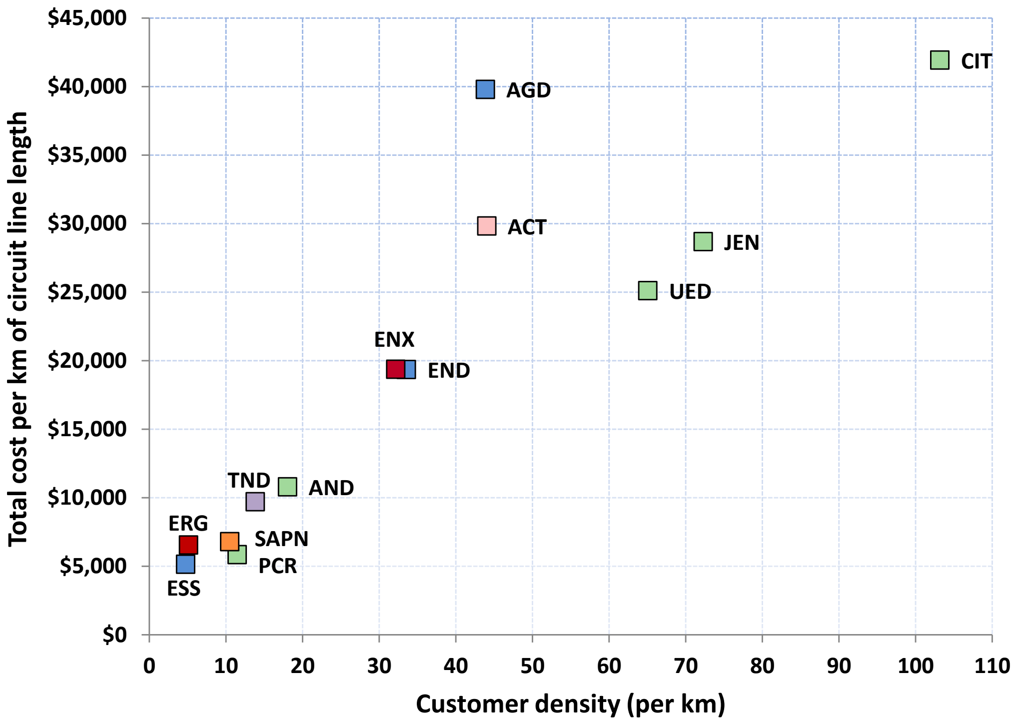
Other poor performers against this metric include regional Victorian DNSPs AusNet Services and mixed metropolitan-urban NSW provider Ausgrid. These DNSPs have considerably higher total cost per MW of maximum demand than DNSPs in their state with lower customer densities, such as Powercor and Endeavour Energy.

### *Total cost per kilometre of circuit line length*

Circuit line length reflects the distance over which DNSPs must deliver electricity to their customers, thus is a key driver of their costs. This measure can favour DNSPs with lower customer density as it spreads their costs over a longer network.

Figure 33 presents total cost per km of circuit line length against customer density.

**Figure 33 Total cost per kilometre of circuit line length ($2016) against customer density (average 2012–2016)**



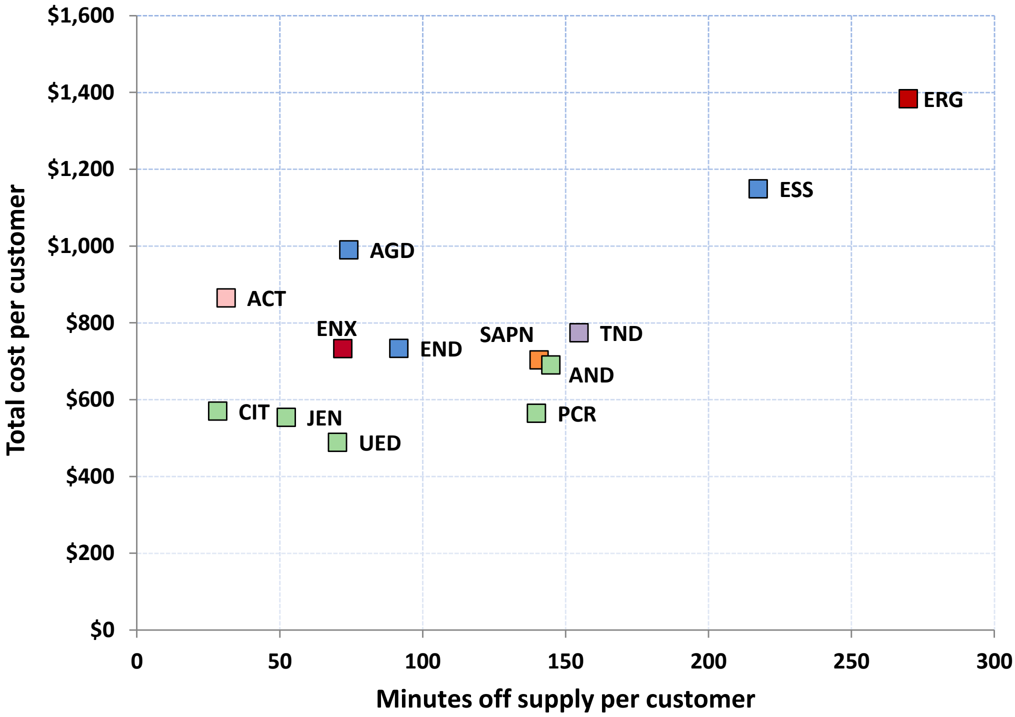

The results indicate an almost a straight line relationship between total costs per kilometre of circuit line length and customer density. The key outliers are Ausgrid and ActewAGL. These DNSPs sit well above the trendline in Figure 33. They spend substantially more per kilometre of circuit line length than DNSPs with higher customer density, i.e. Jemena and United Energy.

### *Total cost per customer and reliability*

Comparing total cost per customer against unplanned minutes off supply per customer provides a 'per customer' reliability metric. Reliability is an important service DNSPs provide to their customers and can be a significant driver of DNSPs' costs. The effect of large, abnormal outage events (known as major event days or MEDs) are excluded from this reliability measure, as MEDs can be unforeseeable, uncontrollable and may affect measured performance.

Figure 34 presents the ‘per customer’ reliability metric.

### Figure 34 Total cost per customer ($2016) against unplanned minutes off supply per customer (excluding MEDs, average 2012–16)




Generally, DNSPs with longer networks (such as Essential Energy and Ergon Energy) would be expected to incur higher minutes off supply per customer, due to the broad spread of their network increasing the response time to fix problems in the network. However, Ergon Energy's and Essential Energy's minutes off supply (and its costs) greatly exceed their peers operating rural networks (Powercor, AusNet Services, TasNetworks and SA Power Networks). This suggests the length of the network only partially explains their poor per customer reliability.

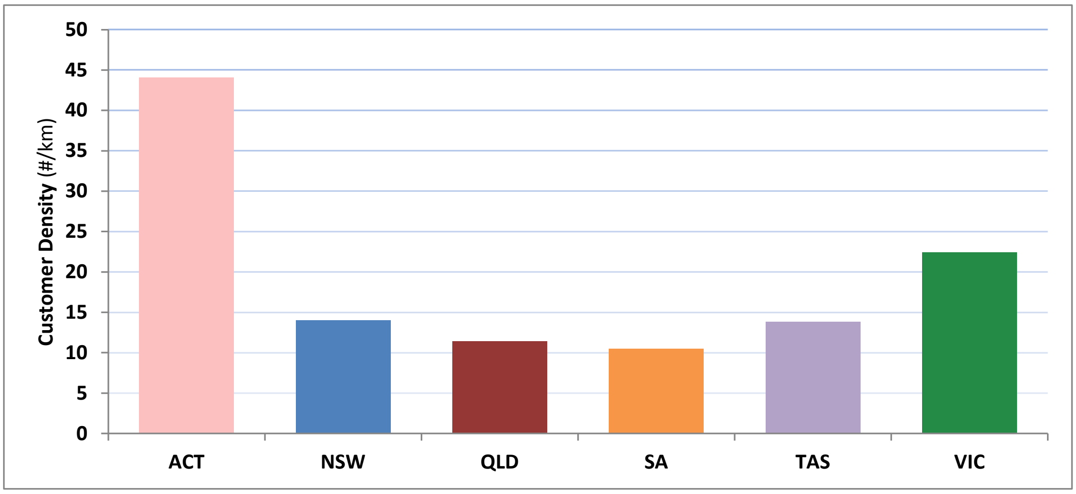
## C.2 Partial Performance Indicator Trends by State

The partial performance indicators presented above are average results for 2012–16. These metrics provide insight into the relative performance of the networks over the most recent five years. However, they do not show the change in performance over time.

This section observes trends in PPI performance over the period 2006 to 2016. The PPI results are presented on a state basis, rather than the individual DNSPs, as there is less variability in customer density across states than across DNSPs.  As noted in section C.1, customer density differences should be taken into account when comparing the trend in PPIs.

Figure 35 presents the relative customer density by state.

### Figure 35 Customer Density by State (customers/km route line length)

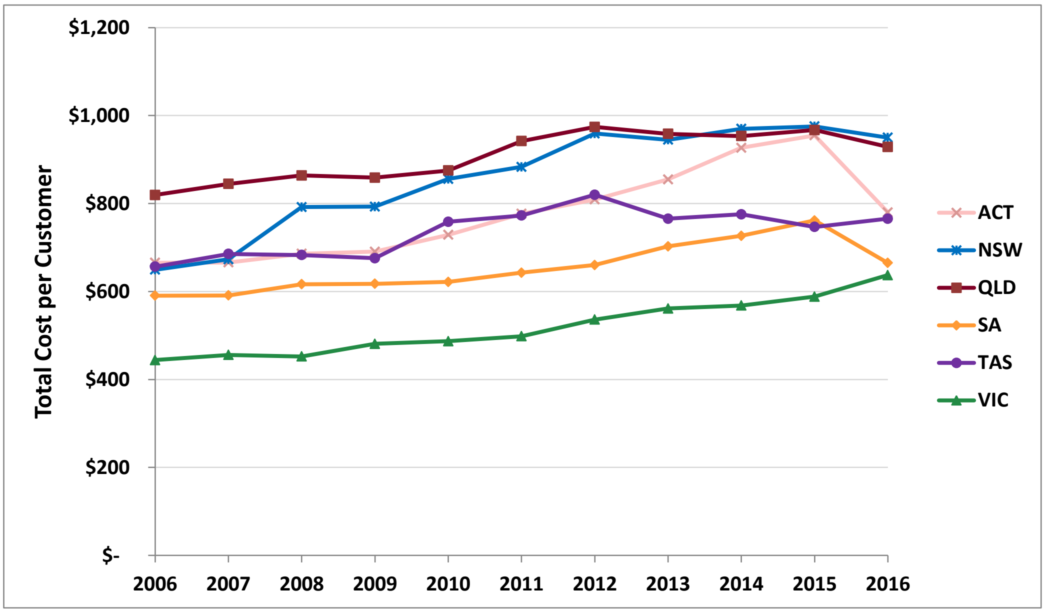



### *Total cost per customer*

Total cost per customer increased steadily between 2006 and 2015 in all states, suggesting the rate of growth in total cost has outpaced that of customer numbers. However, there was a marked turn around in 2016, with all states showing a decrease in total cost per customer, particularly in the ACT and South Australia. This in part reflects effort by all DNSPs, to lower their operational costs over the past five years.

Figure 36 shows the trend in total cost per customer by state.

## Figure 36 Trend in total costs per customer ($2016)




Not surprisingly, the Victorian network is the best performer against this metric, as it has a relatively higher customer density than the other states. Victoria's total cost per customer grew steadily to 2013, but has been relatively stable over the past three years.

South Australia, with the lowest customer density network would be expected to be one of the poorest performers against this metric. However, it performed well, with the second lowest total cost per customer. South Australia's total cost per customer grew steadily from 2006 to 2015, but experienced a marked decline in 2016, falling 13 per cent.

Given its high customer density relative to the other states, ACT would be expected to be the best performer. However, ACT has performed poorly against this metric. Starting as a mid-level performer in 2006, its total cost per customer grew to be one of the highest cost networks by 2015. However, in 2016, ACT experienced a dramatic turn-around with total cost per customer falling around 18 per cent, bringing it back to being a mid-level performer against this metric.

New South Wales and Queensland are the poorest performers against this metric. Total cost per customer grew strongly from 2006 to 2012 in these states, NSW (48 per cent) more so than Queensland (19 per cent). However, total cost per customer has plateaued since, with both states experiencing a moderate decline in this metric (3 per cent and 4 per cent respectively) in 2016.

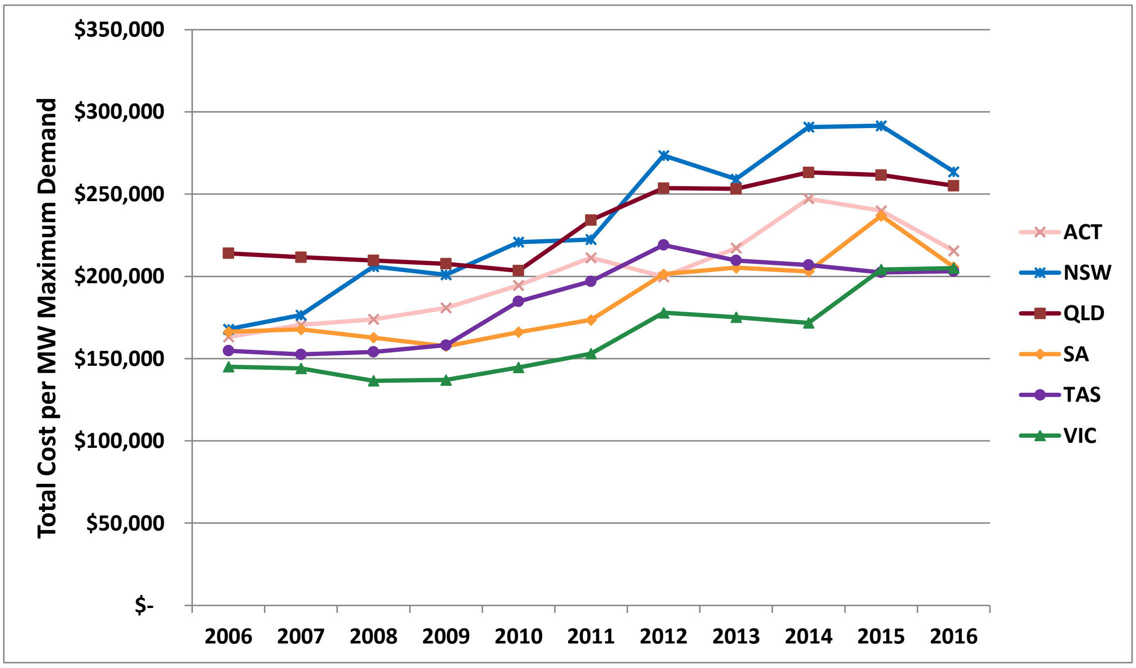
Tasmania has been one of the better performers against this metric, with a steady increase to 2012 (25 per cent), followed by a moderate decrease (7 per cent) between 2012 and 2016. Overall, Tasmania's total cost per customer is 17 per cent higher in 2016 than it was in 2006.

### *Total cost per MW of maximum demand*

This time series is more variable than the trend in total cost per customer, reflecting the volatility in annual maximum demand.

Figure 37 shows the trend in total costs per MW of maximum demand.

## Figure 37 Trend in total cost ($2016) per MW maximum demand




Overall, there was a notable increase against this metric in all states between 2006 and 2015, followed by a decrease in 2016. This suggests the total cost, which increased markedly over the period 2006-15 period then fell back in 2016, had a greater influence on this metric than the volatility in maximum demand.

Victoria and South Australia have exhibited a similar trend in this metric, despite their different levels of customer density. Total costs per MW of maximum demand experienced a modest decrease between 2006 and 2009 before rising sharply to 2012, it then plateaued to 2014 before a sharp increase in 2015. However, (except for Victoria) it turned down again in 2016, returning to almost the same level as in the 2012-2014 period.

New South Wales and Queensland were again the poorest performers, with the highest total costs per MW of maximum demand. Their total cost per MW of maximum demand is notably higher than that of states such as Tasmania and South Australia, with similar (or lower) customer density. NSW again had very strong growth in this metric, relative to all other states, between 2006 and 2015, up almost 75 per cent over this period. However, it experienced a sharp decline in 2016, down 10 per cent, returning it back below its 2012-2013 level.

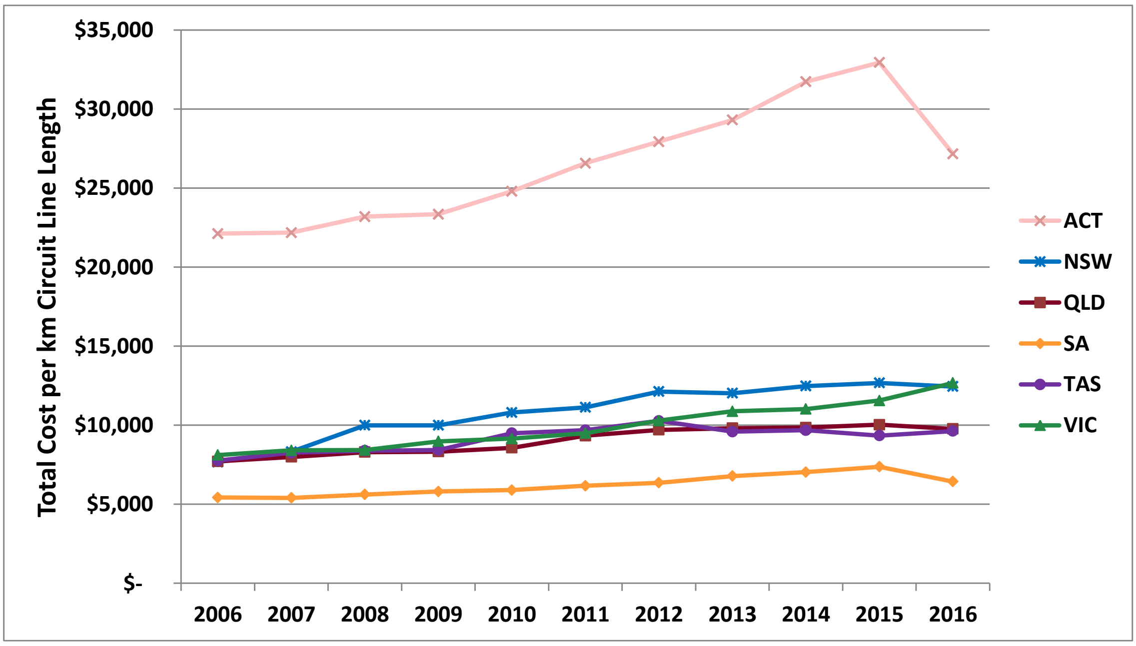
Despite their relatively high density, the Australian Capital Territory is again only a mid-level performer against this metric. Its total costs per MW of maximum demand grew steadily between 2006 and 2014, up over 50 per cent, making it one of the worst performers in 2014. However, a modest decline in 2015, followed by a sharper decline in 2016, brought it back to a similar level as Victoria in 2016, making it one of the better performers against this metric.

### *Total cost per km of circuit line length*

On 'per km' metrics like circuit line length, states with relatively low density network perform better because their costs are spread over a longer network. This goes some way to explain South Australia's very good performance against this metric, with its total costs per circuit line length significantly lower than other states.

Figure 38 shows the trend in total cost per km of circuit line length.

## Figure 38 Trend in total cost per km of circuit line length ($2016)




The Australian Capital Territory is at a disadvantage under this measure given it has a very high customer density. However, the high customer density only partially explains the ACT's much higher trend in total cost per km of circuit line length relative to other states. While the ACT's total costs per km of circuit line length grew very strongly between 2006 and 2015 (up around 50 per cent), there was a sharp decline in 2016 (down 18 per cent).

In 2006, New South Wales, Queensland, Tasmania and Victoria all had very similar costs per circuit km. Since then, New South Wales and Victoria have increased their costs per km at a much greater rate than Queensland and Tasmania, such that NSW's and Victoria's total costs per km of circuit line length is around 30 per cent higher than that of Queensland and Tasmania in 2016.

# D Map of the National Electricity Market

This benchmarking report examines the efficiency of the 13 DNSPs in the National Electricity Market (NEM). The NEM connects electricity generators and customers from Queensland through to New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania. Figure  illustrates the network areas for which the DNSPs are responsible.

## Figure 39 Electricity distribution networks within the NEM

# E List of submissions

We sought comment from DNSPs on a draft version of this report. We received submissions from:

- ActewAGL
- AusNet Services distribution
- Essential Energy
- Jemena
- Queensland Energy (on behalf of Energex and Ergon Energy)
- SA Power Networks
- TasNetworks.

All submissions are available on our website.

Where possible issues raised in the submissions have been addressed in the relevant sections of this final report. Issues raised on the benchmarking modelling undertaken by Economic Insights have been addressed in its report available on the AER's 2017 benchmarking report website.