Annual Benchmarking Report

Electricity transmission network service providers

November 2020

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Executive Summary

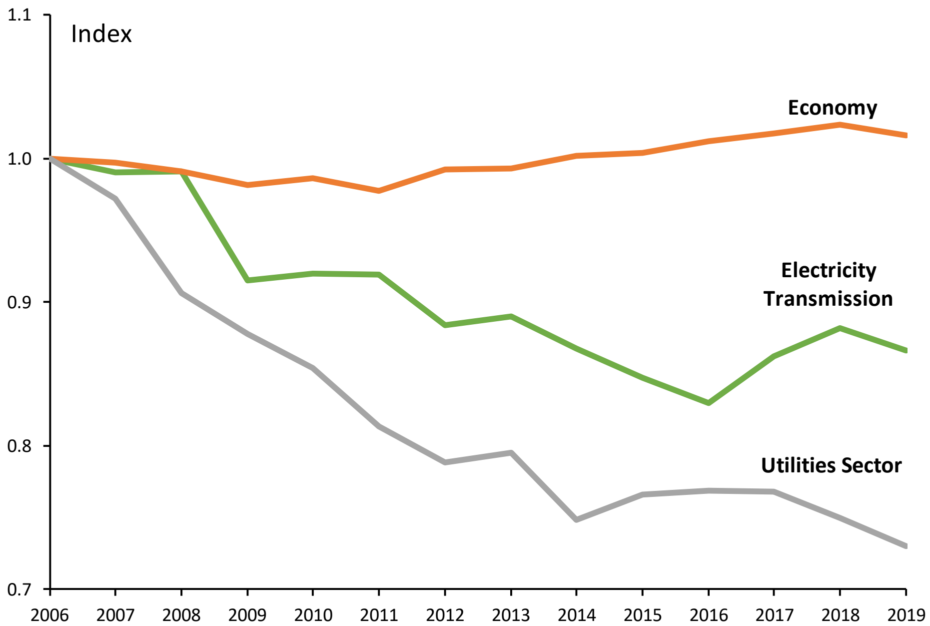
We report annually on the productivity growth and efficiency of transmission network service providers (TNSPs) in the National Electricity Market (NEM). These service providers operate high voltage transmission lines which transport electricity from generators to distribution networks in urban and regional areas. Transmission network costs typically account for between 7 to 11 per cent of what customers pay for their electricity (with the remainder covering generation costs, distribution and retailing, as well as regulatory programs).

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

Transmission network productivity deteriorated following improvement over two consecutive years

Electricity transmission productivity as measured by total factor productivity (TFP) declined by 1.8 per cent over the twelve months to 2019 after improvement in the last two consecutive years, but remains above its lowest level (2016). The decrease in transmission network productivity in 2019 is primarily due to lower network reliability. It is consistent with lower productivity growth for the overall economy and the utility sector (electricity, gas, water and waste services (EGWWS)) over the same period.

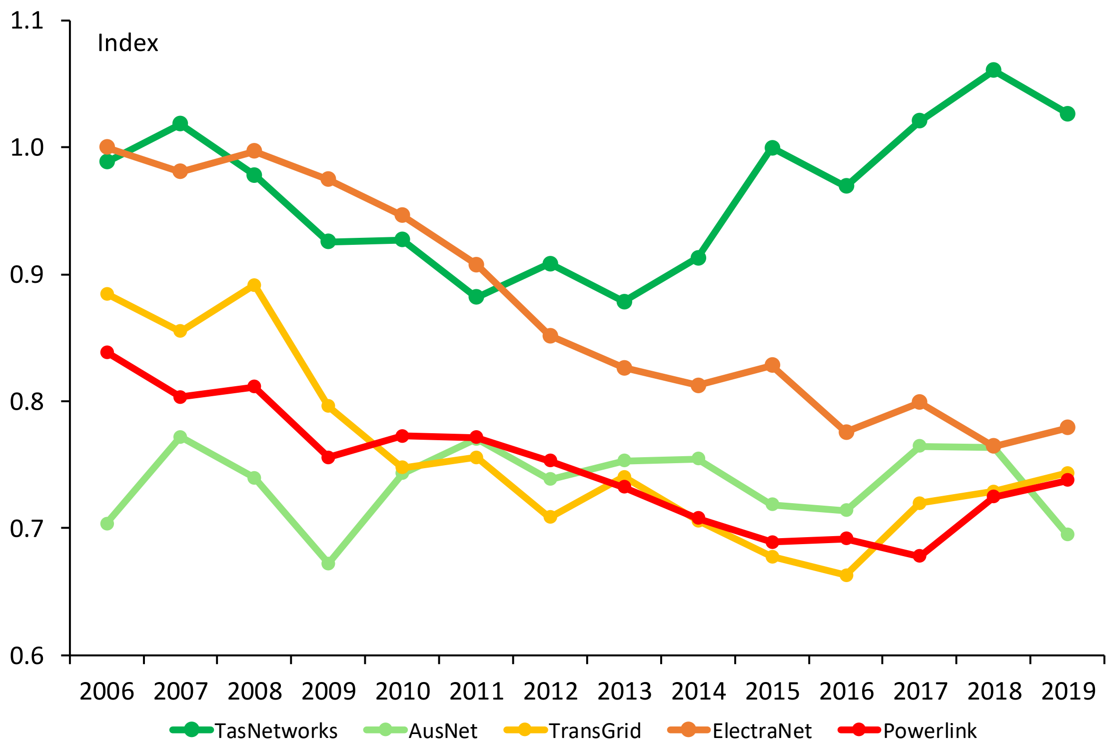
Figure 1 Electricity transmission, utility sector, and economy productivity, 2006–19



Changes in TNSP productivity over 2019

There are five transmission networks in the NEM, with one in each state. Over the twelve months to 2019, three transmission networks (ElectraNet, Powerlink and TransGrid) improved their productivity as measured by multilateral total factor productivity (MTFP) and two of them recorded productivity improvements over the last two consecutive years (Powerlink and TransGrid). However, over the 12 months to 2019 AusNet and TasNetworks experienced a significant worsening in productivity, which drove the overall result for the transmission industry. For AusNet, its lower productivity growth was largely driven by a single outage event that worsened its reliability performance. TasNetworks remained the most productive transmission network in 2019 despite the decline in its productivity.

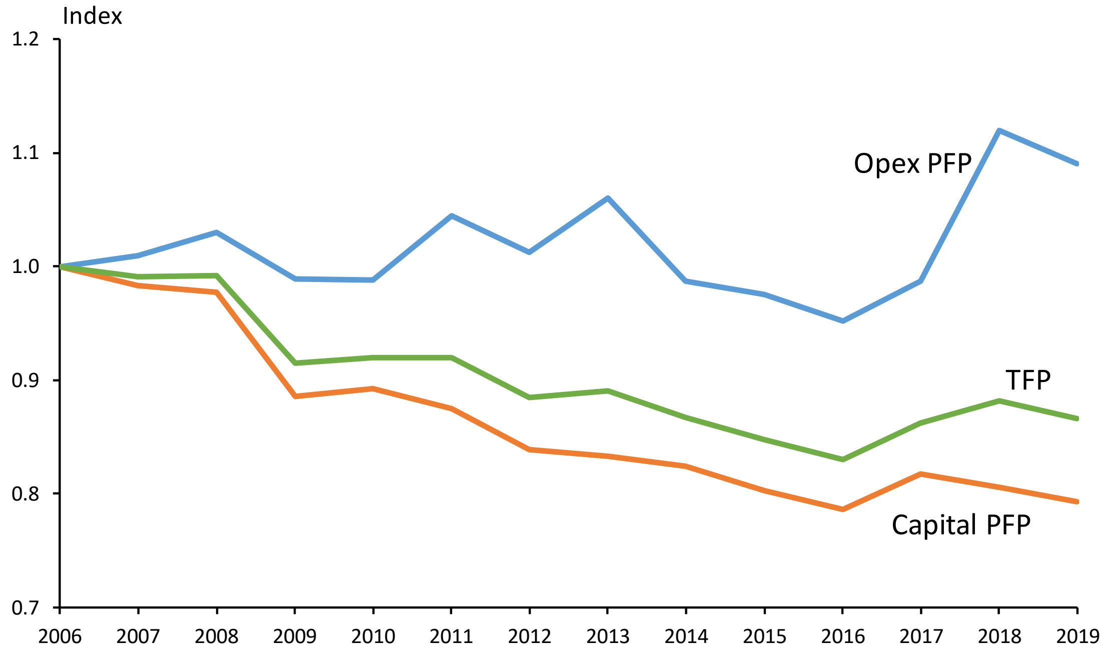
Figure 2 Electricity transmission MTFP indexes by TNSP, 2006–2019



The long term decline in transmission network is driven by declining capital PFP

The productivity of transmission networks has declined at an average annual rate of 1.1 per cent over the last 14 years. Capital partial factor productivity (PFP) declined at an average annual rate of 1.8 per cent compared to average annual opex PFP growth of 0.7 per cent over the same period. The improvement in transmission productivity over the past few years can be linked to reductions in opex.

Figure 3 Transmission network opex PFP and capex PFP over 2006–19



Updates in this year's report

We operate an ongoing transparent program to review and incrementally refine elements of the benchmarking methodology and data. The TFP and MTFP indexes presented in this report reflect four revisions to the methodology we use to measure productivity, which are set out in section 1.1. As a result, they differ from the TFP and MTFP results reported in our previous annual benchmarking reports.

The most substantive update applied this year relates to the weights for non-reliability outputs. These weights were updated because an error was identified in the way they were determined in previous reports which impacted the benchmarking results. All of the results presented in this report (including the historical time series results) reflect the corrected output weights. The remaining three updates applied this year relate to adopting the most up-to-date estimates (e.g. AER's value of customer reliability or VCR estimates), linking the benchmarking results to our current service target performance incentive scheme (STIPS) and refining the indexing approach for TFP.

Contents

1 Our benchmarking report

The National Electricity Rules (NER) require the AER to publish network benchmarking results in an annual benchmarking report.[1] This is our seventh annual benchmarking report for transmission network service providers (TNSPs). This report is informed by expert advice provided by Economic Insights.[2]

National Electricity Rules reporting requirement

6A.31 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 Transmission Network Service Provider in providing direct control services over a 12 month period.

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

Our benchmarking report considers the productive efficiency of TNSPs. TNSPs are productively efficient when they produce their goods and services at least possible cost given their operating environments and prevailing input prices. We examine the change in productivity in 2019, compared to 2018, and trends in productivity over the full period of our benchmarking analysis (2006–19).[3]

Our benchmarking report presents results from two types of 'top-down' benchmarking techniques.[4] Each technique uses a different method for relating outputs to inputs to measure and compare TNSP efficiency:[5]

- **Productivity index numbers (PIN)**. These techniques use a mathematical index to determine the relationship between multiple outputs and inputs, enabling comparison of productivity performance over time and between networks.
- **Partial performance indicators (PPIs)**. These simple ratio methods relate one input to one output.

[1] NER, cll. 6A.31(a) and 6A.31(c).

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

[3] Throughout this report references to calendar years for non-Victorian distributors refer to financial years (that is, 2019 refers to 2018–19 for non-Victorian distributors).

[4] Top down techniques measure a network's overall efficiency, based on high-level data aggregated to reflect a small number of key outputs and key inputs. They generally take into account any synergies and trade-offs that may exist between input components. Alternative bottom up benchmarking techniques are more resource intensive in that they examine each input component separately. Bottom up techniques do not take into account potential efficiency trade-offs that may exist between input components of a TNSP’s operations.

[5] Appendix A provides reference material about the development of our economic benchmarking techniques. Appendix B provides information on the specific benchmarking models and data we use.

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

The primary benchmarking techniques we use in this report to measure the relative productivity of each TNSP in the NEM are multilateral total factor productivity (MTFP) and multilateral partial factor productivity (MPFP). The relative productivity of the TNSPs reflects their efficiency. MPFP examines the productivity of either operating expenditure (opex) or capital in isolation.

What is multilateral total factor productivity?

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

The inputs we measure for TNSPs are:

- Three types of physical capital assets TNSPs invest in to replace, upgrade or expand their networks:
    - Transformers and other capital (quantity proxied by transformer MVA)
    - Overhead lines (quantity proxied by overhead MVAkms)
    - Underground cables (quantity proxied by underground MVAkms)
- Opex to operate and maintain the network.

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

- Circuit line length (52.8 per cent). Line length reflects the distances over which TNSPs transport electricity and is a significant driver of the services a TNSP must provide.
- Ratcheted maximum demand (RMD) (24.7 per cent). TNSPs endeavour to meet the demand for energy from their customers when that demand is greatest. RMD recognises the highest maximum demand the TNSP has had to meet up to that point in the time period examined.
- Energy delivered (14.9 per cent). Energy throughput is a measure of the amount of electricity that TNSPs deliver to their customers.
- Customer numbers (7.6 per cent). The number of end-user customers is a proxy for the complexity of the TNSP's network.
- Reliability (Energy not supplied (ENS)). Reliability measures the extent to which networks are able to maintain a continuous supply of electricity. (Minutes off-supply enters as a negative output and is weighted by the value of consumer reliability).

The November 2014 Economic Insights report referenced in Appendix A details the rationale for the choice of these inputs and outputs. In its August 2017 report, Economic Insights updated the output specification and the weights applied to each output.[6] This output specification is used in this report, however, with updated weights as explained in section 1.1. We also discuss the outputs and inputs used further in Appendix B.

As outlined in section 2.2, we acknowledge the limitations of TNSP benchmarking results given it is relatively new and the small number of electricity transmission networks makes comparisons difficult. However, we consider the analysis presented in this report is reasoned and comprehensive.

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

1.1 Updates in this benchmarking report

This benchmarking report includes updates to four elements of the benchmarking methodology. These changes mean that the productivity results presented in this report are different to those previously reported.

Corrected non-reliability output weights

The PIN techniques we use aggregate a range of outputs into an aggregate output index by allocating weights to each output. In our transmission benchmarking these non-reliability output weights are taken from an estimated cost function.[7] These output weights were updated as a part of the review of the output specification in 2017.[8] The plan was to leave these weights unchanged for a period of around 5 years.[9]

However, this year we have updated the non-reliability output weights reflecting the advice of our consultant Economic Insights. This is because an error was identified in the way the output weights were calculated in previous reports. In estimating the cost function that the output weights are taken from, the time trend (which is included to represent technological change) was incorrectly incorporated, which in turn impacted the estimated output weights.[10] See Appendix C for further details. We consider that having identified the error it should be corrected and all of the PIN results presented in this report (including the historical time series results) reflect the corrected output weights. This means the PIN results in this report cannot be compared to the results in previous year's reports.

6 Economic Insights, *Review of Economic Benchmarking of Transmission Network Service Providers - Position Paper*, 9 August 2017, pp. 29–33.

7 Economic Insights, *Review of Economic Benchmarking of Transmission Network Service Providers - Issues Paper*, 18 April 2017, p. 9.

8 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2017 TNSP Benchmarking Report*, 6 November 2017, p. 3.

9 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, pp. 1–2.

10 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 1.

As Table 1.1 shows, the effect of correcting this error is that weight is transferred from end–user customer numbers and energy throughput to circuit length and ratcheted maximum demand.

Table 1.1 TNSP Leontief cost function output cost weights

Output	Uncorrected 2006–2015 (%)	Corrected 2006–2018 (%)
Energy throughput	23.11	14.91
Ratcheted maximum demand	19.44	24.71
End-user customer numbers	19.90	7.59
Circuit length	37.55	52.79

Source: Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p.2.

The corrected weights set out in Table 1.1 are consistent with expectations regarding the main function of transmission networks.[11] For example, the main function of these networks is the transport of bulk electricity from generation points to load centres. As such, we expect circuit length to be the most important output. The end–user customer numbers output was included in our benchmarking as an additional measure of network size and complexity.[12] While this output provides information on the additional functions TNSPs perform as load centres become larger and more complex, it can be expected to be of secondary importance compared to the primary transport function.[13] Similarly, the capacity of the lines the TNSP has to provide can be expected to be primarily influenced by maximum demand with energy throughput playing an important but secondary role.[14]

This correction impacts the benchmarking results, including the ranking of individual TNSPs under the MTFP benchmarking. While the identification of the error reduces the comparability of results between reports, the transparency of the benchmarking information and review processes means we are continuously improving to enable the benchmarking results to become more robust.

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11 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 2.

12 Economic Insights, *Review of Economic Benchmarking of Transmission Network Service Providers - Position Paper,* 9 August 2017, p. 22.

13 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 2.

14 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 2.

Under the corrected weights, TNSPs which are relatively intensive (i.e. produce more of an output per unit of total input compared to other TNSPs) with regard to outputs that are given more weight under the correction benefit the most from the output weight change. Those TNSPs which are relatively intensive in producing outputs that are given less weight under the correction are worse off. In terms of the MTFP measure, the correction of output weights for customer numbers (lower weight) and circuit length (higher weight) has the biggest impact. With the correction AusNet and TransGrid have relatively lower MTFP results and rankings, TasNetworks has a relatively higher MTFP result, while ElectraNet and Powerlink's MTFP results are less impacted, although their relative rankings are improved as a result of the worsening MTFP results of AusNet and TransGrid. This is shown in Appendix C.[15]

Five of the six submissions on this year's draft report commented on output weights and/or the impact of the impact of new weights on benchmarking results.[16] TasNetworks and ElectraNet were generally supportive of this change. TasNetworks agreed with Economic Insight's assessment that end–user customer numbers and energy throughput are only of secondary importance in comparison with other factors as drivers of cost for TNSPs, particularly RMD.[17] ElectraNet supported the direction of the change in the output weights, but also outlined concerns it has previously raised about the output measures having limitations and not bearing any direct relationship with transmission costs.[18] See Appendix D where these are set out along with our responses.

AusNet noted that the corrected output weights have a material impact on the benchmarking results and that this demonstrates the benchmarking is highly sensitive to changes in model specifications.[19] As a result, it considers the benchmarking can provide insights into productivity changes over time but is not suitable for comparing the productivity of TNSPs. AusNet also sought more information on why the circuit length output should be viewed as the primary TNSP output, as it expected customers to value other factors highly (such as reliability, energy throughput and the ability to meet peak demand.[20]

Economic Insights addressed this issue in its report where it noted that output weights in the MTFP/MPFP framework are based on shares of total cost and assessed the likely distribution of total costs across outputs by examining the shares of the main

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15 This sets out the impact in 2019 on the MTFP rankings using the corrected output weights (from this year's report) and the previous output weights (from the 2019 Annual Benchmarking Report).

16 AusNet Services, *Submission on Economic Insights' 2020 draft report*, 3 August 2020 (email); AusNet Services, *Submission on the AER's 2020 draft annual report*, 10 November 2020; TasNetworks, *Submission on Economic Insights' 2020 draft report,* 3 August 2020 (email); ElectraNet, *Submission on the AER's 2020 draft annual report*, 10 November 2020; Energy Networks Australia, *Submission on the AER's 2020 draft annual report (Distribution and Transmission)*, 10 November 2020.

17 TasNetworks, *Submission on Economic Insights' 2020 draft report,* 3 August 2020 (email).

18 ElectraNet, *Submission on the AER's 2020 draft annual report*, 10 November 2020, p. 2.

19 AusNet Services, *Submission on the AER's 2020 draft annual report*, 10 November 2020, p. 1.

20 AusNet Services, *Submission on the AER's 2020 draft annual report*, 10 November 2020, p. 1.

input components in total cost.[21] Economic Insights notes that over the past 14 years, opex in the transmission industry made up on average around 30 per cent of total costs, lines and cables inputs made up around 30 per cent and transformer and other capital inputs made up around 40 per cent. Based on a more detailed breakdown and analysis, Economic Insights concluded it would expect total costs to be more closely associated with circuit length, RMD and throughput given the importance of long–lived fixed assets in the transmission industry.[22]

Updated VCR estimates used to proxy the cost of reliability

As noted above, one of the outputs included in our transmission benchmarking is reliability, which is a negative output variable that captures ENS as a result of network outages. In our analysis, the cost of reliability is proxied by the value of consumer reliability (VCR).

Up until now, our benchmarking has relied on VCR estimates published by the Australian Energy Market Operator (AEMO) in 2014. In this year's benchmarking report, we have updated the VCR and use the latest estimates published by the AER in 2019.[23]

TasNetworks supported the use of our recently estimated VCR.[24]

Updated cap applied to reliability output weight

As a part of the output specification review in 2017, a cap was applied to the weight given to the reliability output. This was considered reasonable in order to minimise the impact on the productivity results of unusual one-off and significant reliability events. The cap applied was 5.5 per cent of gross revenue (total revenue plus the value of the reliability output).[25] This cap was derived from statistical analysis of ENS series.[26] As Economic Insights explains, a weakness of this approach to calculating the cap is that it is not directly related to the regulatory regime TNSPs face.[27]

In this year's benchmarking report, we have applied a cap to the value of the reliability output that is linked to the relevant STPIS parameters TNSPs face as a part of the regulatory regime. This results in a cap of 2.5 per cent of total revenue which lessens

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[21] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, pp. 5–6.

[22] For more detail, please see: Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, pp. 5–6.

[23] The AER's 2019 VCR estimates have been indexed back to 2006 using an appropriate price index. See AER, *Values of Customer Reliability Review,* December 2019.

[24] TasNetworks, *Submission on Economic Insights' 2020 draft report,* 3 August 2020 (email).

[25] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2017 TNSP Benchmarking Report*, 6 November 2017.

[26] The cap was consistent with a 95 per cent probability of the cap not being binding.

[27] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 3.

the impact on the total factor productivity (TFP) and MTFP results of unusual one-off and significant changes in reliability. For example, this can be seen for AusNet's MTFP results where the impact of the 2009 outage at the South Morang terminal station are now more muted (see Figure 4.1).

TasNetworks supported the linking of the output weight cap to the STPIS parameters and the smoother results presented with the updated approach.[28] Powerlink suggested linking the output weight cap to the STPIS parameters which at the transmission level are likely to result in loss of supply to customers, meaning a tighter cap of 1 per cent of total revenue.[29] In moving to this approach for capping the output weight we consider it is appropriate to include all of the STPIS parameters given the general relationship with reliability.[30] We will review this over time.

Change to the indexing method

We have also updated the indexing method used in the TFP benchmarking to a current method that is able to more accurately capture the impact of large percentage changes that are continuing to occur in the reliability output. We have changed to use the multilateral index method that is also used for the MTFP benchmarking. This ensures the impact of large percentage changes in inputs or outputs, and particularly reliability, are more accurately captured than under the previous indexing method. More detail on this change can be found in the supplementary Economic Insights report.[31]

1.2 Benchmarking development program

As noted earlier, we operate an ongoing transparent program to review and incrementally refine elements of the benchmarking methodology and data.

ElectraNet encouraged further development of the benchmarking including the MTFP model specification to account for new obligations and outputs.[32] Energy Networks Australia supported the ongoing development of transmission benchmarking, stating that this should include developing measures that reflect the changing role of transmission.[33] It considers that these development opportunities are best addressed in conjunction with service providers through the formation of an industry benchmarking working group. The Public Interest Advocacy Centre noted the future Integrated System Plan projects will have an impact on benchmarking and that consideration be given to whether the current benchmarking will be able to adequately

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28 TasNetworks, *Submission on Economic Insights' 2020 draft report,* 3 August 2020 (email)

29 The Loss of Supply and Average Outage Duration parameters. See Powerlink, *Submission on Economic Insights' 2020 draft report,* 4 August 2020 (email).

30 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 6.

31 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, pp. 3–4.

32 ElectraNet, *Submission on the AER's 2020 draft annual report*, 10 November 2020, p. 5.

33 Energy Networks Australia, *Submission on the AER's 2020 draft annual report (Distribution and Transmission)*, 1 November 2020, p. 2.

measure TNSP performance in terms of business as usual and Integrated System Plan projects.[34]

We acknowledge the general support from stakeholders on continuing to progress benchmarking development including incremental improvements. We note this feedback and will review the relative priority of addressing it.

1.3 Consultation

In developing the 2020 Annual Benchmarking Report for transmission we consulted with TNSPs and a wider group of stakeholders including Energy Networks Australia, the Public Interest Advocacy Centre and the AER's Consumer Challenge Panel. This is the first time we have consulted beyond the TNSPs. Some submissions considered that beyond the annual consultation process for the preliminary benchmarking results and draft reports there should be separate consultation on specific development issues. Another submission noted that in order to consult effectively the benchmarking results need to be presented clearly and that this should extend to how the benchmarking is used.

In developing the 2021 Annual Benchmarking Report we will review our engagement and consultation approach taking into account this feedback.

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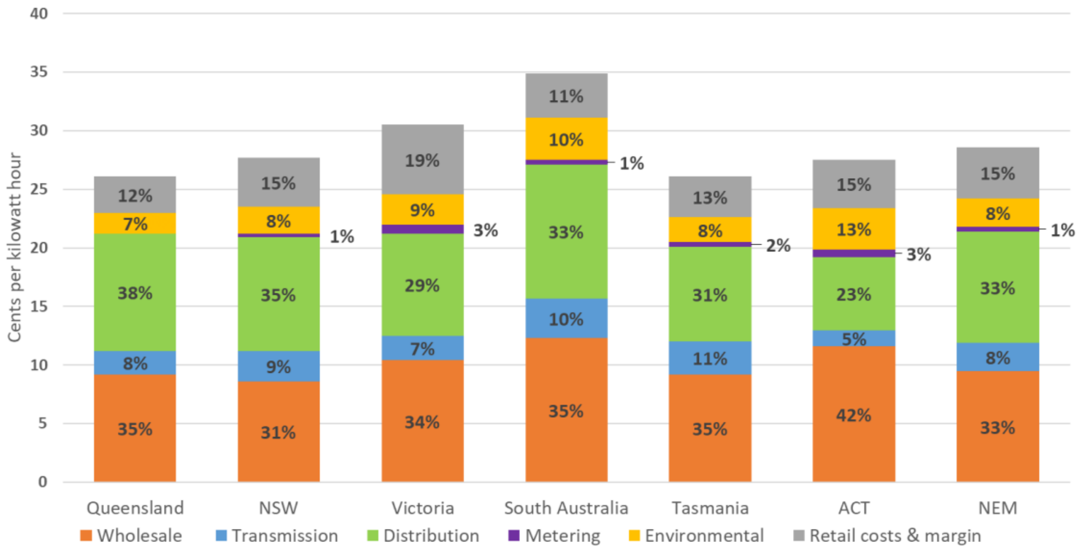
34 Public Interests Advisory Centre, *Submission on the AER's 2020 draft annual report (Distribution and Transmission)*, 12 November 2020.

2 Economic benchmarking and its uses

Electricity networks are 'natural monopolies', which do not face the typical commercial pressures experienced by firms in competitive markets. Unregulated network operators could increase their prices above efficient levels and would face limited pressure to control their operating costs or invest efficiently.

Consumers pay for electricity network costs through their retail electricity bills. Transmission network costs typically account for between 7 to 11 per cent of what consumers pay for their electricity while distribution costs account for around 30 to 40 per cent. The remainder covers the costs of generating, and retailing electricity, as well as various environmental policies. Figure 2.1 provides an overview of the typical electricity retail bill.

Figure 2.1 Network costs as a proportion of retail electricity bills, 2019



Source: ACT data from AEMC, Residential Price Trends, 9 December 2019; AER, *State of the Energy Market,* July 2020*; ACCC, Inquiry into the National Electricity Market*, 29 November 2019.

Note: Queensland metering costs omitted due to data quality issues. Figures may differ from source due to rounding.

Under the National Electricity Law (NEL) and the NER, the AER regulates electricity network revenues with the goal of ensuring that consumers pay no more than necessary for the safe and reliable delivery of electricity services. This is done through a periodic regulatory process (known as revenue determinations or resets) which typically occurs every five years. The electricity network provides the AER with a revenue proposal outlining its forecast expenditures or costs over the following five year period.

The AER assesses and, where necessary, amends the proposal to ensure it reflects efficient costs. On this basis, the AER then sets the network's revenue allowance for the five year period, which is the maximum amount the network can recover from their retail customers through electricity bills.

In 2012, the Australian Energy Market Commission (AEMC) amended the rules to strengthen the AER's power to assess and amend network expenditure proposals.[35] 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 increases in capital and opex allowances of network service providers (NSPs) that are not necessarily efficient and higher charges for consumers.[36]

The rule changes required the AER to develop a benchmarking program to measure the relative efficiency of all electricity networks in the NEM and to have regard to the benchmarking results when assessing capital expenditure (capex) and opex allowances for network TNSPs. The new rules also required the AER to publish the benchmarking results in an annual benchmarking report.[37]

2.1 The uses of economic benchmarking

The AER uses economic benchmarking in various ways when assessing and amending network expenditure proposals.[38] We use it to measure the 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 and the appropriateness of basing forecasts on them.

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.[39]

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

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35 AEMC, Rule Determination, *National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012; National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012*, 29 November 2012, p. vii.

36 AEMC, Rule Determination, *National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012; National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012*, 29 November 2012, p. vii.

37 NER, cll. 6A.31(a) and 6A.31(c).

38 The benchmarking presented in this report is one of a number of factors we consider when making our revenue determinations. For a revenue determination, we examine the efficiency of an individual TNSP's forecast opex and capex. In this report we primarily examine the overall efficiency of transmission networks. Though the efficiency of networks as a whole is relevant to our determinations, we also undertake further analysis when reviewing opex and capex forecasts.

39 AER, *Explanatory Statement - Expenditure Forecast Assessment Guideline,* November 2013, pp. 78–79.

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 clearly see what factors are driving network efficiency and the network cost component of their retail electricity bills. This helps to inform their participation in our regulatory processes and in broader debates about energy policy and regulation.

2.2 Limitations of benchmarking transmission networks

When undertaking economic benchmarking, it is important to recognise that TNSPs operate in different environments. Certain factors arising from a TNSP's operating environment are beyond its control. These 'operating environment factors' (OEFs) may influence a TNSP's costs and, therefore, its benchmarking performance. The benchmarking techniques presented in this report capture key OEFs. For example, MTFP accounts for a TNSP's circuit length, number of end users, ratcheted maximum demand and energy throughput. By including these outputs, we also allow for key network density measures, including throughput per kilometre and maximum demand per customer. However, not all OEFs can be captured in the models.

Further, while transmission networks have undertaken cost benchmarking for a number of years, top-down (whole of business) benchmarking of electricity transmission networks is relatively new. Compared to electricity distribution networks there have not been many top-down benchmarking studies of transmission networks and, consequently, MTFP analysis for transmission networks is still in a relatively early stage of development. The small number of electricity transmission networks in Australia (five) also makes efficiency comparisons at the aggregate expenditure level difficult.

These factors should be taken into account when examining the results presented in the following sections.

However, we consider the benchmarking analysis presented in this report is reasoned and comprehensive. We have consulted with industry participants to refine our transmission benchmarking as part of our ongoing development work program.[40] We have also collected data on all major inputs and outputs for TNSPs, and we consider that the dataset used is robust.

40 In 2017, we reviewed the output specifications of our transmission benchmarking models. Among the issues we considered were the measure of customer connections and the weighting of network reliability. A more detailed description of the updated TNSP benchmarking specifications, stakeholder comments and our rationale for the changes can be found here.

To date, we and Economic Insights have been cautious about using the TNSP economic benchmarking results to compare productivity levels across TNSPs including in assessing and amending network expenditure proposals. Energy Networks Australia supported Economic Insights' position on caution in the use of the TNSP economic benchmarking results.[41] As set out above, we acknowledge that the MTFP analysis for transmission networks is less developed relative to distribution benchmarking and the small number of electricity transmission networks in Australia (five) also makes efficiency comparisons at the aggregate expenditure level difficult. However, as stated by Economic Insights, it is important to note progress in TNSP productivity and efficiency measurement through ongoing development and refinement of transmission benchmarking.[42] The changes introduced in this report represent more steps along this path.

41 Energy Networks Australia, *Submission on the AER's 2020 draft annual report (Distribution and Transmission)*, 10 November 2020, p. 2.

42 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report,* 15 October 2020, p. 5.

3 The productivity of the electricity transmission industry as a whole

Key points

- Electricity transmission productivity as measured by TFP declined by 1.8 per cent over 2019 after improvement over the two previous consecutive years, but remains above its lowest level (2016).
- A decrease in network reliability (ENS), combined with growth in transformer capacity and opex, were the main drivers of the productivity decline over 2019.
- The decrease in electricity transmission productivity in 2019 is consistent with declining productivity in the overall Australian economy and the utilities sector.
- Transmission industry TFP has generally decreased over the period 2006–19, with the long term decline in capital partial factor productivity (PFP) largely driving this result.
- Improvement in transmission productivity over the two years from 2016 can be linked to reductions in opex as reflected by improved opex PFP.

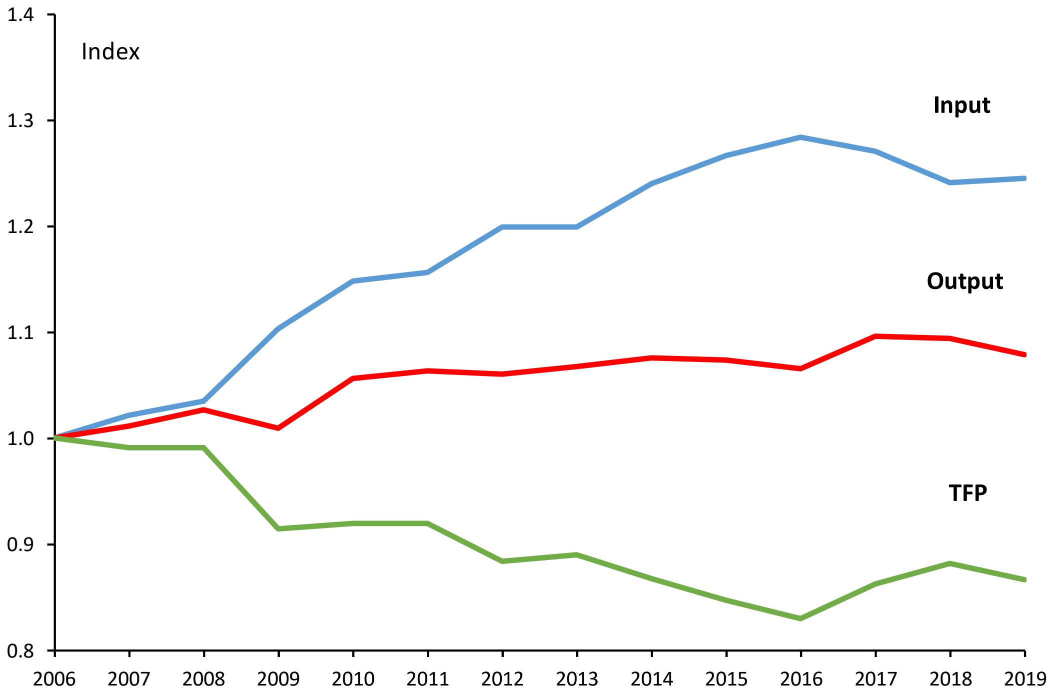
Below we present TFP results for the electricity transmission industry over the 2006–19 period and for the twelve month period to 2019. We also set out the input and output drivers, and their contribution to the industry-wide productivity change in 2019, as well as the TNSP contributions to this change in productivity.

3.1 Transmission industry productivity over time

Figure 3.1 presents TFP for the electricity transmission industry over the period 2006–19. Over this 14 year period, input use grew faster (1.7 per cent per year on average) than outputs (0.6 per cent per year on average). This resulted in a decline in long-term TFP by 1.1 per cent per annum on average.[43] There was an improvement in transmission industry productivity for two years from 2016, although this trend did not continue in 2019 when TFP declined by 1.8 per cent.

[43] This is based on logarithmic endpoint-to-endpoint growth.

Figure 3.1 Transmission industry input, output and TFP indices, 2006–19

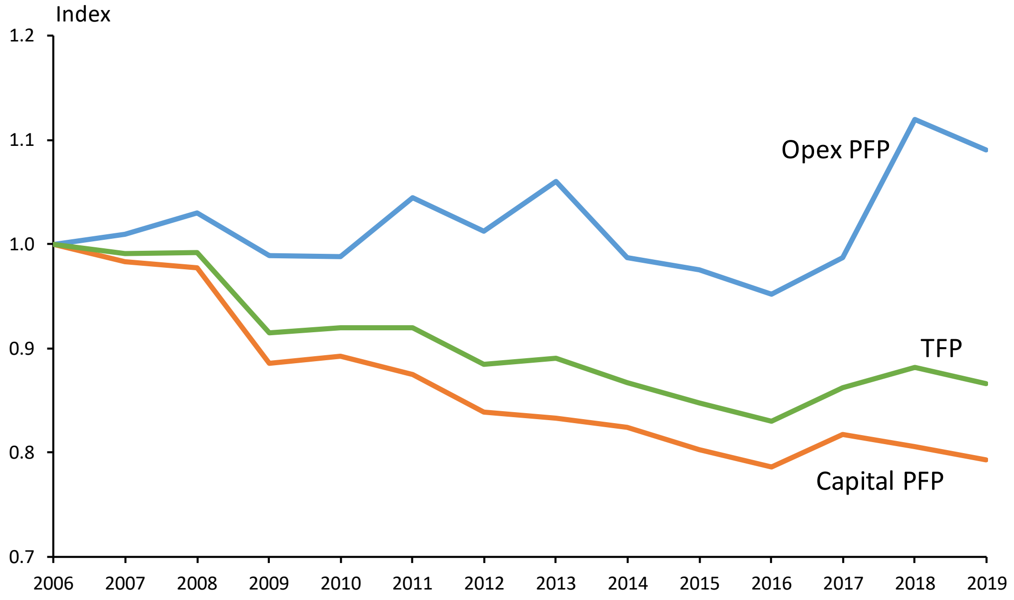


Source: Economic Insights.

Figure 3.2 shows that the long term decline in capital PFP is largely driving this long-term reduction in transmission network productivity. Over the last 14 years (2006–19), capital PFP declined at average annual rate of 1.8 per cent compared to opex PFP average annual growth of 0.7 per cent. The improvement in transmission productivity from 2016 can be linked to both opex and capex PFP. Figure 3.2 shows significant opex PFP growth in 2017 and 2018, while capital PFP grew only in 2017. In 2019, declining opex PFP (2.6 per cent) and capital PFP (1.5 per cent) contributed to the 1.8 per cent reduction in TFP.

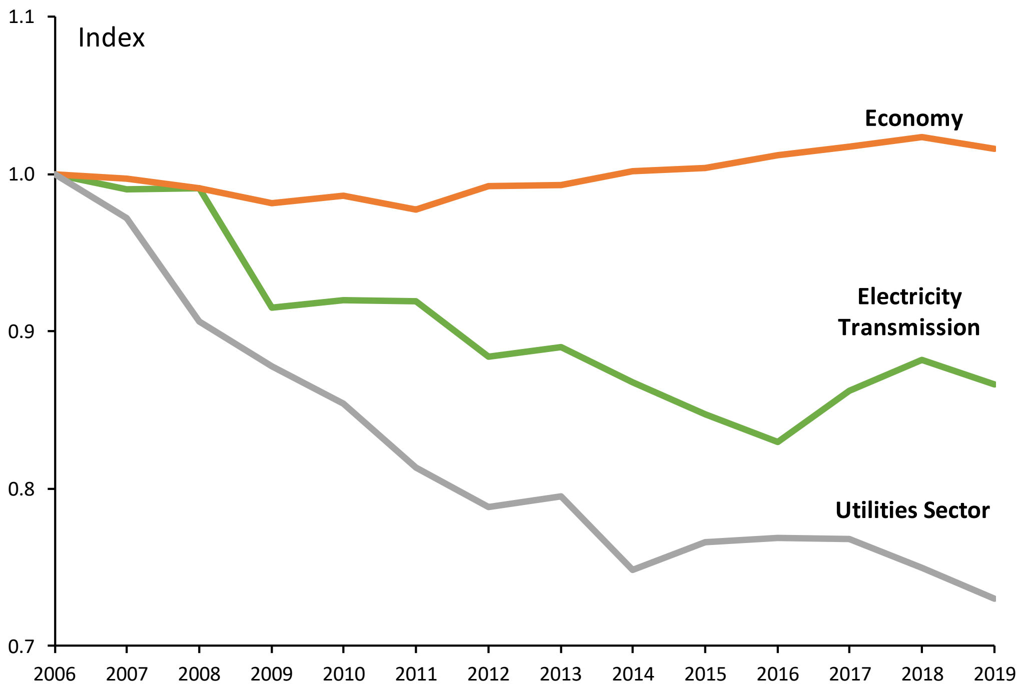
Figure 3.3 compares the TFP of the electricity transmission industry over time relative to estimates of the overall Australian economy and utilities sector (EGWWS) productivity. It can be seen that over the past 14 years, declining productivity in the electricity transmission industry was broadly consistent with the utilities sector, although the average annual rate of decline of –1.1 per cent was not as low as in the utilities sector which experienced average annual growth of –2.4 per cent. In contrast, the Australian economy's productivity grew slightly over the 2006–19 period with average annual growth of 0.1 per cent.

Figure 3.2 Transmission industry opex PFP and capex PFP, 2006–19



Source: Economic Insights.

Figure 3.3 Electricity transmission industry, utilities sector, and economy productivity indexes, 2006–2019



Source: Economic Insights; Australian Bureau of Statistics.

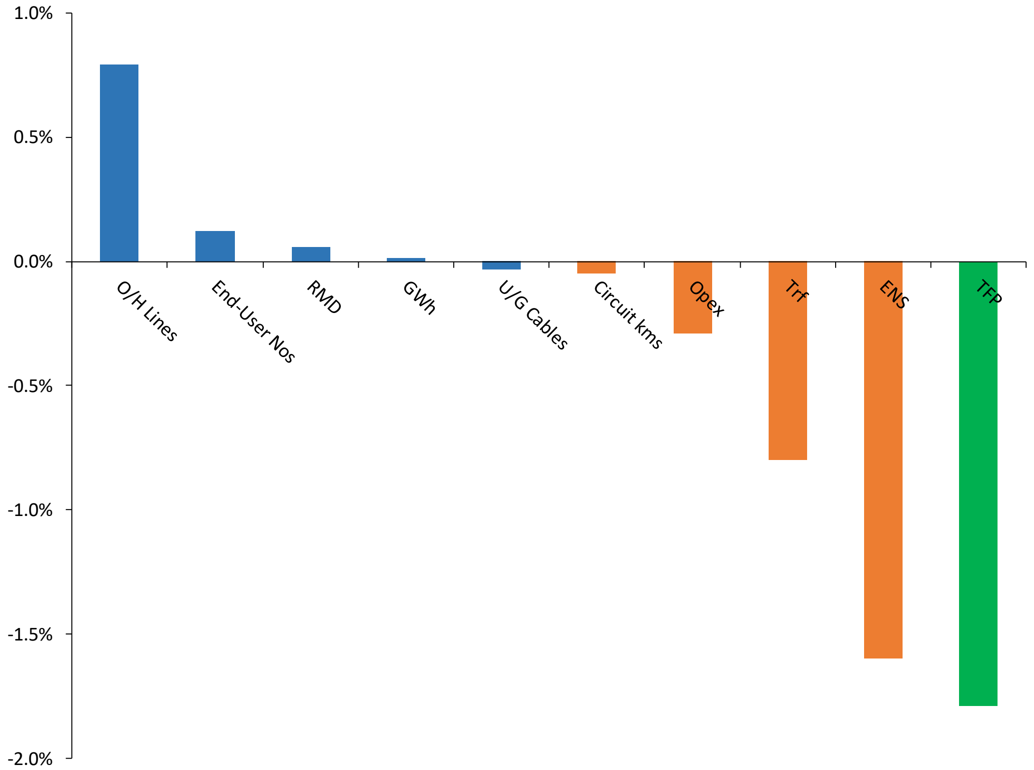
Note: The productivity of the Australian economy and the utility industry is from the ABS indices within 5260.0.55.002 Estimates of Industry Multifactor Productivity, Australia, Table 1: Gross value added based multifactor productivity indexes (a). We have rebased the ABS indices to one in 2006.

3.2 Transmission industry productivity over the 12 months to 2019

Transmission industry productivity measured by TFP declined by 1.8 per cent over the twelve months to 2019. As noted above, this decline follows improvement over two consecutive years.

Figure 3.4 shows the drivers of change in electricity transmission productivity over the past 12 months to 2019 by showing the contributions of each output and each input to the change in TFP. The contributions appear from the most positive on the left to the most negative on the right. If all the positive (blue bars) and negative contributions (orange bars) in Figure 3.4 are added together, they sum to the TFP change given by the green bar on the right of the figure.

Figure 3.4 Transmission industry output and input percentage point contributions to average annual TFP change, 2019



Source: Economic Insights.

Note: The inputs and outputs in this chart are minutes off-supply (ENS), opex, end-user numbers (End-User Nos), ratcheted maximum demand (RMD), circuit line length (circuit kms), energy delivered (GWh), overhead transmission lines (O/H lines), transformers (Trf), underground cables (U/G cables).

It can be seen in Figure 3.4 the primary driver of lower transmission industry productivity was a deterioration in network reliability (ENS). This in isolation contributed a 1.6 percentage point decrease to the growth rate of TFP. ENS enters the total output index as a negative output such that a reduction in ENS represents an improvement in reliability and a higher level of service for end–user customers. Conversely, an increase in ENS reduces total output as end–user customers are inconvenienced more by worsening reliability and not having supply over a wider area and/or for a longer period. In the twelve months to 2019, reliability worsened and there was an increase in ENS. While a significant driver of TFP, we note that this is in the context of ENS increasing from its lowest observed level for the industry over the past 14 years and that it well below its highest level, which was recorded in 2009 due a transformer failure at AusNet's South Morang Terminal. The drivers of this change in reliability at a TNSP level are discussed below.

In addition to deterioration in network reliability, growth in transformer inputs and opex also drove the transmission productivity decline over the twelve months to 2019, each contributing –0.8 per cent and –0.3 percentage points respectively. Their impact was partially offset by reductions in overhead lines (capacity) and increases in end-user numbers, which contributed 0.8 and 0.1 percentage points respectively, to transmission industry productivity.

Individual TNSP contributions to productivity growth over the twelve months to 2019

Table 3.1 presents a decomposition of each TNSP's TFP growth over 2019, which collectively drove industry input and output changes. We have focused on ENS, transformers, opex, overhead lines and throughput contributions given their materiality in driving TFP over 2019.

Table 3.1 Input and output contributions to TFP growth rates by TNSP, 2019

	Annual change in TFP	ENS	Transformers	Opex	Overhead lines	Throughput
	(%)	(ppts)	(ppts)	(ppts)	(ppts)	(ppts)
TNSP / State	**–1.8**	**–1.6**	**–0.8**	**–0.3**	**0.8**	**0.0**
AusNet - Victoria	–9.3	–5.9	–2.7	–0.8	0.0	–0.1
ElectraNet - South Australia	2.1	–1.5	0.0	0.8	0.0	2.8
PowerLink - Queensland	0.7	2.5	–0.8	–1.0	–0.1	–0.3
TasNetworks - Tasmania	–2.9	–1.1	–1.4	–1.0	0.0	0.5
TransGrid - New South Wales	2.0	–0.1	–0.1	0.5	2.1	–0.3

Source: Economic Insights

The productivity of AusNet and TasNetworks decreased over 2019 by –9.3 and –2.9 per cent, respectively. AusNet reported a significant increase in ENS in 2019 due to one outage event impacting a single customer leading this output to make the largest negative contribution to its TFP change at –5.9 percentage points.[44] This was followed by increases in transformers input use (capacity) that contributed –2.7 percentage points and increased opex that contributed –0.8 percentage points. This order is reversed for TasNetworks where transformers contributed –1.4 percentage points, followed by increased ENS and increased opex that contributed –1.1 percentage points and –1.0 percentage points respectively. While ElectraNet also reported lower reliability in 2019, which contributed –1.5 percentage points to its productivity growth, this was more than offset by that of increased energy throughput (2.8 percentage points) resulting in increased productivity of 2.1 per cent.

Powerlink and TransGrid's productivity also improved over 2019 by 0.7 and 2.0 per cent respectively. Productivity growth achieved by Powerlink was primarily driven by its higher reliability outcome at zero ENS, which contributed 2.5 percentage points. Lower overhead lines input use was the largest positive contributor for TransGrid at 2.1 percentage points. This can be largely attributed to the shift in measuring the capacity of overhead lines input from a winter peak demand time in 2018 to a summer peak demand time in 2019. TransGrid's overhead lines input has tended to fluctuate as capacity is measured at the summer, spring or winter peak, whichever is higher in the relevant year.[45] We intend to examine this variability in overhead line capacity (depending on the season peak) in preparing the 2021 Annual Benchmarking Report.

Three TNSPs (ElectraNet, Powerlink and TransGrid) achieved productivity growth in 2019 at a rate that is greater than the average annual over the 2006–19 period (–1.1 per cent). While two TNSPs (AusNet and TasNetworks) were significantly worse than this, which drove the overall industry result. The full set of input and output contributions to TFP over the 2006–19 and 2018–19 period can be found in the Economics Insights' report.[46]

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44 In its submission on our draft report, AusNet confirmed that its productivity decrease in 2019 relative to 2018 reflects its worse reliability performance when one large customer experienced a single outage, and that its higher opex was driven by non-recurrent expenditure including costs associated with its organisational restructure. See: AusNet Services, *Submission on the AER's 2020 draft annual report*, 10 November 2020, p. 2.

45 TransGrid, Response to AER information request of 21 July 2020, 5 August 2020, p. 1.

46 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report,* 15 October 2020, pp. 8–19.

4 Relative efficiency of individual transmission networks

Key points

- TasNetworks continued to be the highest ranking TNSPs as measured by MTFP over 2019 despite a decline in productivity in the year. TasNetworks has remained the most productive since 2012.
- Three TNSPs (ElectraNet, Powerlink and TransGrid) improved their productivity over 2019. TransGrid has continued to improve its productivity since 2016.
- AusNet's productivity deteriorated significantly over 2019 and was close to its 2006 level, driven by a single major reliability incident, and was the lowest ranked TNSP in terms of MTFP.
- The productivity of all TNSPs, except TasNetworks, has deteriorated over the 2006–2019 period.
- The updates set out in section 1.1 have had an impact on the relative performance of TNSPs. In particular, correcting the output weights means that TasNetworks, which is more intensive with regard to circuit length now has a relatively better MTFP, whereas AusNet and TransGrid which are more intensive with regard to customer numbers, have relatively worse MTFP results.

Below we present the economic benchmarking results that we use to measure and compare productivity of individual TNSPs over the period 2006–19 and for the 12 months to 2019. These results incorporate the updates set out in section 1.1. We also provide our key observations on the reasons for changes in relative productivity of each TNSP in the NEM. In particular:

- Section 4.1 presents the results of the MTFP benchmarking, which relates total inputs to total outputs and provides a measure of overall network efficiency relative to other networks. MTFP is the headline technique we use to measure and compare the relative productivity of individual TNSPs. This is supported by the corresponding partial productivity measures of opex and capital inputs.
- Section 4.2 presents the partial performance indicators (PPIs), which provide a general indication of comparative performance in delivering one type of output.

Being a top-down analysis, the results discussed in this chapter, particularly the MTFP results, are only indicative of the TNSPs' relative performance. While the analysis accounts for some factors that are beyond a TNSP's control, such as network density and some system structure factors, additional environmental factors can affect a TNSP's costs and benchmarking performance. Our transmission benchmarking analysis does not incorporate additional operating environmental factors beyond the network density differences which are incorporated via the output specification.

4.1 MTFP productivity results for TNSPs

As outlined in section 1.1, in this year's report we have updated the non-reliability output weights used to determine the MTFP results. This is because an error was identified in the way the output weights were estimated in previous reports. This is discussed further in Appendix C. The analysis presented below uses the corrected weights unless stated otherwise.

Figure 4.1 presents the relative productivity levels of TNSPs as measured by MTFP over the 2006–19 period. It shows that three TNSPs recorded increases in productivity over the 12 months to 2019 of close to 2.0 per cent (TransGrid, ElectraNet, and Powerlink). AusNet recorded the highest decline in productivity over the same period (–9.1 per cent), primarily driven by one network outage event affecting a single customer.[47] TasNetworks also experienced a decline in productivity over 2019 (–3.1 per cent) but was still the highest ranking TNSP as measured by MTFP (see Table 4.1).

Despite the fall in its productivity in 2019, TasNetworks' productivity in 2019 is higher than at the start of the period in 2006. TasNetworks' productivity declined from 2006 to 2014 before trending up from 2015. The positive trend from 2015 likely reflects efficiencies resulting from the merger of Tasmanian distribution and transmission networks.[48] TasNetworks has remained the most productive TNSP since 2012. It is followed by ElectraNet.

The productivity of ElectraNet, TransGrid and Powerlink as measured by MTFP has generally fallen over the 14 year period examined in Figure 4.1 and is lower in 2019 than it was in 2006, despite the productivity increases these three businesses achieved in 2019.

TransGrid's productivity has improved over the last three consecutive years while Powerlink's productivity has improved over the last two consecutive years. This growth in productivity over the last few years can be linked to improvement in opex efficiency levels. For example, TransGrid is the only TNSP that recorded improved opex MPFP performance since 2015 (Figure 4.3). This likely reflects efficiencies resulting from the 99 year lease of the network, which was signed off in December 2015.[49]

AusNet's productivity as measured by MTFP is 1 per cent lower in 2019 than it was in 2006, following the significant decline in productivity in 2019 (as noted above due to a single network outage event). Over the period 2012 to 2018 AusNet's productivity was relatively stable and slightly increased.

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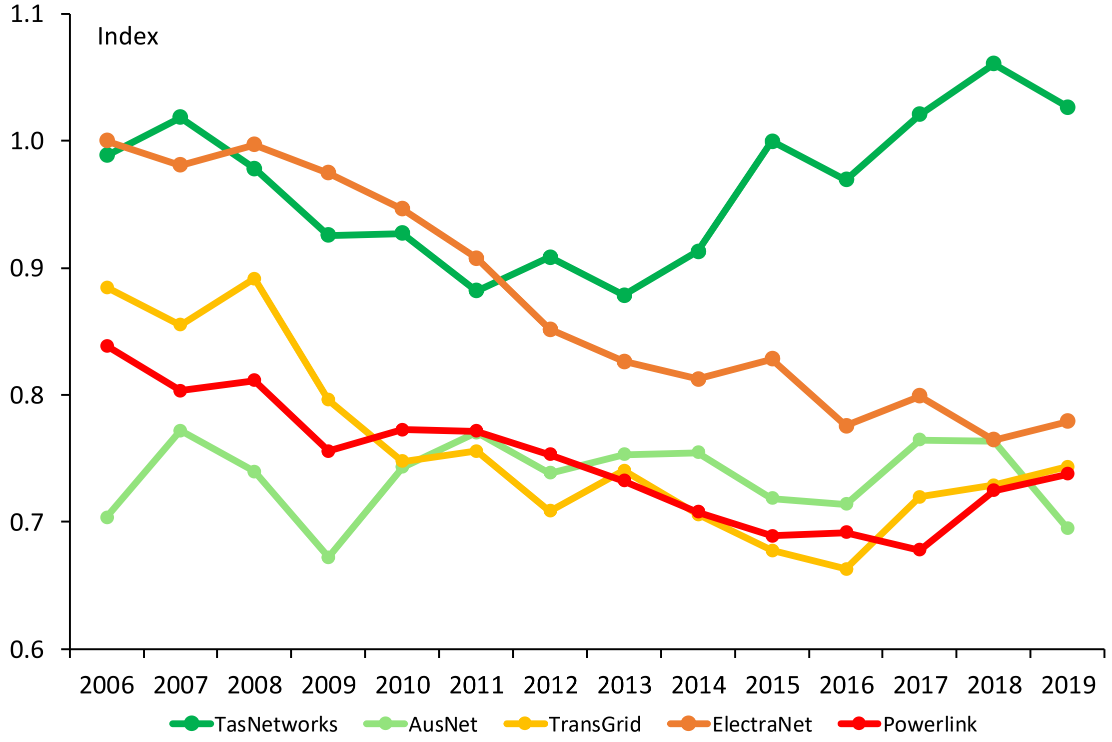
47 AusNet Services, *Email to the AER – AER 2020 annual benchmarking report - follow-up questions on AusNet's (Transmission) 2018–19 EB RIN data,* 24 February 2020.

48 TasNetworks was formed on 1 July 2014 from a merger between Aurora and Transend.

49 TransGrid, *Welcoming our new owners,* 16 December 2015, www.transgrid.com.au/news-views/news/2015/Pages/Welcoming-our-new-owners.aspx

Figure 4.1 Electricity transmission MTFP indexes by TNSP, 2006–2019



Source: Economic Insights.

Table 4.1 presents the MTFP rankings for individual TNSPs in 2019, the change in rankings between 2018 and 2019, and the annual growth in productivity between 2018 and 2019. It shows that TasNetworks and ElectraNet maintained their first and second rankings, TransGrid and Powerlink improved their rankings by one place to be third and fourth respectively and AusNet's ranking moved to fifth.

Table 4.1 TNSP MTFP scores, rankings and changes, 2018 and 2019

TNSP	Rank (2019)	Rank (2018)	MTFP Score (2019)	MTFP Score (2018)	% change between 2018 and 2019
TasNetworks	1	1	1.03	1.06	-3%
ElectraNet	2	2	0.78	0.76	2%
TransGrid	3↑	4	0.74	0.73	2%
Powerlink	4↑	5	0.74	0.72	2%
AusNet	5↓	3	0.70	0.76	-9%

Source: Economic Insights.

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

- Opex MPFP which considers the productivity of the TNSPs' opex.
- Capital MPFP which considers the productivity of the TNSPs' use of overhead lines, underground cables and transformers.

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

Figure 4.2 and Figure 4.3 present capital MPFP and opex MPFP results respectively for all TNSPs over the 2006–2019 period.[50] Consistent with the MTFP results there was positive growth in 2019 in both capital MPFP and opex MPFP for TransGrid (2.3 per cent and 1.5 per cent) and ElectraNet (1.3 per cent and 2.9 per cent), but negative growth for AusNet (–9.5 per cent and –9.5 per cent) and TasNetworks (–2.5 per cent and –5.4 per cent). Meanwhile, Powerlink recorded a positive growth in capital MPFP (2.4 per cent) and a slightly negative growth in opex MPFP (–0.4 per cent).

Figure 4.2 shows that capital productivity has generally declined for all TNSPs since 2006, although since 2013 the rate of decline has decreased. This sustained decline continues to be a cause for concern. TasNetworks remained the highest relative performing TNSP in terms of capital MPFP.

Figure 4.3 shows that in terms of opex MPFP over the 14 year period to 2019 AusNet and TransGrid remained relatively higher performers and Powerlink and ElectraNet relatively lower performers. Despite recording the lowest opex MPFP at the start of the period, TasNetworks joined the higher performing TNSPs in 2015, with opex MPFP in 2019 higher than the 2006 level by 80.1 per cent.

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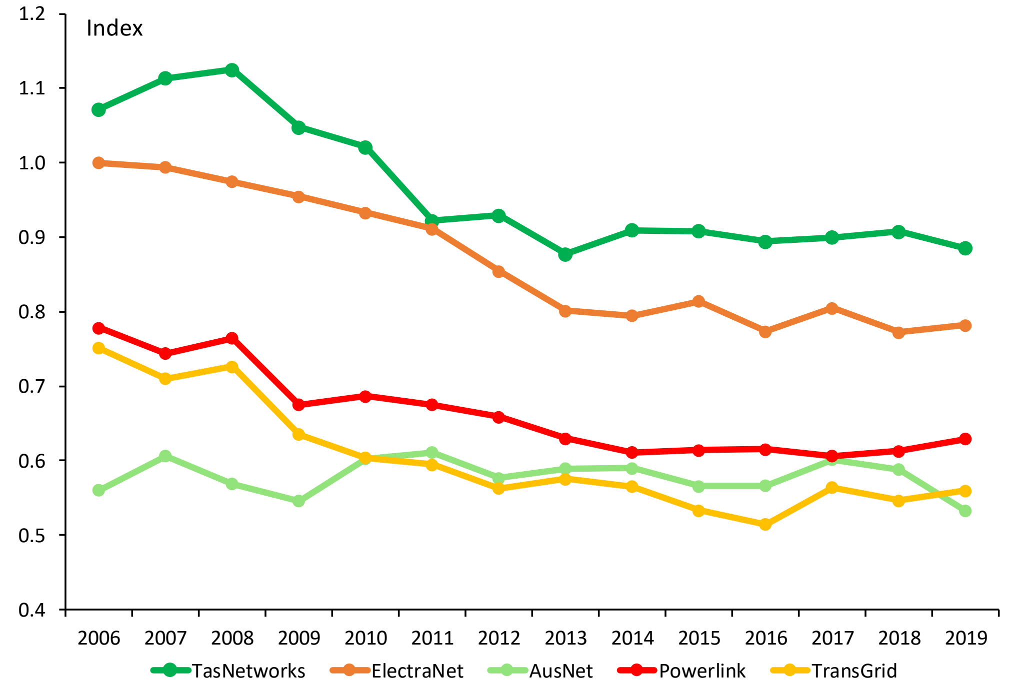
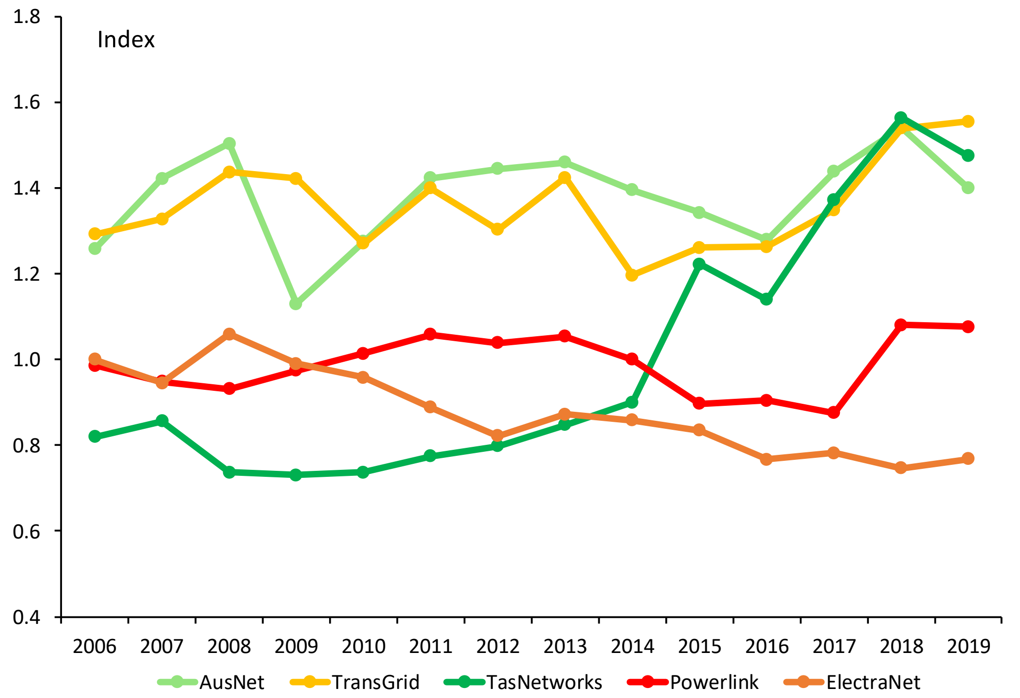
50 2006 is set as the base (i.e., index = 1.00).

Figure 4.2 Capital MPFP index, 2006–19



Source: Economic Insights.

Figure 4.3 Opex MPFP index, 2006–19



Source: Economic Insights.

4.2 Partial performance indicator results of TNSPs

PPIs provide a simple representation of the input costs used to produce particular outputs. The PPIs used here support the MTFP analysis by providing a general indication of comparative performance in delivering one type of output. However, PPIs do not take interrelationships between outputs into account. Therefore, PPIs are most useful when used in conjunction with other top-down benchmarking techniques, such as MTFP.

The inputs we use are the TNSPs' total costs, made up of opex and asset costs. Asset cost is the sum of annual depreciation and return on investment on the TNSP's regulatory asset base.[51] 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 TNSPs and over time.

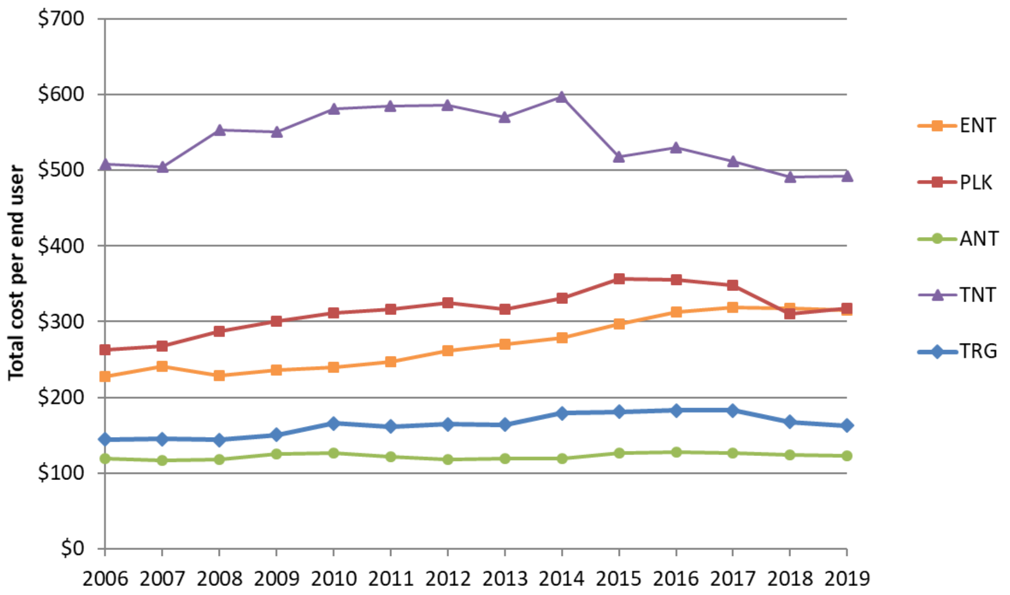
The outputs we use are number of end users, circuit line length, maximum demand served and energy transported. We examine each of these outputs below.

4.2.1 Total cost per end user

We present the total cost per end-user in Figure 4.4. AusNet maintained the lowest cost per end-user in 2019. Conversely, TasNetworks continued to have the highest cost per end-user of all TNSPs at approximately four times that of AusNet. Over the twelve months to 2019, costs per end-user have remained relatively steady for each of the TNSPs, with Powerlink reporting the largest increase (2 per cent). Except for TasNetworks, total costs per end-user have grown for all TNSPs over the past 14 years, with the highest growth by ElectraNet (38 per cent) followed by Powerlink (21 per cent). This is primarily due to TNSPs' costs (mainly its asset costs reflecting the growth in TNSP's regulatory asset bases) increasing faster than the increase in end-users.

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

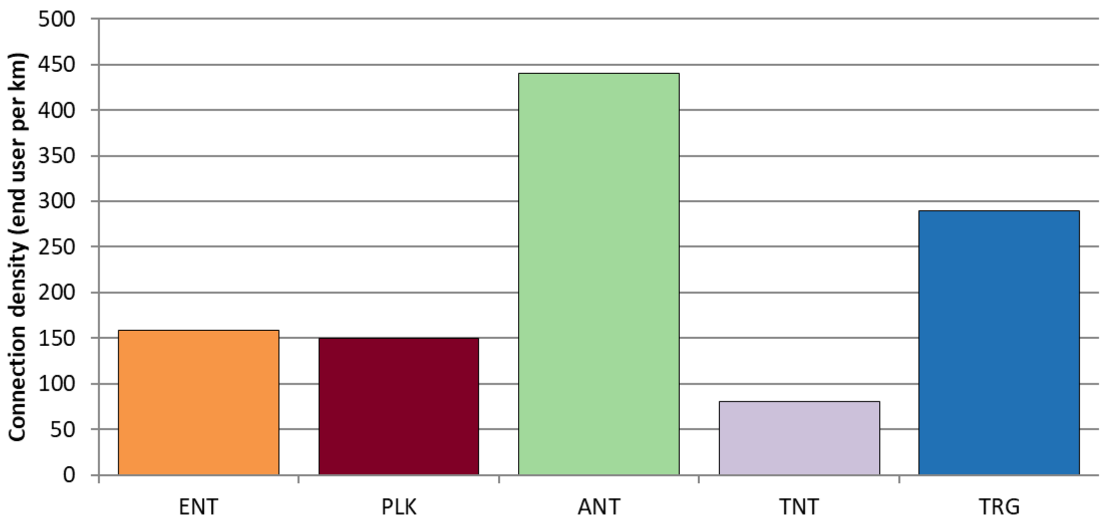
Figure 4.4 TNSP total cost per end user ($2019), 2006–2019



Source: Economic Benchmarking RINs; AER analysis.

We note the total cost per end-user measure potentially favours TNSPs with denser transmission networks (where density is measured in terms of end-users per circuit kilometre). This is because denser transmission networks tend to have more customers per kilometre and hence are required to build and maintain fewer lines per connection point. The average connection density of TNSPs over 2015–19 is presented in Figure 4.5. This shows that AusNet has the highest average connection density, followed by TransGrid, ElectraNet, Powerlink and TasNetworks respectively. This is consistent with the cost per end-user rankings in Figure 4.4.

Figure 4.5 TNSP connection density (end user per circuit km, 2015–19 average)



Source: Economic Benchmarking RINs; AER analysis.

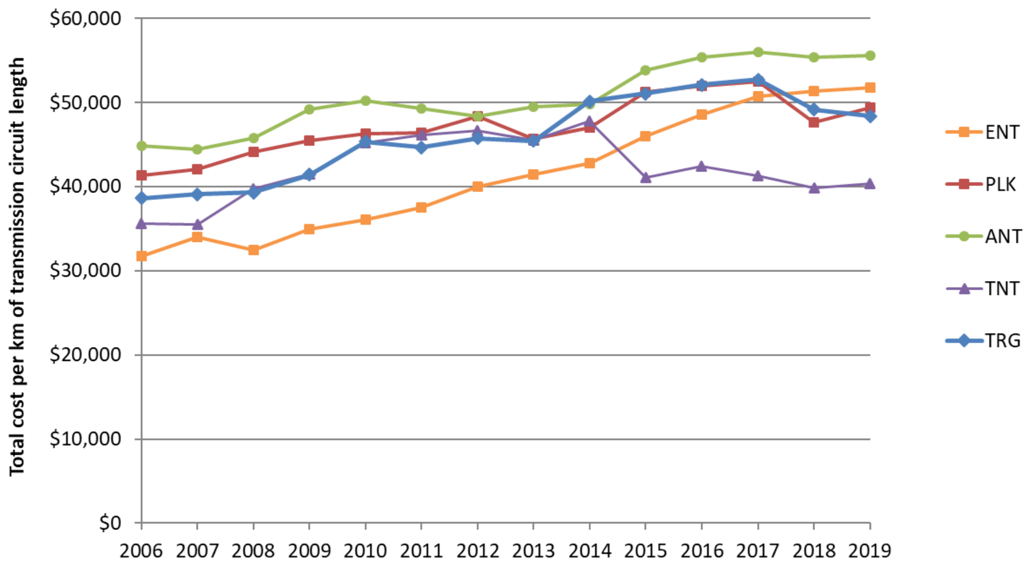
4.2.2 Total cost per km of transmission circuit length

In Figure 4.6 we can see that TasNetworks had the lowest cost per kilometre of circuit length in 2019, while AusNet had the highest cost per kilometre of circuit length.

All TNSPs experienced relatively strong growth in total costs per kilometre of transmission circuit length between 2006 and 2019. This is due to increases in the regulatory asset base and opex exceeding the growth in transmission circuit length. The largest increase in cost per kilometre of circuit length over this period was by ElectraNet (63 per cent), followed by TransGrid (25 per cent). The lowest growth was by TasNetworks, but it was still a relatively significant 13 per cent.

In recent years, the difference in cost per km of transmission circuit length between the highest and lowest ranking TNSPs has widened. Following a low of $7 322 in 2014, the gap in total cost per kilometre of transmission circuit length between TNSPs has increased over the intervening years as a result of a sharp decline in costs by TasNetworks in 2014–15. In 2019, the difference between AusNet (highest cost per km of transmission circuit length) and TasNetworks (lowest cost per km of transmission circuit length) was $15 240.

Figure 4.6 TNSP total cost per km of transmission circuit length ($2019), 2006–2019



Source: Economic Benchmarking RINs; AER analysis.

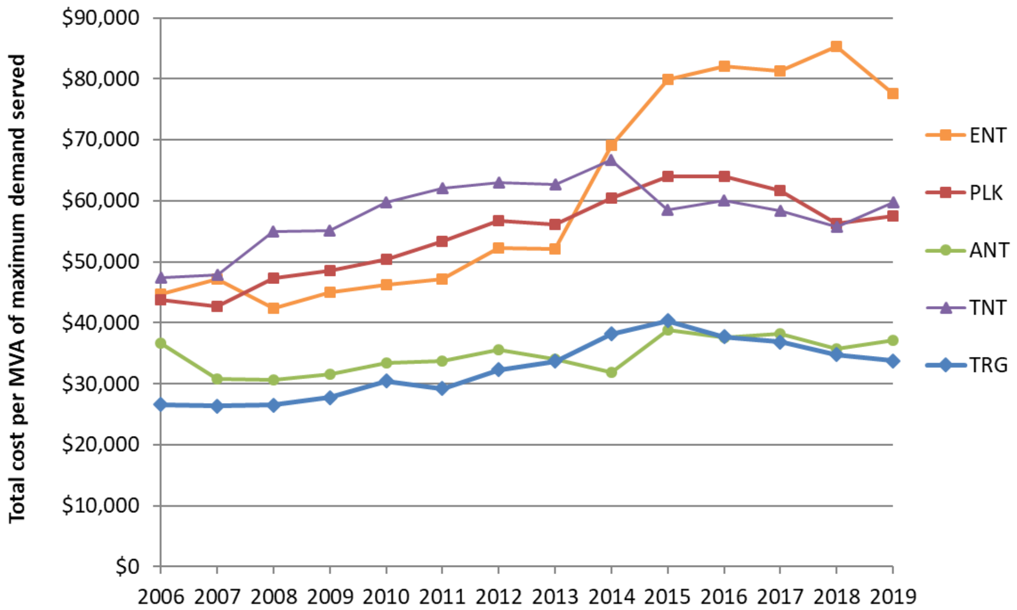
4.2.3 Total cost per Mega Volt Amp (MVA) of non-coincident maximum demand

Figure 4.7 shows TNSPs' total costs per MVA of non-coincident maximum demand.

ElectraNet reported the highest cost per MWA of maximum demand in 2019. This follows large growth between 2013 and 2015 because of a substantial drop in maximum demand with no offsetting decrease in the TNSP's total costs. While ElectraNet's costs per MVA of maximum demand fell in the latest 12 month period (from $85 260/MVA in 2018 to $77 518/MVA in 2019), its costs in 2019 are still more than double that of the two best performing networks, TransGrid ($33 780/MVA) and AusNet ($37 188/MVA).

Across time, there has been continued growth in total costs per MVA of maximum demand across each of the networks. Over the 2006–2019 period, TasNetworks' costs have increased by 26 per cent to $59,774/MVA, TransGrid by 27 per cent to $33,780/MVA and Powerlink by 31 per cent to $57,475/MVA. ElectraNet's total costs per MVA of maximum demand, due to the surge in 2014 and 2015, have increased by 74 per cent. On the other hand, AusNet have experienced a much smaller increase in total cost per MVA of maximum demand over the 2006–2019 period (2 per cent).

Figure 4.7 TNSP total cost per MVA of maximum demand served ($2019), 2006–2019



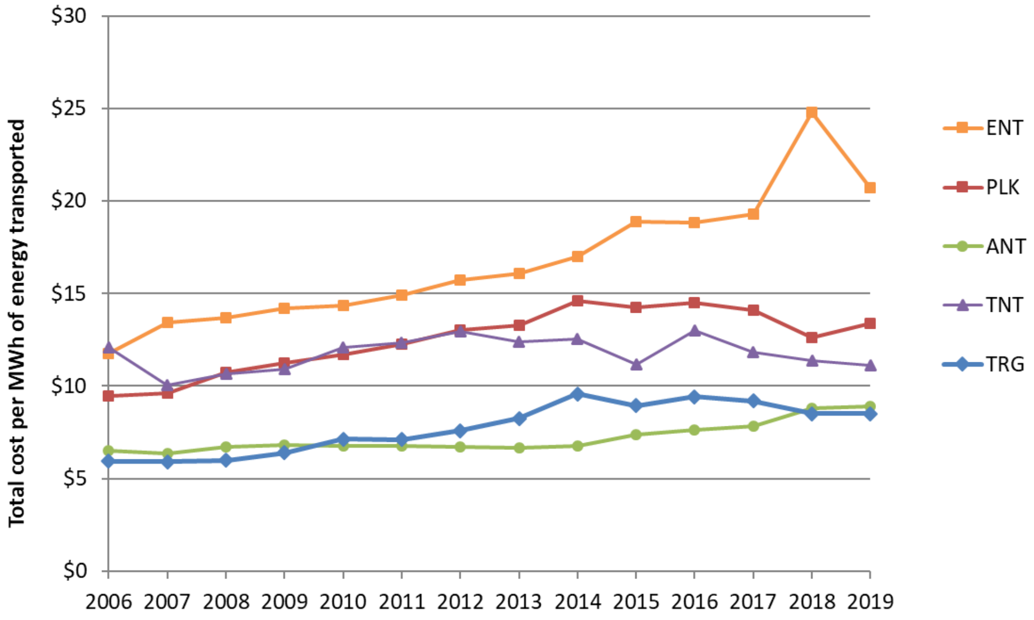
Source: Economic Benchmarking RINs; AER analysis.

4.2.4 Total cost per MWh of energy transported

As can be seen in Figure 4.8 ElectraNet recorded the highest cost per MWh of energy transported in 2019 at $20.72/MWh. In 2019 TransGrid and AusNet are the best performers on this measure, at around one third of the total cost per MWh of ElectraNet, at $8.49/MWh and $8.88/MWh respectively. Their costs per MWh of energy transported in 2019 were relatively stable.

Costs per MWh of energy transported have risen over time for most TNSPs, with the exception being TasNetworks. ElectraNet's costs per MWh of energy transported have risen by 76 per cent over the 2006–2019 period, whereas TransGrid, Powerlink and AusNet's costs have increased by 43 per cent, 41 per cent and 36 per cent respectively. TasNetworks, on the other hand, experienced a decrease of 8 percent in costs per MWh of energy transported over the same period.

Figure 4.8 TNSP total cost per MWh of energy transported ($2019), 2006–2019



Source: Economic Benchmarking RINs, AER analysis.

Shortened forms

Shortened form	Description
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
ANT	AusNet Services (transmission)
Capex	Capital expenditure
ENT	ElectraNet
MW	Megawatt
MWA	Mega Volt Amp
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
Opex	Operating expenditure
PLK	Powerlink
RAB	Regulatory asset base
STPIS	Service target performance incentive scheme
TNSP	Transmission network service provider
TNT	TasNetworks (Transmission)
TRG	TransGrid

Glossary

Term	Description
Efficiency	A Transmission Network Service Provider's (TNSP) benchmarking results relative to other TNSPs reflect that network's relative efficiency, specifically their cost efficiency. TNSPs are cost efficient when they produce services at least possible cost given their operating environments and prevailing input prices.
Inputs	Inputs are the resources TNSPs use to provide services.
MPFP	Multilateral partial factor productivity is a PIN technique that measures the relationship between total output and one input. It allows both partial productivity levels and growth rates 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 both total productivity levels and growth rates to be compared between entities (networks). In this year's annual benchmarking report, we also apply the method to time-series TFP analysis at the industry level and for individual TNSP to better capture large ENS changes.
Prescribed transmission services	Prescribed transmission services are the services that are shared across the users of transmission networks. These capture the services that TNSPs must provide under legislation.
OEFs	Operating environment factors are factors beyond a TNSP's control that can affect its costs and benchmarking performance.
Opex	Operation and maintenance expenditure
Outputs	Outputs are quantitative or qualitative measures that represent the services TNSPs 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 TNSP, observed in the time period up to the year in question. It recognises capacity that has been used to satisfy demand and gives the TNSP credit for this capacity in subsequent years, even though

Term	Description
	annual maximum demand may be lower in subsequent years.
TFP	Total factor productivity is a PIN technique that measures the relationship between total output and total input over time. It allows total productivity changes over time or growth rates to be compared across networks. This method was used in previous annual benchmarking reports, and is relevant to our sensitivity analysis that examines the impact of changing the index method.
VCR	Value of Customer Reliability. VCR represents a customer's willingness to pay for the reliable supply of electricity.

A References and further reading

This benchmarking report is informed by several sources.

Economic Insights publications

The following publications explain in detail how Economic Insights developed and applied the economic benchmarking techniques we used:

- Economic Insights *Report – Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Benchmarking Report,* 15 October 2020
- Economic Insights, *AER Memo Revised 2019 TNSP EB Results*, 24 August 2020
- Economic Insights *Report – Economic Benchmarking Results for the Australian Energy Regulator's 2019 TNSP Benchmarking Report,* September 2019 (link)
- Economic Insights *Report – Economic Benchmarking Results for the Australian Energy Regulator's 2018 TNSP Benchmarking Report,* November 2018 (link)
- Economic Insights *Report – Economic Benchmarking Results for the Australian Energy Regulator's 2017 TNSP Benchmarking Report,* November 2017 (link)
- Economic Insights, *Memorandum – TNSP MTFP Results*, November 2016 (link)
- Economic Insights, *Memorandum – TNSP MTFP Results*, 13 November 2015 (link)
- Economic Insights, *Economic Benchmarking Assessment of Operating Expenditure for NSW and Tasmanian Electricity TNSPs*, 10 November 2014 (link)
- Economic Insights, *AER Response to HoustonKemp for TransGrid determination*, 4 March 2015 (link)
- Economic Insights, *Economic Benchmarking of Electricity Network Service Providers*, 25 June 2013 (link).

AER 2017 TNSP Benchmarking Review

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

ACCC/AER publications

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

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

- WIK Consult, *Cost Benchmarking in Energy Regulation in European Countries*, 14 December 2011.

AER transmission 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 Benchmarking models and data

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

B.1 B.1 Benchmarking techniques

This report presents results from two types of 'top-down' benchmarking techniques:

- **Productivity index numbers**. These techniques use a mathematical index to determine the relationship between outputs and inputs:
  - 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 also allows total factor productivity growth rates to be compared across networks but does not allow productivity levels to be compared across networks. It is used to decompose productivity change into its constituent input and output parts.
  - MTFP relates total inputs 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. It is applied to combined time-series and cross-section (or 'panel') data.
  - MPFP is a partial efficiency measure which uses the same output specification as MTFP but separately examines the productivity of opex and capital against total output. It allows partial productivity levels to be compared between networks.
- **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).

B.2 B.2 Benchmarking data

The inputs and outputs used in the benchmarking techniques for this report are described below. The inputs represent the resources (such as capital and labour) a TNSP uses to provide electricity transmission services. The outputs represent the electricity services delivered (such as the line length and how much electricity they transport).

Data for each of these input and output categories is provided each year by the TNSPs in response to economic benchmarking regulatory information notices (EB RINs). The EB RINs require all TNSPs to provide a consistent set of data which is verified by the TNSP’s chief executive officer and independently audited. We separately test and validate the data. The complete data sets for all inputs and outputs from 2006 to 2019, along with the Basis of Preparation provided by each TNSP, are published on our website.[52]

Box 1: Categories of inputs and outputs used in TNSP benchmarking

Outputs

Outputs are measures that represent the services the TNSPs provide. The outputs we use to measure service provision are:

- Energy throughput (GWh)
- Ratcheted maximum demand (RMD)
- Circuit length (Circuit kms)
- End–user numbers (End User nos)
- (minus) Energy not supplied (ENS) (weight based on AER's 2019 estimates of the value of customer reliability (VCR) capped at a maximum absolute value of 2.5 per cent of total revenue).

Inputs

TNSPs use a mix of physical assets and operational spending to deliver services.

- Capital stock (assets) include:
  - Overhead lines (quantity proxied by overhead MVAkms) (O/H lines)
  - Underground cables (quantity proxied by underground MVAkms) (U/G cables)
  - Transformers and other capital (quantity proxied by transformer MVA) (Trfs)
- Operating expenditure (expenditure TNSPs spend to operate and maintain their assets) (opex).

B.2.1 B.2.1Outputs

Outputs are measures that represent the services the TNSPs provide. TNSPs exist to provide customers with access to a safe and reliable supply of electricity. We explain the outputs we use in more detail in this section.

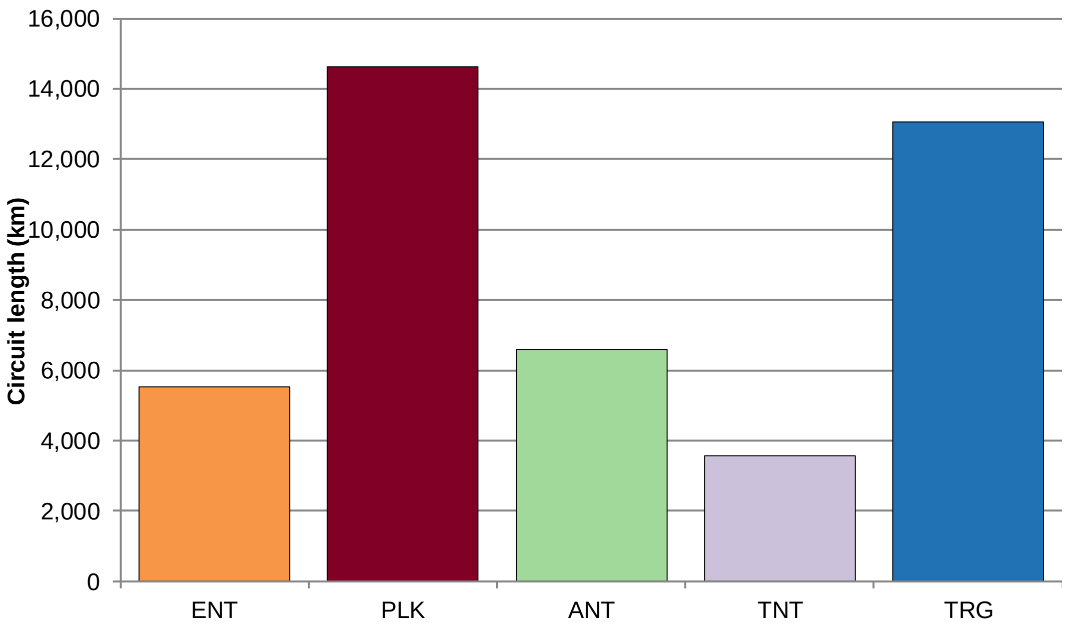
Circuit length

Circuit length reflects the distances over which TNSPs deliver electricity to downstream users from generators, which are typically over thousands of kilometres. We measure line length in terms of circuit line length. This is the length in kilometres of lines, measured as the length of each circuit span between poles and/or towers and underground. This represents the distance over which transmission networks are required to transport electricity.

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

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 TNSP must install and maintain to supply DNSPs who in turn supply consumers with the quantity of electricity demanded at the places where they are located. Figure B.1 shows each TNSP's circuit length, on average, over the five years from 2015 to 2019.

Figure B.1 Five year average circuit length by TNSP (2015 to 2019)

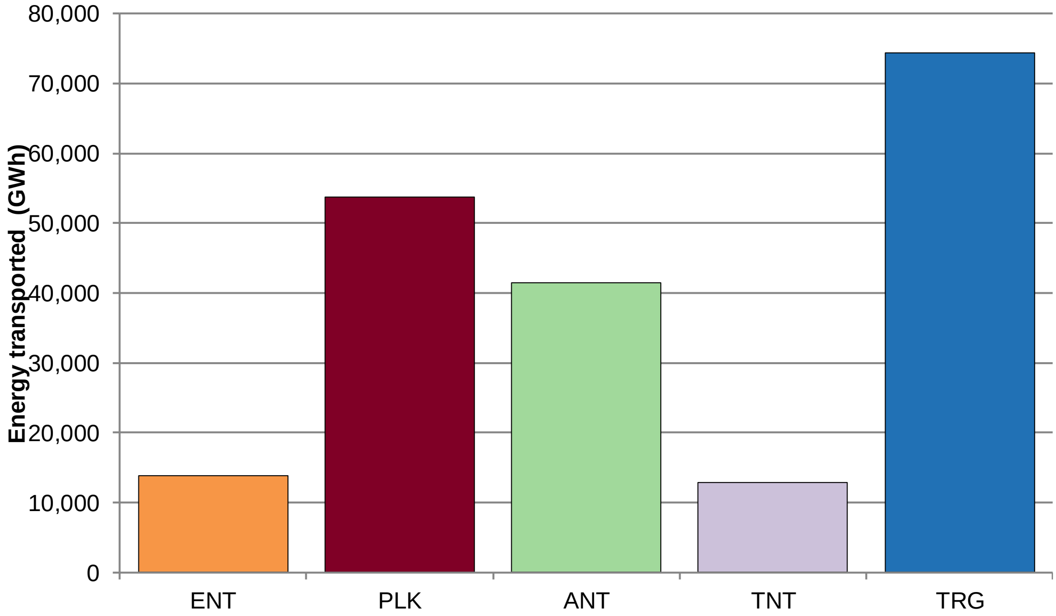


Source: Economic Benchmarking RINs.

Energy transported

Energy transported is the total volume of electricity throughput that is transported over time through the transmission network, measured in gigawatt hours (GWh). We use it because energy throughput is the TNSP service directly consumed by end–customers. Therefore, it reflects a key service provided to customers. However, if there is sufficient capacity to meet current energy throughput levels, changes in throughput are unlikely to have a significant impact on a TNSP's costs. Figure B.2 shows each TNSP's energy transported in 2019.

Figure B.2 Energy transported in 2019 (GWh)



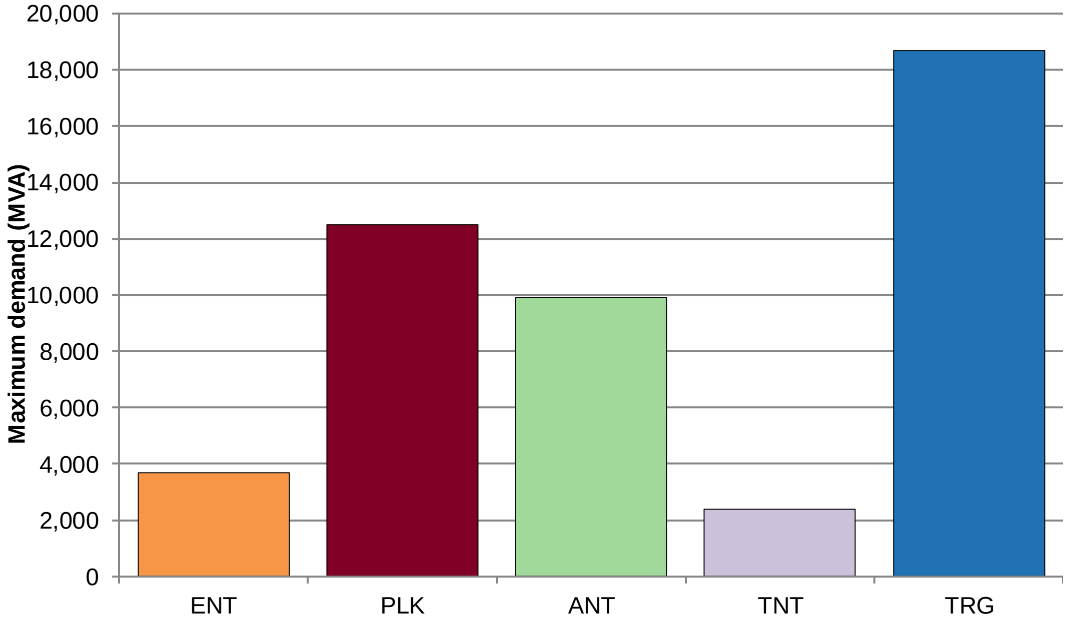
Source: Economic Benchmarking RINs.

Maximum demand

TNSPs are required to meet and manage the demand of their customers. This means 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 benchmarking period up to the year in question for each TNSP. It recognises capacity that has been used to satisfy demand and gives the TNSP credit for this capacity in subsequent years, even though annual maximum demand may be lower in subsequent years. Figure B.3 shows each TNSP's maximum demand in 2019.

Figure B.3 Maximum demand in 2019 (MVA)



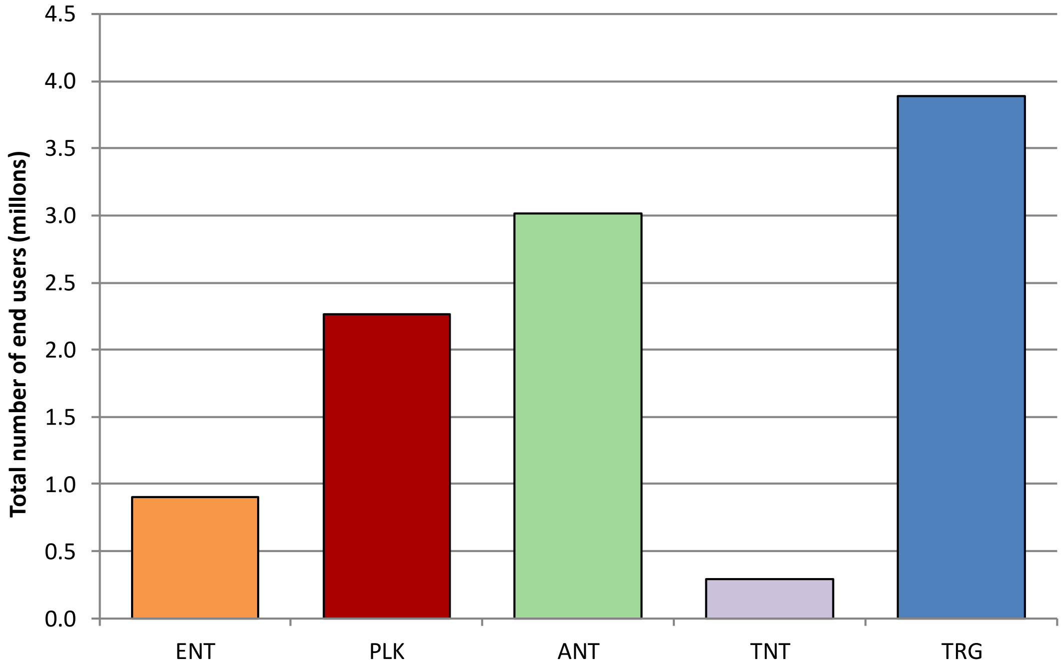
Source: Economic Benchmarking RINs.

End user numbers

The end user number output measures the number of customers TNSPs are required to provide a service for. This is used to represent the size and complexity of the transmission network. Specifically, the greater the number of end users, the more complex the task facing the TNSP and the larger the market the TNSP serves. More complex networks will typically be more asset-intensive. Figure B.4 presents the number of end users serviced by each of the TNSPs.

As expected, the size of the network aligns with the population in each state. NSW is the largest network, with TransGrid providing services for over 3.8 million end-users in NSW, followed by Victoria, with AusNet servicing over 3.0 million end-users. Tasmania has the smallest network, with TasNetworks servicing around 290,000 end users in 2019.

Figure B.4 End user numbers for 2019 (millions)



Source: Economic Benchmarking RINs.

Total outputs

Table B.1 presents the average network outputs from 2015 to 2019 for TNSPs, with the exception of reliability.

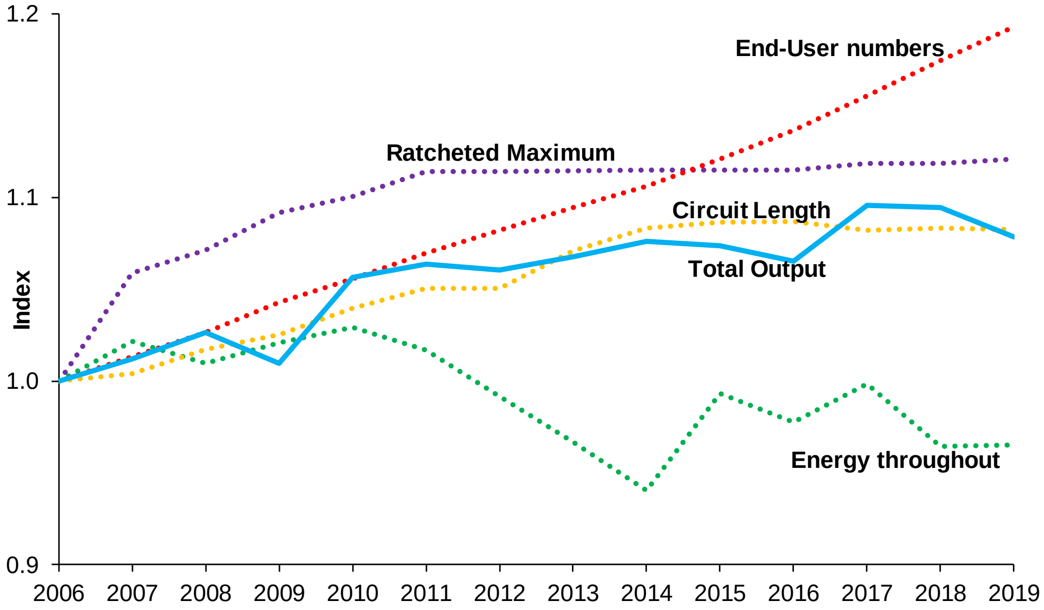
Table B.1 TNSP outputs 2015–2019 average

	Circuit line length (km)	Energy transported (GWh)	Maximum demand (MVA)	Number of end users
ElectraNet	5,520	13,491,975	3,381	878,296
Powerlink	14,619	53,765,681	12,207	2,195,255
AusNet	6,589	45,161,324	9,719	2,901,452
TasNetworks	3,556	12,501,950	2,495	286,884
TransGrid	13,057	74,340,000	18,080	3,778,918

Source: Economic Benchmarking RINs.

Figure B.5 presents indexes of the key industry outputs over the 2006–19 period (with the exception of reliability) along with the total output index.

Figure B.5 Components of total output 2006–2019



Source: Economic Insights.

B.2.2 Inputs

The inputs used in this report are assets and opex. TNSPs 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.

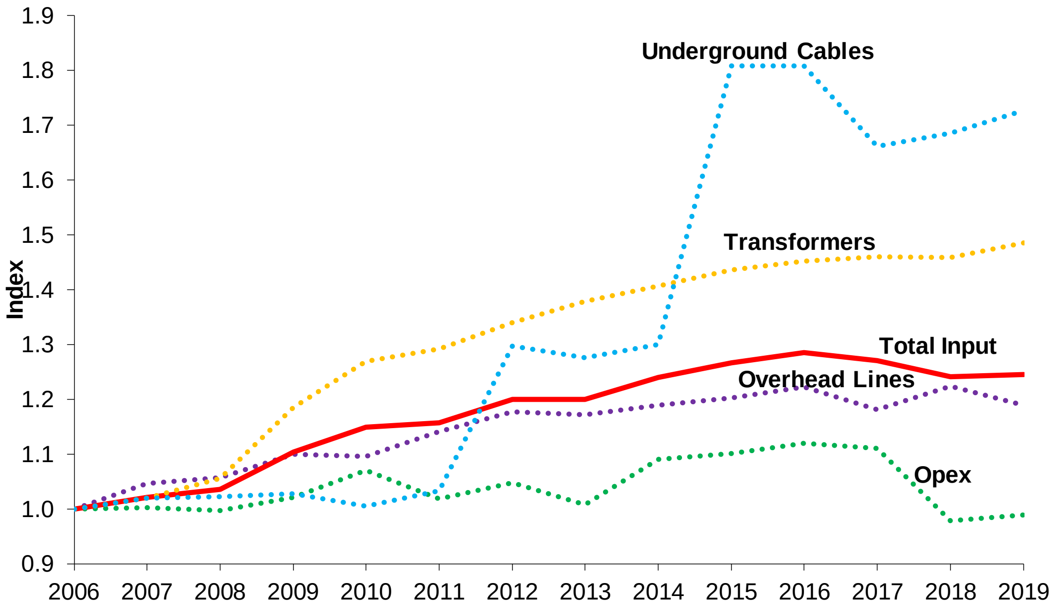
The two inputs we use in our MTFP technique are:

- Operating expenditure (opex). This is the expenditure TNSPs spend on operating and maintaining their assets. We use the observed opex spent on prescribed services. Nominal opex is deflated by an index of labour and other relevant prices to obtain a measure of the quantity of opex inputs.
- Capital stock (assets). TNSPs use physical assets to provide services and invest in them to replace, upgrade or expand their networks. We split capital into overhead lines, underground cables and transformers.
  - For our MTFP analysis we use physical measures of capital inputs. Using physical values for capital inputs has the advantage of best reflecting the physical depreciation profile of TNSP assets.[54]
  - For the PPIs we use the real value of the regulatory asset base as the proxy for assets to derive the real annual cost of using those assets.

[54] Economic Insights, *Memorandum – TNSP MTFP Results*, 31 July 2014, p. 5.

Figure B.6 presents the change in industry input over the 2006–19 period.

Figure B.6 Factors contributing to total inputs, 2006–2019



Source: Economic Insights.

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

Table B.2 Average annual costs for network inputs for 2015–19 ($'000, 2019)

	Opex	Capex	RAB	Depreciation	Asset cost
ElectraNet	92,859	165,898	2,302,100	104,298	181,482
Powerlink	220,027	184,766	6,951,003	286,762	519,814
AusNet	91,203	145,735	3,058,917	170,263	272,822
TasNetworks	34,744	40,982	1,455,851	62,339	111,151
TransGrid	172,309	254,930	6,388,402	275,551	489,740

Source: Economic Benchmarking RINs.

C Corrected output weights for the PIN techniques

C.1 Description of the output weight error and correction

As part of their initial proposals in the Victorian 2021–26 Electricity Distribution Pricing Review context, CitiPower, Powercor and United Energy submitted a Frontier Economics report that raised concerns about statistical problems with estimation of the cost function model used to determine the non-reliability output weights used in the opex MPFP model. In particular, it identified a coding error in the estimation of these weights.[55]

Economic Insights reviewed Frontier Economics' report and agreed there was a coding error in the estimation. Economic Insights found correcting this error significantly improves the performance of the cost function model and consequently mitigates the other concerns raised by Frontier Economics.[56]

The error affects the non-reliability output weights used in the PIN techniques, including the opex MPFP models. These techniques aggregate a range of outputs into an aggregate output index by allocating weights to each output. In our transmission benchmarking, these non-reliability output weights are taken from the estimated total cost function.[57] In estimating the total cost function, the time trend (which is included to represent technological change) was incorporated incorrectly, which in turn generated incorrectly estimated output weights.[58]

Specifically, the time trend variable should start from a common integer value in the first year of each time period (2006) and then increment by one for each following year. For example, if the time trend is one in 2006, then it should be two in 2007, three in 2008, and so on, up until the final year of the sample (the time trend was 10 for 2015, which was the final year of data for the report this error was identified in). This should be the same for all occurrences of this variable in the dataset and should not vary among TNSPs.

However, in the coding the time trend variable was mistakenly formed over the entire sample. The data was structured by first ordering observations by TNSPs and then

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55 Frontier Economics, *Review of econometric models used by the AER to estimate output growth*, 5 December 2019, pp. 7–15.

56 Economic Insights, *Memorandum prepared for the AER on review of reports submitted by CitiPower, Powercor and United Energy on opex input price and output weights*, 18 May 2020.

57 Economic Insights, *Review of Economic Benchmarking of Transmission Network Service Providers - Issues Paper Report prepared for Australian Energy Regulator*, 10 November 2014, p. 9.

58 Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, p. 1.

chronologically by years. This meant the first 10 observations in the dataset were the 2006–15 observations of the first TNSP in the database, then the 11th–20th observations were the 2006–15 observations from the second TNSP, and so on. The time trend for the first TNSP was correct, however the time trend did not reset to start from one for the second TNSP. This meant observation 11 in the database (the 2006 value for the second TNSP) had a time trend value of 11 instead of one. This continued throughout the dataset which meant the time trend was incorrectly set to equal the observation's position in the dataset. Given the non-linear nature of the regressions, this had a distorting effect on the results obtained.

The output weights were last updated as a part of the review of the output specification in 2017.[59] The intention was to leave these weights unchanged for a period of around 5 years.[60] However, this year as a result of the above error being identified we now have three extra years of data. Economic Insights included this data when it re-estimated the models after correcting the coding error that impacts the non-reliability output weights. The corrected output weights are set out in Table 1.1.

C.2 Impact of the corrected output weights

We present here the TNSP MTFP rankings for 2019 using corrected output weights (from this year's report) and the previous output weights (from the 2019 Annual Benchmarking Report). This comparison is done using the data used in this year's benchmarking report. While there are some other less significant methodology changes (updated VCR estimates, the cap applied to ENS weight and revised index number methods) this year, the effect of the change in weights has been isolated here given its significant impact.

Table C.1 shows the impact on the MTFP results and rankings for the TNSPs in 2019. With the correction AusNet and TransGrid have relatively lower MTFP results and rankings, TasNetworks has relatively higher MTFP result and maintains its number one ranking, while ElectraNet and Powerlink's MTFP results are less impacted but their relative rankings are improved as a result of the worsening MTFP results of AusNet and TransGrid. To understand this, with the corrected weights the TNSPs that are relatively intensive with regard to customer numbers, which has reduced weight under the correction, have relatively worse MTFP results and rankings (TransGrid and AusNet). Further, the TNSP which is relatively intensive with regard to circuit length, which has increased weight under the correction, has a better MTFP result and retains its number one ranking (TasNetworks).

[59] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2017 TNSP Benchmarking Report*, 6 November 2017, p. 3.

[60] Economic Insights, *Economic Benchmarking Results for the Australian Energy Regulator's 2020 TNSP Annual Benchmarking Report*, 15 October 2020, pp. 1–2.

Table C.1 2019 MTFP rankings under corrected and previous weights

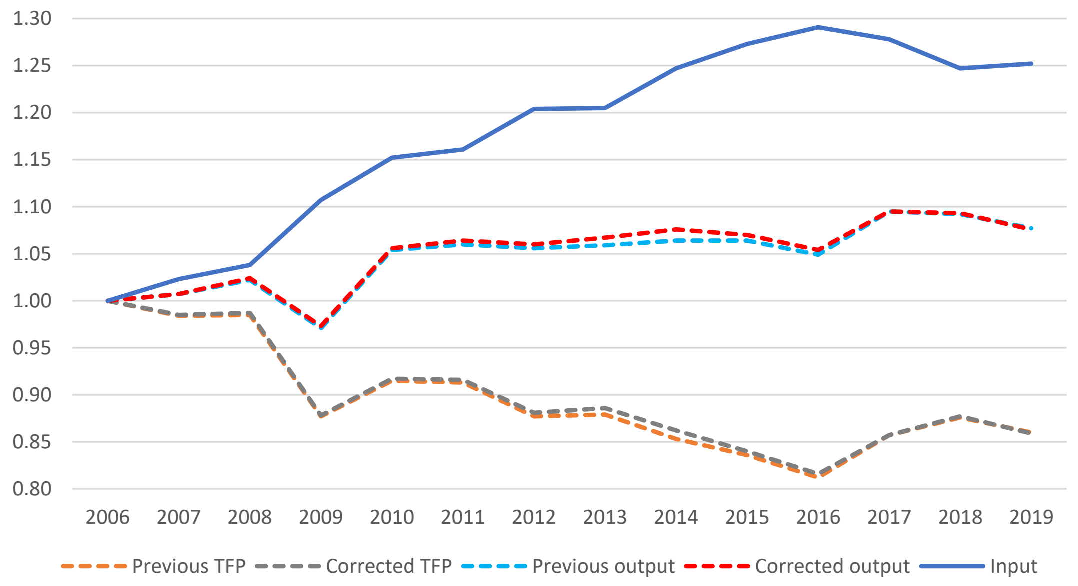
TNSP	Ranking – corrected weights	Ranking – previous weights	Score – corrected weights	Score – previous weights
TasNetworks	1	1	1.026	0.981
ElectraNet	2↑	4	0.779	0.785
Powerlink	3↑	5	0.75	0.773
TransGrid	4↓	2	0.747	0.84
AusNet	5↓	3	0.667	0.798

Industry-wide impact of the corrected output weights

The correction made to output weights also affects TFP at the aggregate electricity transmission industry level. We present here a comparison of electricity transmission TFP and output before and after the correction. As above, the impact of the weighting change is isolated from other methodology changes made this year in the analysis below.

Figure C.1 illustrates the impact of the weight correction on TFP in the electricity transmission industry. Unlike the MTFP results for individual TNSPs, the correction had minimal impact on industry TFP. As can be seen, from 2006 to around 2012 and 2016 to 2019, this impact was negligible and there was only a small clear divergence between the two series between 2012 and 2015. The uncorrected output weighting understated the value of total output slightly in the latter period, meaning that since this correction has no impact on industry input the value of industry TFP was also slightly understated for these years. For the period as a whole, however, there is negligible impact because the industry productivity is measured relative to 2006. Output densities do not change that much over time. To put this another way, while the correction has an impact on TNSP productivity levels, it has minimal impact on industry TFP growth rates.

Figure C.1 Electricity transmission industry TFP under corrected and previous weights (2006–19)



Source: Economic Insights.

D Other issues raised in ElectraNet's submission

In this Appendix we address elements of ElectraNet's submission on a draft of this year's report that were raised in previous years and have not been addressed earlier in this year's report.

D.1 Threshold concerns

ElectraNet suggested that the report acknowledge at the outset the limitations of the data in drawing any inferences over the relative efficiency of network businesses. It noted three concerns which are set out below along with the AER's response.

Sample size and diversity

ElectraNet pointed to limitations in TNSP benchmarking due to the small sample size and the extent of the diversity between the transmission networks being compared. It considered it important that these limitations are highlighted through the course of benchmarking and annual reporting in order to provide a balanced view of the use of the data and to ensure that differences are appropriately considered in interpreting the results. ElectraNet noted that the diversity between transmission networks is increasing over time with ongoing structural changes in the sector, including the merger of distribution and transmission businesses. This diversity is increasing the difficulty of meaningful comparisons across transmission networks.

We discuss limitations of transmission benchmarking in sections 1.1 and 2.2 and note that these should be taken into account when examining the results in subsequent sections.

Basis for model specification

In ElectraNet's view, there remains no robust basis for determining that the model specification for MTFP developed by Economic Insights is the most appropriate. ElectraNet suggested that further testing and development should be carried out to provide greater confidence in the robustness of the model before any more widespread application would be possible in revenue determination processes. Specifically, ElectraNet pointed to the adoption of alternative model specifications, which appears to lead to significant variations in measured MTFP and relative rankings across the businesses.

We note that ElectraNet raised this point in its submission during the 2017 review of the output specification and in 2014 when we were initiating benchmarking. As indicated previously, we consider that the MTFP benchmarking presented in this report is the best measure of relative productivity that we have available to us. We acknowledge that transmission benchmarking is in its relative infancy, but consider that the results provide a useful contribution and should be presented. Over time we intend to further refine this analysis.

In developing and specifying the MTFP model, Economic Insights tested a range of output selection options based on how well they meet a range of performance standards and other functions. The criteria used to guide output selection for benchmarking included the following:[61]

1) The output aligns with the NEL and NER objectives
2) The output reflects services provided to consumers
3) The output is significant.

The first criterion requires that economic benchmarking outputs should reflect the deliverables the AER expects in setting the revenue requirement and which it believes are necessary to achieve the expenditure objectives specified in the NER. Aligning the outputs included in economic benchmarking and those the TNSPs are financially supported to deliver means economic benchmarking can help ensure the expenditure objectives are met at an efficient cost.

The second criterion is intended to ensure the outputs included reflect services provided directly to customers rather than activities undertaken by the TNSP. This minimises the risk a TNSP would have an incentive to oversupply those activities and not concentrate sufficiently on meeting customers' needs at an efficient cost.

The third criterion requires that only significant outputs be included. TNSP costs are dominated by a few key outputs and only those key services should be included to keep the analysis manageable and to be consistent with the high level nature of economic benchmarking.

Measures

ElectraNet considers the limitations of the measures themselves should be recognised, noting that it is not possible to draw firm conclusions about relative efficiency from the Partial Performance Indicator (PPI) benchmarks due to the exclusion of the range of external factors that impact on efficient transmission costs, and noting that the MTFP results reflect productivity changes rather than business efficiency. ElectraNet encourages further engagement on these issues to ensure that the ongoing development of the model and refinement of model inputs is fully informed, and that the benchmarking results can be meaningfully interpreted and applied.

We note that in section 4.2 of this report we acknowledge that PPIs do not take interrelationships between outputs into account, and therefore, are most useful when used in conjunction with other top-down benchmarking techniques, such as MTFP. We also acknowledge in section 1.2 future development priorities.

D.2 Model Specification

ElectraNet supported the direction of the changes to the output weights applied in the draft 2020 Annual Benchmarking Report, noting Economic Insight's assessment that end–user customer numbers and energy throughput are only of secondary importance

61 Economic Insights, Review of Economic Benchmarking of Transmission Network Service Providers – Position Paper 9 August 2017, pp. 4–6.

in comparison with other factors as drivers of cost for TNSPs. However, ElectraNet considered that there are remaining flaws in the output measures that do not bear any direct relationship to transmission costs. In particular, ElectraNet was of the view that while its obligations have increased substantially over the assessment period (e.g. provision of system strength and inertia services), this is not reflected in any of the outputs being measured.

Specifically, ElectraNet suggested that our TFP model specification implies that a TNSP's task has not changed substantially since 2014. It also suggested that the new weights imply that a TNSP is primarily a supplier of network length, and that the performance of that network can be accurately measured by reference to the TNSP's maximum demand, energy throughput and the total number of end customers supplied indirectly from the distribution networks to which it connects (p.3). ElectraNet's key outstanding issues are that:

- The number of end customers connected to the grid in South Australia (which have remained static) is a poor proxy for the complexity of the transmission network and for the way that complexity has changed in recent years (e.g. requirements to provide system strength and inertia). For this reason, it does not support the substitution of end-user customer numbers for the previous current voltage-weighted connections output measure used prior to the 2017 Annual Benchmarking Report. ElectraNet also noted that end user numbers do not take account of differences in external operating environments (such as population density and the resulting network topology) and will unreasonably disadvantage networks with low customer density.
- Energy throughput is irrelevant as a measure of output, particularly considering the substantial increases in rooftop solar in South Australia. It bears no relationship to the efficient costs incurred by the TNSP and has no impact on the level of effort required by a TNSP to maintain its assets. Throughput is unrelated to the service being provided by a transmission network, which is focused on ensuring adequate, secure and reliable levels of network capacity.
- Providing new system security services, including system strength and inertia, is a substantial part of our output, and has increased substantially in recent years, but is not reflected in the productivity analysis.

ElectraNet raised similar concerns in 2017 during our review of transmission benchmarking. Economic Insights addressed these as a part of this review and we summarise this below, reflecting the reasoning behind the output specification that we adopted in the 2017 review.

As stated above, the transmission outputs used in our economic benchmarking were chosen on the basis of how well they met the three criteria above, taking into account the issues and arguments raised by industry.

In terms of the appropriateness and measurability of current voltage-weighted entry and exit connections as an output, while this was considered to meet the AER's first and third criteria, it less satisfactorily meets the second criterion as end-users are not direct beneficiaries of the services provided at the connection points. There are also issues identifying the number of connection points on a consistent basis, and whether voltage-weighted connections appropriately reflect the relative scale of transmission output provided by TNSPs. These issues prompted consideration of a number of options: continuing to use the voltage-weighted connection output, changing to TNSP Mega Volt Amp rating of connections as a method of weighting, changing to the number of end-users, or exclude this output altogether. End-user numbers was considered superior to the other options because it satisfied all three criteria, and scored more highly than other outputs for the second criterion. The data on the number of end-users is also readily available, robust and provides a direct measure of the scale and complexity of the transmission services. While many of the outputs provided by TNSPs are not directly consumed by end-users, end-users are the ultimate beneficiaries of transmission services and ultimately bear the related costs. Jurisdictional end-user numbers was therefore substituted for voltage-weighted connections.

The inclusion of energy throughput as output in our benchmarking was also based of the three criteria stated earlier. While throughput has a small direct impact on TNSP costs, it reflects the main output of value to customers.

Further, we note that output weights in the MTFP/MPFP framework are based on shares of total cost. Economic Insights assessed the likely distribution of total costs across outputs by examining the shares of the main input components in total cost and concludes that the corrected output weights are reasonable.

We also note that the output specification cannot take account of all operating environment factors (OEFs) and unusual circumstances facing a TNSP, or the changes over time. This may be better dealt with through the application of separate OEF analysis, or further investigations to explain the measured MTFP results in terms of changes over time or variations across TNSPs.

D.3 Network support costs

Network support costs constitute 10 per cent of ElectraNet's annual opex. ElectraNet considered that these cost should be removed or appropriately adjusted in the opex MPFP measure and states that failing to adjust for these payments distorts the benchmarking results.

ElectraNet has previously raised network support costs in the context of capex / opex trade-offs and whether they should be included in total cost benchmarking. While our general preference is not to exclude costs, this issue requires further consideration, including around the nature and magnitude of the network support costs and the basis for and appropriateness of excluding these costs

D.4 Overall benchmarking limitations

ElectraNet encouraged the AER to review the form and use of the transmission benchmarking measures moving forward and looks forward to engaging further on the issues raised in its submission, including the impact of operating environment factors beyond a TNSPs control.

As noted in section 1.2, we acknowledge the general support from stakeholders on continuing to progress benchmarking development work and will review the relative priority of addressing the different development possibilities.

E Map of the National Electricity Market

This benchmarking report examines the efficiency of the five TNSPs in the 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 D.1 illustrates the network areas for which the TNSPs are responsible.

Figure D.1 Electricity transmission networks within the NEM