Final decision paper

Forecasting productivity growth for electricity distributors

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AUSTRALIAN ENERGY REGULATOR

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Shortened forms

Shortened form	Extended form
ABS	Australian Bureau of Statistics
ACM	Authority for Consumer Markets (The Netherlands)
ACT	Australian Capital Territory
AER	Australian Energy Regulator
Capex	Capital expenditure
CCP	Consumer Challenge Panel
CEPA	Cambridge Economics Policy Associates Ltd
DAE	Deloitte Access Economics
DNSP	Distribution network service provider
EBSS	Efficiency Benefit Sharing Scheme
EPRG	The University of Cambridge's Energy Policy Research Group
ERA	Economic Regulation Authority (Western Australia)
ETU	Electrical Trades Union
EUAA	Energy Users Association of Australia
EU KLEMS	European Union-level analysis of Capital, Labour, Energy, Materials and Service inputs
GSL	Guaranteed Service Level payments
(The) Guideline	Expenditure Forecast Assessment Guideline
HR	Human resources
ICT	Information and communications technology
IPART	Independent Pricing and Regulatory Tribunal (New South Wales)
LSE	Least squares econometrics
MFP	Multifactor productivity
MPFP	Multilateral partial factor productivity
MEU	Major Energy Users Inc

MSS	Minimum Service Standards
NEM	National Electricity Market
NEO	National Energy Objective
NER	National Electricity Rules
NERA	NERA Economic Consulting
NSW	New South Wales
OEB	Ontario Energy Board
Ofgem	Office of Gas and Electricity Markets (The United Kingdom)
Ofwat	(The) Water Service Regulation Authority (The United Kingdom)
Opex	Operating expenditure
PC	Productivity Commission
PFP	Partial factor productivity
PIAC	Public Interest Advocacy Centre
QCA	Queensland Competition Authority
RIIO	Revenue=Incentives+Innovation+Outputs (Ofgem's model for network price controls)
RIN	Regulatory Information Notice
SA	South Australia
SFA	Stochastic frontier analysis
TFP	Total factor productivity
Totex	Total expenditure
VIC	Victoria
WA	Western Australia

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Overview

Forecasting operating expenditure

In setting revenue allowances for electricity distributors, we assess the efficiency of operating expenditure (opex) forecasts proposed by electricity distributors for a 5 year regulatory period. We generally do so by applying a base-step-trend approach to develop an estimate of the forecast opex that a prudent distributor would require when acting efficiently. We then compare our estimate against the forecast opex as proposed by the distributor. If the proposed opex forecast is materially higher than our own estimate, we do not accept it.

Our base-step-trend approach is summarised in the following steps:

1. We use the electricity distributor's revealed opex in a recent year as a starting point (or base opex). We assess the revealed opex to test whether it is efficient (for example, through benchmarking). If we find the revealed opex not to be materially inefficient, we accept it. On the other hand, if we find it to be materially inefficient we may make an efficiency adjustment.
2. We then trend the base opex forward by applying a forecast 'rate of change', which consists of three forecast components — input prices (labour and non-labour price growth), output growth (such as increases in customer numbers, maximum demand and network circuit length) and productivity growth.
3. Finally we add or subtract any step changes for costs not compensated by base opex and the rate of change, which are generally costs associated with material regulatory obligation changes or capex/opex substitutions.

This review concerns the productivity growth factor that is included within the trend component of our opex forecasting approach. This productivity growth factor captures the improvements in good industry practice that should be implemented by efficient distributors as part of business-as-usual operations. Another way of putting this is that it reflects the improvement in the efficient production frontier within the electricity distribution industry. This comes from such things as new technology, changes to management practices and other factors that contribute to improved productivity within the industry over time.

Forecasting productivity growth and incentives to improve productivity

The regulatory regime established in Chapter 6 of the National Electricity Rules (NER) establishes an ex-ante framework that incentivises network businesses to improve the efficiency of their opex and spend less than our opex forecasts. The framework rewards network businesses if their opex is below the AER's forecast that underpins the revenue allowance, and penalises them if their opex is above the forecast. The efficiency benefit sharing scheme (EBSS) ensures that the associated efficiency gains and losses are consistently shared with customers over time.

The AER's opex forecast is typically based on the network businesses' past performance. If the network businesses respond to the incentives to find efficiency gains over time, the regulator can then rely on the revealed costs to set efficient opex forecast.

Some stakeholders have questioned whether a productivity growth factor should be included within our opex forecasting approach in light of this revealed cost incentive framework. The incentive-based framework is not meant to incentivise the business-as-usual productivity growth that would be expected within the sector but rather, the productivity growth that exceeds what we have forecast.

It's important to note too that where actual opex is above the forecast efficient opex set in the revenue allowance, the framework provides that customers share some of this cost.

Movements in the efficiency frontier versus catch up

The efficiency of individual electricity distributors vary across the National Electricity Market (NEM). Some distributors currently operate at or near the efficient industry frontier and as such would be considered the most efficient. While others are materially below the frontier and have some catch-up to do before they could be considered an efficient distributor.

The productivity growth factor is not intended to capture the inefficiencies in the costs of an individual distributor. To ensure consumers are not charged for such inefficiencies, we would make an efficiency adjustment to the individual distributor's forecast base opex such that it reflects an efficient forecast. Since we consider the scope for catch-up productivity as part of our assessment of an individual distributor's base opex, the productivity growth factor that we use in trending forward base opex should only capture the productivity growth that would be achieved by a distributor on the efficiency frontier.

Our review of forecast opex productivity growth

Since 2013, we have applied a productivity growth factor of zero per cent in all our determinations for electricity distributors in the NEM. We estimated that the productivity growth of the electricity distribution industry had been negative on average since 2006 but noted that this productivity decline reflected the major changes in regulatory obligations relating to reliability and safety that occurred prior to 2011. These regulatory obligation changes increased the inputs but not the outputs we measured in our productivity analyses, and for which we had allowed explicit opex step changes in our opex forecasts.

A negative productivity growth factor of this sort would have provided additional opex to the amount provided for in step changes. This would have had the effect of compensating distributors twice for the new regulatory obligations. Similarly, we did not consider that a prudent and efficient distributor would reduce its productivity unless it was required to meet new uncontrollable obligations.

We have continued to monitor the productivity growth of the electricity distribution industry as we collect and publish more data in our annual benchmarking reports. We have observed positive productivity growth in electricity distribution over the 2011–17 period. Since around 2012, changes in regulatory obligations have not been as significant as those experienced by the electricity distributors prior to 2011.

Therefore, this trend in productivity growth since 2011 and 2012 suggested that now is an appropriate time to review our previous productivity growth factor of zero per cent. In addition, the Consumer Challenge Panel (CCP) argued for us to consider a positive productivity growth factor within the context of the current distribution determinations and

some distributors have forecast positive productivity growth in their revenue proposals. Together we considered it appropriate to conduct a review of our opex productivity growth factor in time to be taken into account in the current distribution determinations, rather than have to wait until the following regulatory period in five years' time.

Our new opex productivity growth forecast

In this final decision, we determine that a forecast of 0.5 per cent per year represents an appropriate opex productivity growth factor for electricity distributors. This reflects the best estimate of the opex productivity growth that an electricity distributor on the efficiency frontier should be able to achieve going forward, rather than any efficiency catch-up by individual distributors.

In forecasting the productivity growth factor, it would be ideal to rely upon consistent and reliable productivity data for the electricity distribution sector over the long term. The estimates of electricity distribution productivity is negative from 2006-2017. However, as noted above, the measured productivity over this period is significantly impacted by the increased regulatory obligations relating to safety and reliability imposed on the sector prior to 2011, such that the 2006–17 period does not reflect business-as-usual operations within the sector.

There are a number of ways to address the issue of material step changes affecting the productivity trend. This includes:

- providing additional output variables in the productivity models
- re-estimating the trend by excluding the costs associated with the step changes
- focusing the productivity measurement on the period following the step changes period.

We have focused on forecasting productivity using productivity measured on the period following the step change period. The other approaches will likely be difficult and time consuming to develop and require relatively significant further engagement with industry and additional data collection, including extensive recasting of data. This was not possible within the time available to complete this review.

To minimise the effects of these regulatory changes, we examined electricity distribution productivity from 2011–2017. Specifically, we examined:

- Opex partial factor productivity analysis results from the period 2011–2017, which estimates positive productivity of between 0.35 per cent and 0.97 per cent.
- The rate of technical change (i.e. productivity) estimated in econometric models for the Australian electricity distribution sector, which estimates positive productivity of between 1.2 per cent and 2.2 per cent. These estimates likely reflect broader industry productivity, including efficiency catch-up by individual distributors.

While these productivity estimates minimise the effects of regulatory changes and reflect more recent information, the annual rate of productivity growth is based on a relatively short time period and a small sample of distributors used to proxy the frontier. The resultant productivity growth rates vary significantly as the time period changes and as different

distributors are selected. While this still provides us with valuable information on productivity growth, we cannot and do not use these estimates in a deterministic way.

Therefore we have also looked to other information sources to help forecast the productivity growth factor, including in sectors comparable to electricity distribution and over the longer term. This broader approach of drawing on a wider range of information sources is also consistent with the recommendations of the Australian Competition Tribunal, and the approaches to forecasting productivity by other international economic regulators.

We consider that the two most useful sources of information to inform our estimate of the opex productivity growth factor for electricity distributors are:

- Time trends estimated in econometric models for gas distribution industry which we have relied upon in our previous gas distribution determinations. This provides opex productivity estimates of between 0.43 to 0.7 per cent.
- Labour productivity forecasts for the utilities sector provided by Deloitte Access Economics and BIS Oxford Economics and labour productivity estimates for selected non-utilities sectors over multiple periods as provided by Cambridge Economic Policy Associates (CEPA). These all estimate opex productivity of between 0.3 to 0.7 per cent.

We consider that operating costs within the gas distribution industry are sufficiently similar to the electricity distribution industry, such that we can use opex productivity growth from gas distributors as a proxy to estimate the opex productivity growth factor for electricity distributors. In comparison to electricity distribution, gas distribution has not been affected by step changes and changes in regulatory obligations of the same magnitude as electricity distribution. It is also considered to be subject to some competitive pressure.

The labour productivity estimates are useful because we have relied upon a range of sources that include labour productivity in the utilities sector (which includes both electricity and gas distribution) as well as other industries that perform similar functions to electricity distribution. We consider the selected non-utilities sectors productivity growth estimate provides a reasonable productivity forecast as it is based on a relatively long data period and it represents sectors that undertake similar activities to electricity distribution, and there are likely to be greater competitive pressures in these sectors compared to electricity distribution.

Gas distribution and sectoral labour productivity growth estimates and forecasts both rely on relatively long datasets and both yield similar results that lend support to an opex productivity growth factor of 0.5 per cent per year. We further note that this productivity growth factor is not inconsistent with our electricity distribution productivity analyses:

- It is at the lower end of the range of estimated opex partial factor productivity growth rates for frontier distributors from 2011 to 2017
- It is less than the econometric time trends estimated for the period from 2011 to 2017. This reconciles with our findings that the econometric time trends are likely include the effects of catch-up.

All of these information sources support our productivity growth factor as being productivity growth that may be reasonably achievable by electricity distributors on the efficiency frontier.

We have also examined firm specific opex productivity results from increased undergrounding. While we consider undergrounding supports the case for positive productivity, we do not consider the results can be applied as a sector-wide indicator at this point in time to avoid potentially double-counting productivity growth.

Finally, as a cross-check for the reasonableness of our opex productivity growth factor, we have considered the regulatory precedents made in the water industry and overseas electricity distribution sectors, as suggested by some stakeholders. The firms in these sectors provide utility services similar to Australian electricity distributors and are subject to highly regulated environments. They provide some indication of what reasonable productivity growth is expected of regulated utilities service providers. We have also considered the Productivity Commission's long-term multifactor productivity growth rates estimated in the Australian electricity supply industry over the period 1975–2010. These information sources are broadly consistent with a productivity growth factor of 0.5 per cent per annum, taking into account the differences between each forecasting approach and ours.

Implementing our new productivity growth forecast

We intend to set an opex productivity growth factor of 0.5 per cent per year in our next regulatory determinations for each electricity distributor. We do not expect that we will need to update this productivity factor prior to 2021 unless we identify significant change in the underlying economic drivers of opex that may affect electricity distributors' abilities to generate productivity gains. This should provide some predictability for electricity distributors in preparing their regulatory proposals.

In relation to the revenue proposals currently under consideration, we will publish final decisions on these revenue proposals in April 2019. Prior to this we will provide distributors with an opportunity to submit their views on whether a different productivity growth factor should be applied in their individual circumstances. However, it is important to note that the productivity growth factor is meant to capture the productivity growth of a distributor on the efficiency frontier and not specific to individual distributors. We recognise that some distributors have proposed a higher percentage for productivity growth. We do not consider that this is inconsistent with this decision but rather that it likely captures what the individual distributor considers it can reasonably achieve. The key factor is whether a distributor's total opex forecast meets the criteria set out in the NER.

Our review and consultation process

This final decision has been informed by public consultation on the draft decision we published on 9 November 2018. In that draft decision, we forecast an opex productivity growth factor of 1.0 per cent per annum.

Since the publication of our draft decision paper, we:

- held an industry-wide workshop
- have had bilateral meetings with stakeholders in the consultation period to facilitate more in-depth discussion of the issues that concerned stakeholders
- received 17 written submissions from stakeholders, with supporting consultant reports

- published an updated annual benchmarking report on 30 November 2018, which contains updated productivity and benchmarking analysis (our 2018 annual benchmarking report).[1]

Stakeholders expressed concern about our review process, in particular proceeding directly to a draft decision without consulting on the issues at hand. Those same stakeholders were concerned with the six-week consultation period which they submitted was too short to engage meaningfully with us. Some stakeholders pointed to other, arguably more complex, reviews that we have undertaken.

The issue of reviewing our productivity growth factor was first raised in the context of setting the opex forecast for the NSW, Tasmania and Australian Capital Territory (ACT) electricity distributors (the 2019-24 distribution determinations). As noted, the CCP argued for us to revise the zero productivity growth factor given the evidence of recent positive productivity trends. This coincided with our own view that the productivity growth factor needed to be reviewed.

The risk of not revising our productivity growth factor in the 2019-24 distribution determinations meant that a zero productivity growth factor would remain in place until 2025. This would have been inconsistent with the evidence available to us.

Given the sector wide implications of setting the productivity growth factor, we determined it was most appropriate to consider this issue outside *but in parallel to* the 2019–24 distribution determinations. This would enable all industry stakeholders to make submissions and inform the opex productivity growth factor for the 2019–24 distribution determinations as well as future determinations.

Stakeholders and consultants have made substantial submissions to us following the draft report and we have taken these submissions into account in reaching our final decision. This is demonstrated in Appendix A, as a well as throughout this final decision.

We considered the six-week consultation process, comprised of written and oral submissions, has afforded stakeholders with adequate opportunity to provide us with their views of this matter. Furthermore, it is not inconsistent with the timing provided for under the NER.[2] The forecasting approach does not present a departure from the Expenditure forecast assessment guideline but rather proposed to update our forecast using the best available evidence.

We have also committed to provide the stakeholders of the 2019-24 distribution determinations another opportunity to make submissions following the conclusion of this review. For other stakeholders, they will have further opportunities to engage with us on this issue in future distribution determination processes.

Many stakeholders have made constructive submissions to us in the six-week consultation process. For example, CEPA (supporting Ausgrid, Evoenergy and Jemena's submissions)

1 AER, *2018 Distribution network service provider benchmarking report*, 30 November 2018.
2 NER, clause 6.16.

proposed an alternative labour productivity forecasting approach.[3] We have benefited from the inputs and analysis provided by stakeholders and we have carefully considered stakeholders' feedback in arriving at our final decision. We consider this review process has been constructive and we appreciate the commitments stakeholders have made to engage meaningfully in this review given other competing priorities.

In arriving at our final decision to apply a 0.5 per cent per annum productivity growth factor, we acknowledge that we have taken a "middle of the range" approach and departed from the 1 per cent provided for in our draft decision. Following the draft decision, we have received a number of submissions that argued that we should take either a conservative or a less conservative approach to our final decision. We have carefully considered all the evidence available to us and the strengths and weaknesses of each. Having done so, we consider that an estimate of 0.5 per cent per annum is the best available estimate of the productivity growth factor, while providing scope for individual distributors to propose some "catch up" to efficient operations within their revenue proposals.

3 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, pp. 24-32.

1 The opex productivity growth forecast review

Our role is to find the best estimate of efficient opex forecast when reviewing an electricity distributor's proposed opex forecast. This includes forecasting an opex productivity growth factor. While we have been forecasting an opex productivity growth factor of zero per cent per year, the evidence available to us suggest a positive productivity trend may be emerging. Given we had also received submissions from stakeholders to the NSW 2019–24 distribution determinations that were proposing a positive productivity growth factor, we considered it an appropriate time to initiate an industry wide review allowing all stakeholders to participate.

1.1 Our draft decision

On 9 November 2018, we published our draft decision paper for the opex productivity forecast growth review. In that paper, we presented a range of productivity growth forecasts of 0.0 –1.6 per cent by considering six options:

- the status quo (zero productivity growth)
- using the productivity growth from the increased proportion of undergrounding as estimated by our electricity distribution econometric studies (0.5 per cent productivity growth)
- using the productivity growth from the increased proportion of undergrounding as estimated by our electricity distribution econometric studies, plus the time trend estimated in gas distribution econometric studies (1.0 per cent productivity growth)
- using industry average opex MPFP growth over the period 2012-16, adjusted to remove catch up (1.6 per cent productivity growth)
- labour productivity growth forecasts (0.9 per cent productivity growth)
- a holistic approach that draws on all sources of information to forecast productivity growth (1.0 per cent productivity growth).

We proposed an annual opex productivity growth factor of 1 per cent using the holistic approach. This is because it was broadly consistent with the two estimates that we considered more weight could be given to, namely the labour productivity forecast by Deloitte Access Economics, and the time trend estimated in gas distribution econometric models coupled with the opex impact based on the industry average network undergrounding growth rate. We considered these estimates to be less biased as they were unlikely to include the impact of significant regulatory changes or 'catch-up' effects and incorporated most possible sources of productivity.

In our draft decision paper, we noted that we intended to incorporate the opex productivity growth factor set in this review into our final decisions for the 2019-24 distribution determinations.

1.2 Stakeholders' submissions

Since the publication of our draft decision paper, we held an industry-wide workshop on 30 November 2018. We provided six weeks for stakeholders to respond to our draft decision

paper and we received 17 written submissions from stakeholders, with supporting consultant reports.

The key issues raised in stakeholders' submissions and our corresponding responses are summarised in Appendix A or otherwise addressed throughout this decision.

Table 1 presents the productivity growth forecasts suggested by stakeholders and the reasons why.

Table 1 Stakeholders' proposed productivity growth forecasts

Stakeholders	Proposed productivity growth (per cent p.a.)	Basis for forecast/ Reasons
AusNet Services	0.00	No expectation of positive growth
Ausgrid/CEPA/Evoenergy	0.00-0.70	The higher end of the range based on CEPA's productivity analysis
Citipower/ Powercor/ United Energy/ NERA/ HoustonKemp	0.00	Reliance on long term electricity econometric modelling (negative productivity growth observed)
Consumer Challenge Panel (CCP)	1.90	CCP's sensitivity testing of opex MPFP analysis (post 2012) provides a range of 1.50-3.00 per cent
Jemena Electricity Networks	0.25	Not convinced a move from 0.00% is warranted but suggests a forecast of not more than 0.25 per cent
BIS Oxford Economics	0.50	Based on its own forecast labour productivity growth for the utilities sector
SA Power Networks	0.00	The case for a productivity adjustment is not established
Ergon Energy and Energex	1.00	Largely supports 1.00 per cent but notes its concerns with the AER's approach
Energy Networks Australia	N/A	Supports the AER doing further work to explore data issues
Spark Infrastructure	0.00	Recommends the AER not change the status quo without identifying a material net benefit to do so
Endeavour Energy	-0.70	Relying on opex partial factor productivity analysis for 2006-17 based on top quartile electricity distributors
Energy Users Association of Australia	1.50-2.00	Supports PIAC's and CCP's submissions

Stakeholders	Proposed productivity growth (per cent p.a.)	Basis for forecast/ Reasons
Major Energy Users Inc.	1.00-2.00	Relying on Australia all industries productivity growth
Public Interest Advocacy Centre	1.50	Lower bound of the CCP's estimate
Power and Water Corporation	0.00 (implicit)	Supports ENA's submission. Also notes the opex savings it has proposed already

1.3 Our review process

Stakeholders have expressed concerns about our review process, stating that:[4]

- it deviates from the AER's standard consultation process as the AER went straight to a draft decision without conducting its usual steps of consultation, raising concerns about procedural fairness
- it has been shorter than the process for other reviews, with less scope for participation
- the timing coincided with the AER's regulatory tax approach review consultation process and for some distributors, the period in which they must prepare their revised proposals
- the AER had given pre-eminence to the Consumer Challenge Panel's (CCP) views in coming to its draft decision while distribution businesses were not consulted
- the draft decision for this review was released before the AER's 2018 Distribution network service provider benchmarking report and the AER did not provide guidance on how the updated data will be used in its final decision.

We initiated this review to assist us in determining the opex productivity growth factor in the context of setting the opex forecast for the New South Wales, Tasmania and Australian Capital Territory and Northern Territory electricity distributors (the 2019-24 distribution determinations). There were several information sources suggesting that it may be appropriate to use a different opex productivity growth factor from our previous determinations. We had also received submissions from some stakeholders, including the CCP, proposing a positive productivity factor in our opex forecast.

4 Evoenergy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.2; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.3; Spark Infrastructure, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.1; CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 14-15; Jemena Electricity Network, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.1; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.3; Citipower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.4.

The risk of not revising our productivity growth factor in the 2019–24 distribution determinations meant that a zero productivity growth factor would remain in place until 2025. This would have been inconsistent with the evidence available to us.

Given the sector wide implications of setting the productivity growth factor, we determined it was most appropriate to consider this issue outside *but in parallel to* the 2019–24 distribution determinations. This would enable all industry stakeholders to make submissions and inform the opex productivity growth factor for the 2019–24 distribution determinations as well as future determinations.

We considered the six-week consultation process, comprised of written and oral submissions, has afforded stakeholders with adequate opportunity to provide us with their views of this matter. Furthermore, it is not inconsistent with the timing provided for under the NER.[5] The forecasting approach does not present a departure from the Expenditure forecast assessment guideline but rather proposed to update our forecast using the best available evidence.

We have also committed to provide the stakeholders of the 2019-24 distribution determinations another opportunity to make submissions following the conclusion of this review. For other stakeholders, they will have further opportunities to engage with us on this issue in future distribution determination processes.

Many stakeholders have made constructive submissions to us in the six-week consultation process. For example, CEPA (supporting Ausgrid, Evoenergy and Jemena's submissions) proposed an alternative labour productivity forecasting approach.[6] We have benefited from the inputs and analysis provided by stakeholders and we have carefully considered stakeholders' feedback in arriving at our final decision. We consider this review process has been constructive and we appreciate the commitments stakeholders have made to engage meaningfully in this review given other competing priorities. It is our usual approach to take into account the most updated and recent information, such as our annual benchmarking reports, when making a decision.[7] To the extent our 2018 annual benchmarking report is relevant to the estimation of productivity growth, we have taken into account this new information along with any other new information we have obtained from submissions.

5 NER, clause 6.16.

6 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, pp. 24-32.

7 One of the opex factors that we must take into account when evaluating an opex forecast is the most recent annual benchmarking report that we published.

2 How we use forecast opex productivity growth

The NER sets out a propose-respond approach whereby we assess the business' forecast opex to determine whether it reflects the given opex criteria.[8] If we are so satisfied, we accept it. However if we are not satisfied that the business' forecast reasonably reflects the criteria, we substitute the forecast for one that does.[9] The *Expenditure forecast assessment guideline* (the Guideline) sets out how this works in practice.[10]

The alternative estimate as described in the Guideline serves two purposes. First, it provides a basis for assessing whether a business' proposal is reasonable. Second, we can use it as a substitute forecast if a business's proposal does not reasonably reflect the opex criteria.

As set out in the Guideline, we use a base-step-trend approach to derive our alternative estimate. We call the trend component of this forecast the rate of change. To forecast the rate of change we forecast the growth in outputs, productivity and the price of inputs.[11]

Productivity measures how much output can be produced using a given quantity of inputs. If a firm can produce more output using the same quantity of inputs then it has increased its productivity. By accounting for forecast price, output and productivity growth, we forecast the rate of change in opex required to deliver the forecast increase in outputs. It is important when forecasting the rate of change that the productivity growth factor best reflects the same definitions of outputs and inputs used when forecasting output and price growth respectively. If the rate of change forecast is derived from a productivity growth measure that reflects different outputs and inputs, this inconsistency should be taken into account. It is also important to note that, if we consider a distributor to be materially inefficient, we apply an efficiency adjustment to its base opex. Consequently, the productivity growth factor is only meant to capture the productivity growth that can be achieved by a prudent and efficient operator. We discuss this more in the next section.

The Guideline does not specify how we will forecast a productivity growth factor. It simply states that in doing so we will likely consider (but may not be limited to):[12]

- forecast output growth
- forecast changes in the distributor's specific business conditions
- forecast technological change
- how close the distributor under consideration is to the efficiency frontier in our benchmarking analysis
- historical productivity performance

8 NER, cl. 6.5.6(c).
9 NER, cll. 6.5.6(d) and 6.12.1(4)(ii).
10 AER, Better Regulation, Expenditure Forecast Assessment Guideline for Electricity Distribution, November 2013; AER, Better Regulation, Explanatory Statement, Expenditure Forecast Assessment Guideline, November 2013.
11 AER, *Expenditure forecast assessment guideline for electricity distribution*, November 2013, pp. 23–24.
12 AER, *Expenditure forecast assessment guideline for electricity distribution*, November 2013, pp. 23–24.

- any difference between industry average productivity change and the rate of productivity change at the efficiency frontier.

At the time we published the Guideline we did not have sufficient data to inform a reasonable estimate of productivity growth. As such we did not specify a value for forecast productivity growth in the Guideline. However, we now have significantly more data that we have collected for our benchmarking work. Given this we think it is now appropriate to provide further guidance on the opex productivity growth an efficient and prudent distributor can achieve.

2.1 Why we include forecast productivity growth

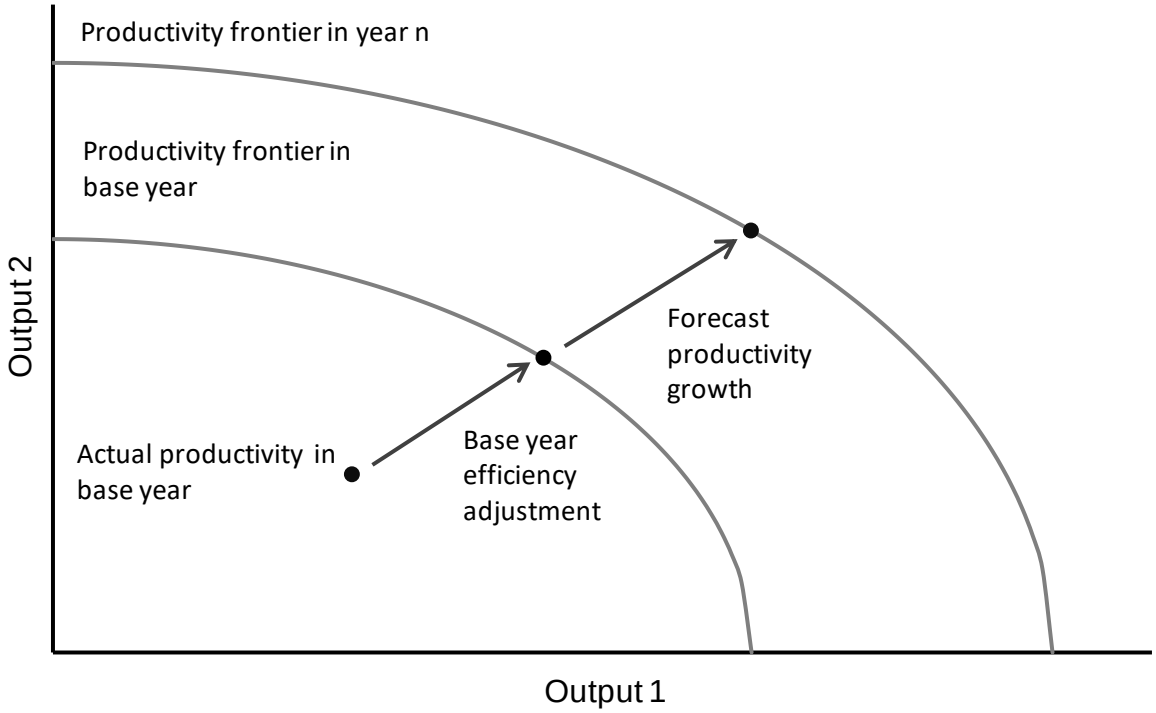
When we apply the base-step-trend approach, it is important to remember that forecast opex must reflect the efficient costs of a prudent firm.[13] To do this it must reflect the productivity improvements a prudent and efficient distributor can reasonably be expected to achieve.[14] The productivity growth factor is not intended to account for any inefficiencies in a distributor's revealed costs. If we consider that a distributor is materially inefficient, we make an efficiency adjustment to its revealed opex (also referred to as base opex).[15] This can be demonstrated by considering where a distributor sits relative to the efficiency frontier, and how we consider the frontier will shift over time.

The efficiency frontier represents the maximum quantity of outputs a firm can produce for a constant quantity of inputs. So firms on the frontier are the most efficient. If a firm is under the efficiency frontier then it is not producing the maximum possible quantity of outputs for the quantity of inputs it is using. These firms are inefficient compared to those on the frontier.

If productivity improves over time, and more outputs can be produced from the same quantity of input, then the frontier shifts out. So, in terms of the productivity frontier, productivity growth can be decomposed into 'catch up' and 'frontier shift'. In our assessment framework, our base opex efficiency adjustment is intended to account for any necessary catch up. It sets opex equal to the level required by an efficient and prudent firm on the efficiency frontier in the base year. The productivity growth factor is intended to account for our best estimate of the shift in the efficiency frontier over time. We have demonstrated this in Figure 1.

13 NER clauses 6.5.6(c)(1) and 6.5.6(c)(2).
14 AER, *Expenditure forecast assessment guideline*, Explanatory statement, November 2013, pp. 65–66.
15 AER, *Expenditure forecast assessment guideline*, Explanatory statement, November 2013, p. 66.

Figure 1 Forecast productivity growth is the forecast shift in the efficiency frontier



Source: AER

SA Power Networks stated that we did not articulate the problem we were trying to 'solve via pre-emptive productivity adjustments'.[16] It further claimed that we did not substantiate the view that, 'without pre-emptive productivity adjustments, the regulatory framework provides insufficient competitive pressure on distributors'.[17] However, the purpose of our productivity growth forecast is not to incentivise productivity gains that would not otherwise occur. As we stated in our draft decision, the purpose of forecasting productivity growth is simply to ensure our opex forecasts reflect the efficient costs of a prudent firm going forward. To do this, the forecast opex must reflect the productivity improvements a prudent and efficient distributor can reasonably be expected to achieve.[18]

It is important to distinguish between the role of the opex productivity growth factor and the incentive regime, and particularly the EBSS. The EBSS is not intended to capture all productivity gains. Efficiency gains and losses, which are shared by the EBSS, are to be measured relative to forecast opex.[19] In turn, the opex forecasts must reflect the efficient

16 SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 3.
17 SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 3.
18 AER, *Forecasting productivity growth for electricity distributors*, Draft decision, 9 November 2018, p. 8.
19 NER cl. 6.5.8(a).

costs of a prudent firm.[20] So, as noted by PIAC, the EBSS is intended to provide a fair sharing of the opex savings the distributor has made *relative to the opex forecast*.[21]

In this way, network users will receive 100 per cent of the productivity gains a distributor makes *if they are included in our forecast productivity growth*. However, if the distributor is able to underspend forecast opex by making further productivity gains, then the EBSS will allow the distributor to keep 30 per cent of those additional savings.

Once an opex forecast is determined, the distributor's incentive should be to minimise its opex, regardless of the opex forecast. The distributor will be rewarded for 30 per cent of its outperformance and penalised for 30 per cent for underperformance, relative to the opex forecast. Regardless of the level of opex forecast set, the distributor will always be better off it is able to reduce its opex, all else equal.

Therefore, the productivity growth factor does not modify the sharing of the gains and losses relative to the opex forecast. Forecasting a higher productivity growth has the same effect as forecasting lower output growth or lower step changes, for example. It does not affect the sharing ratio under the EBSS and the incentives the distributor faces to outperform the total opex forecast.

SA Power Networks stated that network users would receive 100 per cent of the forecast productivity growth, plus 70 per cent of the extra productivity growth the distributor achieves. It stated that the network users would receive 170 per cent of the benefits of the productivity gain and this would not be in line with the incentive framework.[22] In saying this, SA Power Networks suggested that distributors would be worse off for making productivity gains beyond those forecast, since network users would benefit more than the productivity gain.

SA Power Networks is correct that network users receive 100 per cent of the forecast productivity growth, plus 70 per cent percent of the extra productivity growth the distributor achieves. But this does not mean it receives 170 per cent of the productivity gain achieved. Assuming a distributor achieves productivity growth of 1.5 per cent compared to a *forecast* of 0.5 per cent. The network users will indeed keep a 100 per cent of the forecast productivity growth, which is 0.5 per cent, but will share the remaining one per cent opex savings with the distributor under the EBSS. The network users do not receive benefits more than the *total* productivity growth (1.5 per cent) the distributor has made.

Endeavour Energy stated that forecasting productivity growth would create a high powered incentive because the distributor would 'bear the full cost of failure'.[23] However, to the extent that a distributor is not able to achieve the forecast productivity growth, all else equal and with an EBSS in place, this overspend would be shared between the distributor (30 per cent) and network users (70 per cent), consistent with all other efficiency gains and losses.

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20 NER cl. 6.5.6(c).

21 PIAC, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 19 December 2018, p. 2.

22 SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 4.

23 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.

Altering the productivity growth factor should not change how the EBSS shares unforeseen efficiency gains and losses.

However, if we were to use the revealed productivity growth of an individual distributor to forecast that same distributor's productivity growth in subsequent regulatory periods, this would change the share of efficiency gains and losses that the distributor would retain. Using the revealed productivity gains of an individual distributor would reduce its forecast opex for the regulatory period. This would reduce the distributor's incentive to improve productivity. This issue was raised by CitiPower, Powercor and United Energy[24] and Endeavour Energy.[25] It is for this reason that we do not intend to use the revealed productivity gains of a distributor to forecast productivity growth for that distributor. We discussed the incentive effects of using a distributor's revealed price growth to forecast its price growth in our most recent decision for AusNet Services.[26] The same reasons apply to forecasting productivity growth.

Both Endeavour Energy[27] and the Electrical Trades Union[28] raised concerns that an inappropriate productivity growth forecast could negatively impact safety or service levels. The purpose of this review is to identify the level of productivity growth that can be achieved by a prudent and efficient distributor, while maintaining the reliability and safety of its networks. Based on the available evidence, we do not consider our productivity growth factor of 0.5 per cent per year is inappropriate or would lead to an opex forecast that is insufficient for a prudent and efficient distributor to maintain a reliable and safe network.

We set a revenue allowance that incorporates an efficient forecast of opex. Once the revenue allowance is set, the distributor has discretion to reallocate costs to deliver safe and reliable services. We would not expect an efficient and prudent distributor to put returns ahead of safe and reliable services. In many cases we have observed that distributors have outperformed the revenue allowance while being able to deliver safe and reliable services.

2.2 Why we have previously forecast zero productivity

In the electricity distribution determination we have completed since we released the Guideline, we have set a productivity growth factor of zero per cent. These determinations we influenced by the negative productivity growth we had estimated between 2006 and 2012 (as measured by opex partial factor productivity growth and the time trend in our econometric models). However, for most distributors, the decline levelled off or reversed between 2012 and 2014.[29]

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24 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.

25 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.

26 AER, *Final decision AusNet Services distribution determination 2016 to 2020, Attachment 7 – Operating expenditure,* May 2016, p. 7-58.

27 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.

28 ETU, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, December 2018, p. 2.

29 See for example, AER, *Draft Decision TasNetworks distribution determination 2017-18 to 2018-19, Attachment 7 – Operating expenditure*, September 2016, p. 7-16.

We considered that the negative trend we had witnessed was largely attributable to an increase in costs required to meet significant new regulatory obligations, which we did not expect to continue for the forecast period.[30] We did not consider that a prudent and efficient distributor would reduce its productivity unless it was required to meet new uncontrollable obligations. Further, given our opex assessment framework allows for step changes for new regulatory obligations, we considered it would be inappropriate to set a negative productivity growth factor. Therefore, we have set zero productivity growth given the lack of information on the underlying productivity growth distributors could achieve in the absence of new regulatory obligations.

In setting a zero productivity growth factor we considered:[31]

- the historical data for the electricity transmission and gas distribution industries
- the historical change in productivity from Economic Insights' economic benchmarking analysis for the electricity distribution industry
- the businesses' proposals
- our expectations of the distribution industry in the short to medium term.

Our decision to apply zero opex productivity growth was consistent with Economic Insights' recommendation at the time. Economic Insights noted there was a reasonable prospect of opex productivity growth moving from negative towards zero productivity as energy use and maximum demand stabilised, and the impact of abnormal one-off step changes receded.[32] Economic Insights also expressed concerns with the incentive effects of including negative opex partial productivity growth rates in the rate of change formula.[33]

2.3 Why we are reviewing our approach now

We have continued to monitor opex productivity performance and evidence now suggests that distributors across the industry have continued to improve their opex productivity performance since around 2012. This can be seen in the upward trend in industry's opex partial factor productivity since 2012 (Figure 2).

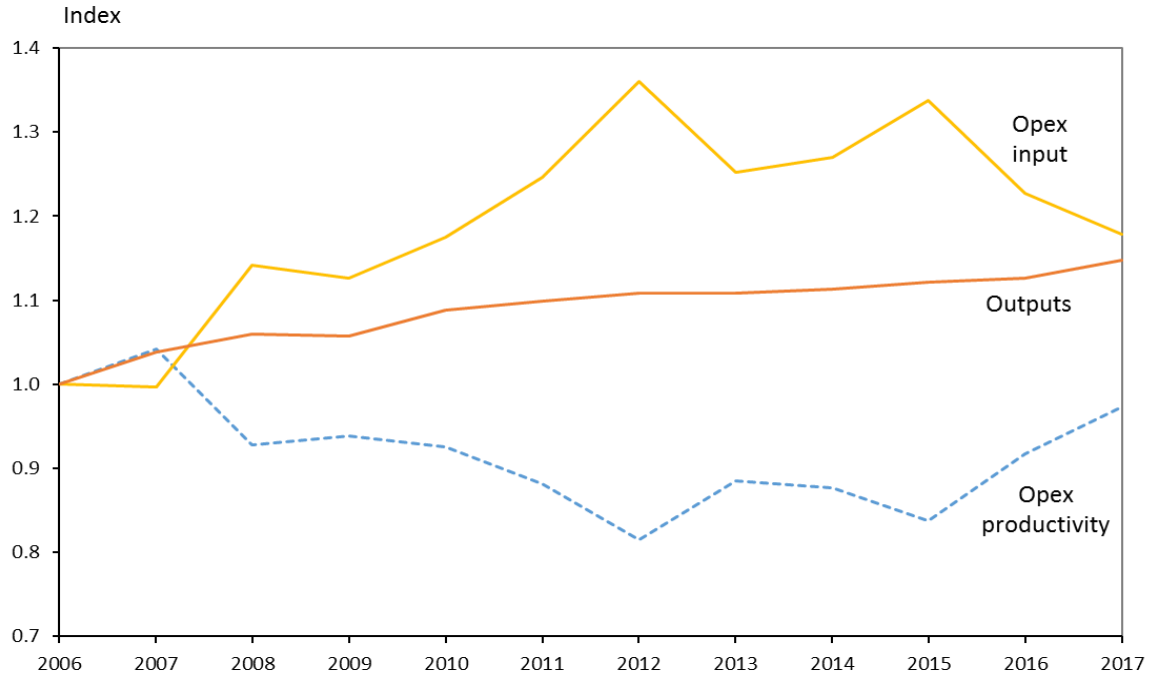
30 See for example, AER, *Draft Decision TasNetworks distribution determination 2017-18 to 2018-19, Attachment 7 – Operating expenditure*, September 2016, p. 7-16.

31 AER, *Final Decision Jemena distribution determination 2016 to 2020, Attachment 7 – Operating expenditure*, May 2016, p. 7–60.

32 Economic Insights, *Response to Consultants' Reports on Economic Benchmarking of Electricity DNSPs, Report prepared for Australian Energy Regulator*, 22 April 2015, p. 71.

33 Economic Insights, *Response to Consultants' Reports on Economic Benchmarking of Electricity DNSPs, Report prepared for Australian Energy Regulator*, 22 April 2015, p. 71.

Figure 2 Electricity distribution opex productivity indices, 2006 to 2017



Source: Economic Insights

We also acknowledge that, in the context of the current NSW, ACT, Tasmania and Northern Territory resets, the CCP submitted that it is reasonable to expect continuous improvement in productivity. It argued that most businesses operating in competitive markets have strong incentives to make continuous productivity gains. It also contended that meeting the national energy objective (NEO) means that network businesses need to be looking for productivity improvements each year.[34] We agree with the CCP that it is reasonable to expect an efficient and prudent distributor to be continually looking for, and making, productivity gains. It is important to note that we are not proposing a change in how we incorporate productivity growth in our opex forecasting approach. We have not changed our view that the forecast productivity growth we include in our alternative opex estimate should reflect our best estimate of the shift in the efficiency frontier.[35] We have been forecasting zero productivity growth because we considered that to be the best estimate of productivity growth, not because we thought productivity growth should not be included from our alternative opex estimate.

34 CCP, *CCP10 Response to Evoenergy regulatory proposal 2019–24 and AER issues paper*, May 2018, p. 12.
35 AER, *Explanatory statement - expenditure forecast assessment guideline*, November 2013, pp. 65–66.

3 How we consider the information sources to estimate an opex productivity growth factor

In our draft decision, we examined various information sources and devised six options to forecasting productivity growth. We opted for a holistic approach which took into account all information sources. All the information sources provided some indication of what a reasonable forecast of the productivity growth in the electricity distribution sector may be. Nonetheless, noting the advantages and disadvantages of each information source, we did not rely on a single measure of productivity growth. We considered the middle of the range of available estimates reflected a reasonable opex productivity growth forecast.[36]

As a part of the draft decision, we also asked if all information sources should be given equal weight or if different weights should be applied and if so why. Submissions expressed different views about this:

- The CCP considered that the opex partial factor productivity information source from 2012 should be given the greatest weight as it is the best, most relevant and simplest proxy for the underlying measure of trend productivity.[37] Further, the CCP considered that labour productivity forecasts, extended to all costs, should be given greater weight than the other options and that the undergrounding effect and gas distribution time trend should be considered as floors for the estimate of trend productivity improvement.[38]
- The PIAC agreed with the CCP in relation to the weight given to opex partial factor productivity analysis results.[39]
- AusNet Services considered that we should use our electricity distribution econometric models to determine the productivity adjustment and not give other information sources substantive weight, with the gas distribution productivity trends not given any weight.[40]
- Evoenergy considered that the productivity growth estimated from undergrounding growth rate should be given no weight as it would create perverse incentives.[41]

In its report for CitiPower and associated distributors, NERA considered that our draft decision did not transparently set out the criteria we used to determine our preferred forecasting approach and as a result, this led to an inconsistent application of the criteria being used to assess each of the options.[42] It proposed criteria to be used for setting opex productivity growth[43], which were supported by several of the distribution businesses.[44]

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36 AER, *Draft decision - Forecasting productivity growth for electricity distributors*, 9 November 2018, p. 25.
37 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p 3.
38 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p 3.
39 PIAC, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 19 December 2018, p. 2.
40 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 8.
41 Evoenergy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.
42 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 9–18.
43 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower,*

Specifically, it considered that in order to ensure that regulated companies have reasonable prospects of recovering their expected efficient costs, the productivity assumption must comply with the criteria:

- The approach captures trends in productivity for the distribution businesses
- The approach separates frontier movement from catch up
- The approach is objective and stable over time
- The approach does not limit incentives to reduce costs.

For this final decision, to provide more transparency about the weight we are putting on the different information sources informing the opex productivity growth forecast, we have considered whether each information source:

- Reflects a reasonable estimate of the underlying productivity growth achievable by an electricity distribution business, independent from cyclical events and one-off factors (such as step changes) and taking into account any issues with the estimation approach
- Estimates the shift in the efficiency frontier, and the extent to which it excludes catch-up effects
- Does not create any perverse incentives for distribution businesses to not pursue productivity gains if relied upon deterministically
- Reflects the most recent available data
- Is based on a transparent methodology.

We consider these factors are consistent with our position explained in the Guideline, and the associated explanatory statement, published in November 2013 about how we would ideally forecast productivity growth in the rate of change component of our total opex forecasts.[45] In the explanatory statement we noted that: [46]

> We will incorporate forecast productivity change in the annual 'rate of change' we apply to base opex when assessing opex. The forecast productivity change will be the best estimate of the shift in the productivity frontier.
>
> Forecast opex must reflect the efficient costs of a prudent firm. To do this it must reflect the productivity improvements it is reasonable to expect a prudent NSP can achieve. This is consistent with the productivity improvements an efficient firm operating in a competitive market would be able to retain.

The factors are also largely consistent with those proposed by NERA and supported by many of the distribution businesses. NERA proposed that the approach should be objective and stable over time. The factors we have used relating to whether the most recent information has been used, in addition to historical information, and whether the

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Powercor, SA Power Networks and United Energy, 20 December 2018, pp. 12–18.

44 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 12; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p 5.

45 AER, *Expenditure forecast assessment guideline for electricity distribution*, November 2013, pp. 23–24; AER, *Explanatory statement - expenditure forecast assessment guideline*, November 2013, pp. 65-70.

46 AER, *Explanatory statement - expenditure forecast assessment guideline*, November 2013, p. 65.

methodology is transparent and reproducible by interested parties will help ensure the approach is objective. We also consider that the criteria around stability (of the method) is more relevant to how we implement the opex productivity growth forecast and whether it is updated for each reset or put in place for a longer timeframe. In the draft decision we noted that we did not expect to update the forecast prior to 2021 unless there was a significant change in the underlying economic drivers. This is addressed further in section 6.

In section 4 we consider the information sources available to inform our opex productivity growth forecast and examine how they perform against the above factors. We then use this in section 5 to inform our analysis and conclusions in relation to forecast opex productivity growth.

4 What information is available?

In our draft decision, we considered productivity information specific to electricity and gas distribution industries, labour productivity within the broader utilities sector, and productivity due to undergrounding of powerlines. Following submissions to our draft decision, to forecast electricity distribution opex productivity growth in this final decision, we have considered the following information sources:

- electricity distribution opex partial productivity analysis from the our annual economic benchmarking reports, including opex multi-lateral partial factor productivity (opex MPFP), econometric modelling and undergrounding
- electricity industry productivity analysis from the Productivity Commission
- labour productivity growth analysis of the utilities sector and other similar, selected, sectors
- gas distribution opex productivity analysis
- water industry productivity targets
- electricity distribution productivity analysis and forecasts from the United Kingdom, Ontario Canada and New Zealand.

Table 2 summaries the results from these different sources, including our assessment against the factors that we are using to establish the weight we put on the different information sources in informing the opex productivity growth forecast.

We consider each of these information sources below and outline our consideration of this information is more detail.

Table 2 Summary of available productivity estimates

	Electricity distribution	Electricity distribution	Electricity distribution (undergrounding)	Gas distribution	Labour productivity	Electricity supply chain	Water	International electricity
Estimation method	Opex PFP	Econometric time trend	Econometric coefficient	Econometric time trend	Gross Value Added	Multi Factor Productivity	Efficiency target	Total Factor Productivity
Productivity estimates (%)	0.35 - 0.97	1.2 - 2.2	0.1 - 1	0.43 - 0.7	0.3 - 0.7	1.3	0.25-1	0 - 1
Time period measured	2011-17	2011-17	2011-17	1999-2015	1999-2018	1975-2010	Variable	Variable
Factor 1: Underlying productivity growth	Unclear	Unclear	Yes	Yes	Potentially	Potentially	Potentially	No
Factor 2: Excludes catch-up	Yes	No	Yes	Potentially	Potentially	Limited	Unclear	No
Factor 3: Most recent data	Yes	Yes	Yes	No	Yes	No	No	Yes
Factor 4: Preserves incentives	No	Potentially	No	Yes	Yes	Yes	Yes	Yes
Factor 5: Transparent methodology	Yes	Yes	Yes	Yes	Partially	Yes	No	Yes

Source: AER analysis

4.1 Electricity distribution opex productivity

Our annual economic benchmarking reports for distribution measure the productivity of the electricity distribution sector over time, as well as the relative performance of individual distributors. This provides our best measure of opex productivity of electricity distribution in Australia. These productivity results are updated annually in our annual benchmarking reports, and have been developed over several years in consultation with the industry.

We have two main techniques for measuring opex productivity:

- Opex partial factor productivity (PFP). This is an index-based method that measures the productivity growth of a distributor or distributors as a group over time by measuring the relationship between the opex used and outputs delivered (e.g. customer numbers, line length, ratcheted maximum demand, energy delivered, minutes off supply). Where a distributor is able to deliver more outputs for a given level of opex, this reflects an increase in its productivity. This can be expanded to opex multi-lateral partial factor productivity (MPFP) to measure the relative productivity of individual distributors.
- Econometric modelling of opex cost functions. These econometric techniques estimate the relationship between opex and outputs within the electricity distribution sector as a whole. These models include a time trend that estimates the change in productivity over time not attributable to other variables in the cost function. The drivers of this time trend include changes in technology (including the use of labour), changes in process, or changes in legislative or regulatory obligations. The models also include a variable on share of network undergrounding, which is negatively related to opex.

We present the results of these measures in this section, as well as the views from submissions and additional information we have gathered in response to submissions. The results of the econometric variable on the share of undergrounding is discussed separately in section 4.2.

The results presented in this section focus on the changes in measured productivity over time for the industry as a whole, as well as individual or groups of distributors. These rely upon aspects of our productivity and benchmarking models that are best suited to measuring changes in productivity over time (such as partial factor productivity indices and technical time trends). The models can also be used for benchmarking purposes, which rely on other elements of the models to measure the relative efficiency of individual distributors (such as opex MPFP and the efficiency scores produced from our econometric models).

4.1.1 Opex partial factor productivity performance

In our draft decision, we examined opex productivity growth from those distributors that we have not found to be materially inefficient in our most recent determinations.[47] This included all distributors excluding Ausgrid, Essential Energy, Evoenergy and Energex. We concluded:

47 AER, *Forecasting productivity growth for electricity distributors*, Draft decision, 9 November 2018, p. 13-15.

> We think the average growth rate of 1.6 per cent for those distributors whose base opex we did not find materially inefficient is more reflective of the shift in the productivity frontier over the period 2012–16 than the average rate over the whole industry.

Our draft decision focused on productivity achieved by these distributors over 2012-16 because it better reflected 'business as usual' conditions. We observed:[48]

> If we are going to use historic productivity growth to forecast we need to be satisfied that past productivity performance is reflective of what can be achieved going forward. However, we have not been satisfied that the past productivity growth that we have estimated, particularly for the period 2006 to 2012, occurred in 'business as usual' conditions. This reflects the significant new regulatory obligations that distributors were required to meet, and which required significantly increased opex, but with no change in measured output.

We then stated:[49]

> We have continued to monitor opex productivity performance and evidence now suggests that distributors across the industry have improved their opex productivity performance since around 2012.

We received submissions from a number of distributors that state:

- the opex productivity growth rates are sensitive to the choice of frontier firms, and our selection of firms likely included some catch-up
- the opex productivity growth rates are sensitive to the choice of starting and end years, and we should examine opex productivity growth over a longer time period than just 2012-16.

As discussed further below, Economic Insights and the CCP agreed that the productivity growth rates are sensitive to the selection of the frontier firms and the time period chosen. In contrast to the submissions from distributors, Economic Insights and the CCP considered that it was appropriate to examine productivity growth from 2012 onwards.

In this final decision, we:

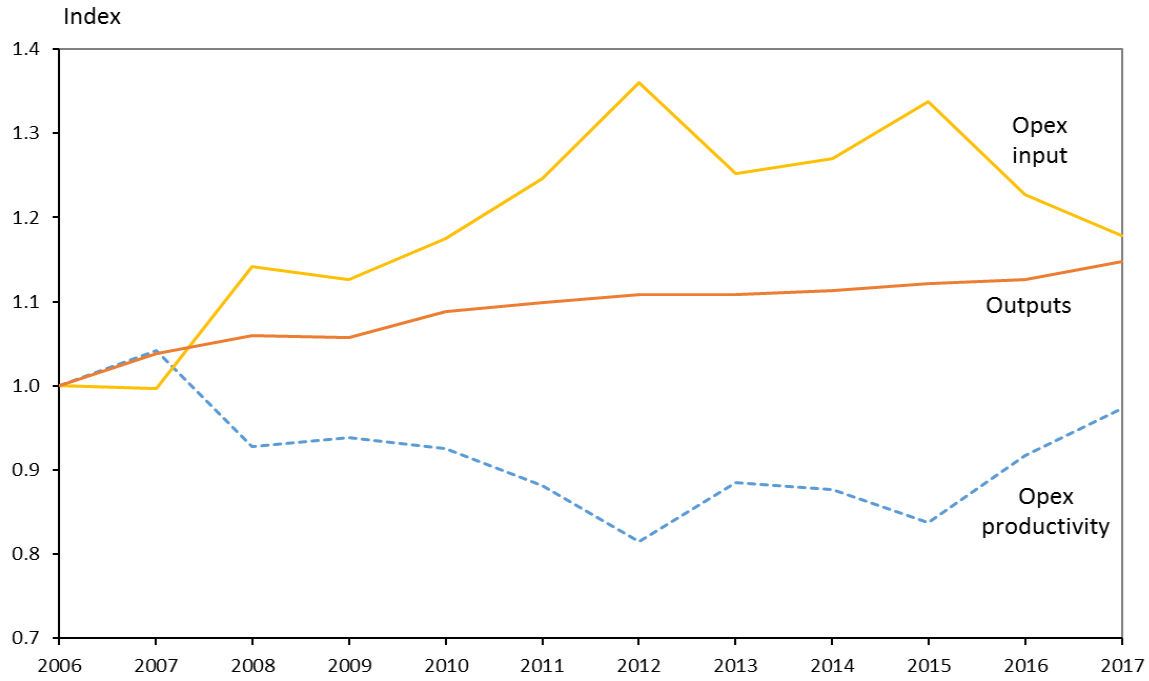
- present updated opex productivity growth rate calculations, including by using a range of time periods and estimation techniques, and adding the 2017 year
- address submissions relating to the relevant time period for estimating opex productivity growth
- address submissions relating to the selection of frontier firms, including examining different groupings of distributors to consider the sensitivity of our estimate of the frontier to the selection of the firms.
- provide an overall conclusion on the appropriate estimate of opex productivity growth that we are relying upon for this final decision.

48 AER, *Forecasting productivity growth for electricity distributors*, Draft decision, 9 November 2018, p. 10.
49 AER, *Forecasting productivity growth for electricity distributors*, Draft decision, 9 November 2018, p. 101

Opex partial factor productivity growth rates

Figure 3 presents opex partial factor productivity for the total electricity distribution industry over the period 2006–17. On average over the 2006–17 period, electricity distribution opex productivity declined by 0.25 per cent per annum. However, the trend in productivity changed significantly over this time period. Between 2007 and 2012, productivity declined because opex increased at a greater rate than outputs. Opex productivity increased in 2013 before falling slightly again to 2015. It then grew significantly from 2015 to 2017 due to opex decreases.

Figure 3 Electricity distribution opex productivity indices, 2006 to 17



Source: AER analysis, Economic Insights

The opex productivity trend of the total electricity distribution industry likely includes a combination of productivity growth from distributors at the efficient industry frontier, as well as productivity growth related to 'catch-up' from less efficient businesses. However, we are most interested in identifying productivity growth from the industry frontier.

In our 2018 annual benchmarking report, we measure and rank productivity results for each distributor over time from 2006 to 2017, as measured by opex MPFP.[50] The higher ranked distributors are more productive than the lower ranked distributors, and more likely are reflective of the efficient industry frontier. We currently measure opex productivity for thirteen distributors.

In our final decision, we consider that an appropriate estimate of the efficiency frontier reflects productivity growth achieved by the top four ranked distributors in 2017 — CitiPower,

50 AER, *2018 Distribution network service provider benchmarking report*, 30 November 2018, p 16.

Powercor, United Energy and SA Power Networks. These distributors have consistently measured as the most productivity in the NEM since 2006.

Table 3 presents a range of productivity growth rates for these distributors as calculated by Economic Insights (and also compared to the total industry).

Table 3 Average annual opex productivity growth, endpoint-to-endpoint method, per cent

Distributors selected	2006–12	2012–16	2006–17	2011–17	2012–17	2013–17
Industry	–3.41	2.96	–0.25	1.65	3.55	2.39
Top 4	**–3.14**	**2.48**	**–0.87**	**0.35**	**1.85**	**2.75**

Source: Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7

As set out in the sections below, we have considered both 2011-17 and 2012-17 as possible time periods that better reflects business-as-usual opex productivity growth within the sector and for those frontier distributors. Table 3 shows that the average annual productivity estimate over 2011-17 is 0.35 per cent and over 2012-17 is 1.85 per cent.

These estimates reflects the compounding average growth as measured from the starting point to ending point of the series.[51] Within this period, productivity remains variable, with much higher average growth rates observed in later years (e.g. 2013 to 2017), and with productivity growth being particularly sensitive to whether 2011 or 2012 is the starting year, and whether 2016 or 2017 is the ending year. This was highlighted by the submissions from NERA and HoustonKemp.

To reduce the risk that either the 2011-2017 or 2012-17 period is atypical or that the start and end points reflect unusual circumstances, Economic Insights also calculated average annual productivity growth using two additional methods: [52]

- an average of the annual growth rates observed across the different periods within 2011-17 with at least five consecutive annual changes (i.e. 2011-16, 2011-17 and 2012-17)
- a regression-based technique across the annual data points within 2011-17.

Table 4 presents the average annual opex productivity growth using these methods. This shows that average annual opex productivity growth of the top four distributors is between 0.92 and 0.97 per cent over 2011 to 2017. Economic Insights concludes that an appropriately conservative interpretation of the opex productivity growth rates is that current frontier growth is around 1 per cent per annum.[53]

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51 Economic Insights addresses the measurement of opex productivity growth using an endpoint-to-endpoint method in its memo, and also addresses issues raised by submissions about this method. See Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7-8

52 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7-9.

53 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7-9.

Table 4 Average annual productivity growth 2011-17, opex MPFP, per cent

Distributors selected	Average of annual growth rates	Regression
Industry	2.00	1.71
Top 4	**0.92**	**0.97**

Source: Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7-9

The remaining sections below address the issues raised by submissions relating to the selection of the industry frontier distributors and the appropriate time period.

The appropriate time period to measure opex productivity of distributors

Our draft decision examined productivity change over the 2006-16, 2006–12 and 2012–16 periods only. We received numerous submissions from distributors on our observations. Key points from distributors were:

- Our choice of the 2012–16 period captures a high productivity growth period that is sensitive to the starting and ending years, and this does not represent a business-as-usual operating environment.[54]
- We did not provide evidence of the why the 2006-12 is not representative of the forecast operating environment, including the significant new regulatory obligations introduced over 2006–12 that we said significantly increased costs and reduced productivity.[55]
- We did not attempt to analyse or remove one-off cost savings that would not be replicable into the future. Submissions point to a need to forensically analyse the costs of individual distributors over 2006–12 and 2012–16 to determine where there are one-off events, catch-up and changes in obligations.[56]
- CitiPower, Powercor and United Energy submitted that its 2012 operating expenditure experienced an unusually high increase due to higher than usual vegetation

54 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 34-37; Evoenergy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 6; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 6-7; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 1

55 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 11; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 6; Energy Networks Australia, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 2; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 2

56 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 12 and 14; NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 13, 54-55; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 6, 8; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 2

management activities and an increase in lines maintenance resulting from a directive from Energy Safe Victoria.[57] As such, it states that any comparison to 2012 would not be a true reflection of its average annual productivity performance.

- Endeavour Energy submitted that there is evidence to suggest that 2012 was an outlier year on account of movements in provisions, a non-efficiency related opex adjustment.[58] This suggests the 2012–16 opex partial factor productivity trend is not wholly reflective of potential productivity gains.
- AusNet Services and Jemena noted that changes in capitalisation approaches by distributors can potentially have an impact on the observed productivity changes from 2012 onwards.[59]

Submissions from AusNet Services, CitiPower, Powercor and United Energy, Endeavour Energy, Evonergy, Energy Queensland and Spark Infrastructure more broadly argued that we should measure productivity over the longest time period possible.[60] NERA and HoustonKemp argued that the productivity of the electricity industry is cyclical, and taking a long perspective reduces the impact of outliers and one-off productivity events. The reports consider that examining a shorter 2012–16 period is too short to account for volatility.[61]

We agree that it is desirable to take a longer time period when estimating an underlying trend. This maximises the amount of information available to estimate an underlying productivity trend, and can help 'wash out' the effect of unusual circumstances. However, if we use historical productivity trends to forecast productivity, we need to be confident that the historical results reflect similar business conditions to the forecast period. This is noted by Economic Insights:[62]

> As a general rule, the more data one has available to undertake productivity analysis, the better. This applies as much to estimating productivity growth trends as it does to estimating efficiency levels. If part of the available time period reflects unusual circumstances then estimating a trend that incorporates that period may produce a distorted estimate of future productivity growth possibilities. This may necessitate use of a shorter time period to base the trend estimate on where this time period is more likely to reflect business as usual conditions.

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57 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 15

58 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 15

59 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 6-7; Jemena, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 2

60 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 12, 14; AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 6; Spark Infrastructure, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 3; Energy Queensland, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 5-6; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 2, 8

61 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, p. 34; HoustonKemp, *Operating expenditure productivity growth*, 19 December 2018, p 13-16

62 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 1

The CCP also agreed that a longer time series is usually preferable to a shorter time series. However, it stated that the quality and relevance of the data is also important for estimating the trend in productivity.[63]

Within the electricity distribution industry, step changes are likely to have significant implications for measured productivity growth over the 2006 to 2017 period. These step changes will affect the productivity results where they led to increased opex but no corresponding change in measured outputs such as customer numbers, circuit length and maximum demand. This is primarily an issue for productivity measurement where business conditions, such as regulatory obligations, change substantially over time.

As noted above, some submissions state that our draft decision did not provide evidence of the significant new regulatory obligations introduced over 2006–12 and that we need to forensically analyse the costs of individual distributors over 2006–12 (as well as 2012-16) to determine where there are one-off events, catch-up and changes in obligations.

In this final decision, we have examined the cost impact of new regulatory obligations on distributors over time by:

- examining forecast opex increases we have previously provided distributors in our distribution revenue determinations as 'step changes'
- examining actual costs incurred by distributors as reported in regulatory information notices (RINs)

We have identified three step increases in costs incurred by distributors that likely contributed to the significant decline in industry and frontier productivity between 2006 and 2012. These are:

- For the 2011–15 regulatory control period, we provided the Victorian distributors $211.7 million ($2010) of forecast opex to meet additional vegetation management and bushfire mitigation requirements imposed by the *Electricity Safety (Electric Line Clearance) Regulations 2010.* This was part of a total $378 million ($2010) opex step changes we approved.[64] Over the 2011–15 regulatory control period, Powercor and AusNet Services were forecast to incur, on average, 11.2 per cent and 13.4 per cent higher opex compared to their 2009 opex levels respectively.
- In August 2005, the NSW Government introduced the Design, Reliability and Performance Licence Condition for NSW distributors relating to reliability performance. The Independent Pricing and Regulatory Tribunal of New South Wales' (IPART) provided the NSW distributors with $185 million ($2005–06) in opex pass-throughs to implement these new licence conditions (in addition to capex) within the 2004–09 regulatory control period.[65] The AER provided further step changes in costs to meet these licence conditions in its determination for the 2009 to 2014 period.

63 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 17.

64 AER, *Final decision – appendices, Victorian electricity distribution network service providers, Distribution determination 2011-2015*, *Appendix L*, October 2010, p. 447.

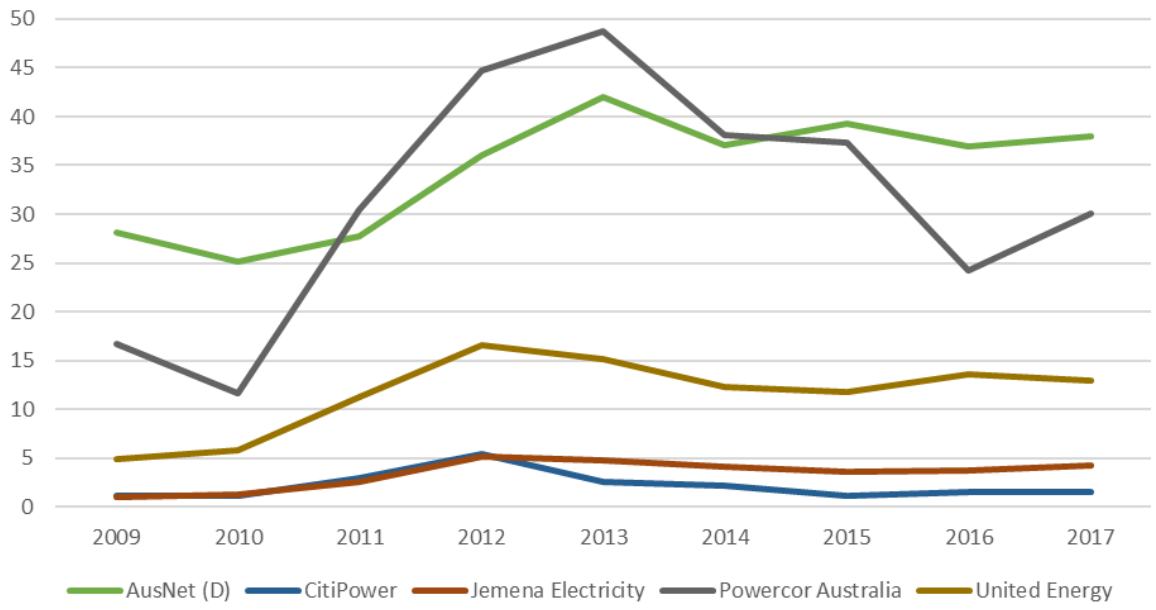
65 IPART, *Final Decision - Statement of reasons for decision – NSW Electricity DNSPs – Applications for a cost pass through*, 6 May 2006.

- The Queensland Competition Authority (QCA) 2005–10 regulatory determination provided Energex with $142.9 million ($2004–05) in opex, and Ergon Energy with $81.9 million ($2004–05) in opex, to implement the findings of the Government's 2004 Electricity Distribution and Service Delivery Review.[66] This review examined reliability problems in Queensland and established network planning standards, Minimum Service Standard (MSS) and Guaranteed Service Level (GSL) payments. The QCA also provided additional funding to attract and retain employees to implement these new standards.

Further analysis of these step changes is set out in Appendix B.

The Victorian vegetation management obligations are particularly relevant because the Victorian distributors are broadly within the industry frontier (in particular, Powercor and CitiPower), as explained in more detail further below. As shown in Figure 4, vegetation management increased significantly for Powercor, AusNet Services and United Energy from 2010 and up until 2012. In some cases there were further smaller increases in 2013 or 2015. These significant increases align with the decline in opex productivity results.

Figure 4 Vegetation management opex by Victorian distributor, 2009–17 ($m, 2018-19)



Source: AER analysis of Category Analysis RINs

In its submission to our draft decision, the CCP stated that there is clear and strong evidence that the opex of the network sector was substantially affected by step changes prior to 2011.[67] It outlined in particular that the timing of the Victorian distributors' vegetation management step changes, and the NSW distributors' increase in costs associated with

66 QCA, *Final Determination Regulation of Electricity Distribution*, April 2005, pp. 151 and 157.
67 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p 19.

complying with their licence conditions, aligns with the decline in opex productivity up until 2012.[68]

Economic Insights also considered that there is 'reasonable prima facie evidence to indicate that the decline in industry opex productivity after 2007 started to reverse around 2012'. It also examined the opex step changes from the Victorian and NSW distributors and stated:[69]

> The presence of extensive opex step changes in the 2006 to 2012 data make inclusion of this period in the calculation of forecast future productivity trends problematic. Data for the period 2012 to 2017 is likely to provide a more accurate basis for forming these forecasts as the impact of step changes appears to have been largely worked through by 2012.

However, Economic Insights also stated that:[70]

> While data from 2012 onwards is likely to provide a more accurate basis for forecasting future opex productivity trends, it has the disadvantage of being of shorter duration than is ideal. This points to the need to use a range of sources of information which are not impacted by the step changes to form the productivity trend forecast.

We agree with Economic Insights and the CCP the productivity growth over 2006 to 2012 is likely materially affected by step changes in costs due to some key changes in regulatory obligations. We maintain our position in the draft decision that opex productivity over this time does not reflect underlying business-as-usual conditions for distributors. Similarly, while the 2006-17 dataset is the longest we have, overall it does not reflect opex likely to be incurred under business-as-usual conditions for distributors for most of that period.

Economic Insights noted that there are a number of ways to address the issue of material step changes affecting the productivity trend:[71]

- Develop and include additional output variables in the opex MPFP or econometric models, such as an output measuring safety or security. This would ideally capture the objectives of the regulatory obligations relating to bushfire management in Victoria (safety) and the reliability standards in NSW (security).
- Exclude the costs associated with the step changes from the opex data, and re-estimate the productivity trend. This would require information from each distributor about the incremental costs of complying with these regulatory obligations.
- Focusing the productivity measurement on the period following the step changes period.

We agree that including an appropriate output variable or excluding the costs of step changes from the opex series would provide a better estimate of the underlying productivity trend. However, these will likely be difficult and time consuming to develop and require relatively significant further engagement with industry and additional data collection, including extensive recasting of data.

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68 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 20-22.

69 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 10

70 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 11.

71 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 15.

This leaves us with forecasting productivity using productivity measured on the period following the step change period. Here we are mindful that the periods of 2012–16 and 2012–17 are relatively short to form a single estimate of productivity growth that may be achievable going forward. This is recognised by Economic Insights. While there are no clear and material changes in regulatory obligations over this period, there may be variations in productivity year to year that will affect the productivity trend over this period of time.

Some examples of annual factors affecting the productivity from 2012 onwards, as raised by submissions, include:

- movements in provisions in 2012
- changes in the capitalisation of costs after 2012
- unusually high increases in vegetation management activities in 2012.

In light of this, we also considered 2011 as an alternative starting point to account for the potential abnormalities in using 2012 the starting year. We have not used 2013 as the starting point because it will further shorten the duration of the data set and make the opex productivity trend less reliable.

We do note that the Victorian distributors' bushfire mitigation and vegetation management expenditure were still increasing in 2011, as shown in Figure 4. This means that 2011-2017 may include some effects of regulatory change. Nonetheless, the use of 2011 as a starting point would at a minimum reduce some of the productivity decline captured in our opex MPFP analysis over the full 2006 to 2017 time series attributable to the Victorian bushfire regulatory obligations.

Both 2011 and 2012 have their relative strengths and weaknesses, and we do not necessarily have a preference for one or the other. As set out previously in Table 4, we present opex productivity growth rates using two additional measures that reduce the impact of the starting and end points on the calculation of the productivity growth trend.

The selection of the efficient frontier

In our draft decision, we estimated the efficient industry frontier as comprising all distributors in the NEM except for Ausgrid, Essential Energy, Evoenergy and Energex. These reflected the distributors that we have not previously found to be materially inefficient in our revenue determinations.

Submissions from AusNet Services, CitiPower/Powercor/United Energy, Evoenergy and Jemema (including associated reports from NERA, HoustonKemp and CEPA) argued that the AER's approach to selecting the frontier networks does not appear to capture only frontier shift.[72] They provide examples of productivity improvements from Endeavour, Ergon

[72] CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 15-16; NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 39-41; AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 5; Evoenergy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 7; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review*

Energy, AusNet Services and TasNetworks since 2012 that appear to relate to catch-up, rather than frontier shift.[73]

Since the draft decision, we have considered a wider range of groupings of distributors to consider the sensitivity of our estimate to the selection of distributors that can be used to proxy the efficiency frontier.[74] In addition to our not materially inefficient distributors, we have considered:

- the top four distributors based on their opex MPFP rankings in 2017, being CitiPower, Powercor, United Energy and SA Power Networks
- the top five distributors based on their opex MPFP ranking in 2017, being CitiPower, Powercor, United Energy, SA Power Networks and Energex
- the top nine distributors (or excluding the bottom four) based on their opex MPFP ranking in 2017, being CitiPower, Powercor, United Energy, SA Power Networks, Energex, AusNet Services, Evoenergy, Endeavour Energy, Essential Energy
- the top five distributors based on their average opex efficiency scores for the period 2006 to 2013 (ie the AER's upper quartile from its 2014 determinations), being CitiPower, Powercor, United Energy, SA Power Networks and AusNet Services

Table 5 shows the various opex productivity growth rates for each group of distributors we considered. This shows that the growth rates are sensitive to the selection of the distributors, with average productivity growth rates varying by 1 per cent or more over the 2011 to 2017 period. It also shows that the growth rates of the top four distributors is broadly lower than other groupings — this is likely due to the fact that it excludes the effect of catch-up.

Table 5 Average annual opex productivity growth, endpoint-to-endpoint method, per cent

Distributors selected	2006–12	2012–16	2006–17	2011–17	2012–17	2013–17
Industry	–3.41	2.96	–0.25	1.65	3.55	2.39
Top 4	**–3.14**	**2.48**	**–0.87**	**0.35**	**1.85**	**2.75**
Top 5	–3.18	2.73	–0.73	0.82	2.21	3.70
Top 9	–4.27	3.33	–0.77	1.37	3.44	4.16
Not Materially Inefficient	–2.28	0.86	–0.33	0.91	2.01	0.88
Top 5 (2014 upper quartile)	–3.36	0.52	–1.19	0.17	1.42	2.73

Source: Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 7

73 *Draft Decision Paper*, 20 December 2018, p. 2
CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 15

74 Economic Insights also calculated productivity using a weighted-average based on the aggregate inputs and aggregate outputs of each of distributors in each of the above groupings. This addresses concerns raised by several submissions that our draft decision relies upon an unweighted average of individual DNSP opex productivity growth rates.

Having reviewed the submissions, we consider that limiting opex productivity analysis to the top four distributors in 2017 will remove the most catch-up effect. As set out in our 2018 annual benchmarking report, CitiPower, Powecor, United Energy and SA Power Networks have all consistently been amongst the top ranked distributors over the 2006–17 period, using opex MPFP.[75] Conversely, the rankings of the other distributors vary over the 2006–17 period and likely include elements of catch-up from 2011 onwards. For example, TasNetworks, Endeavour, Energex and AusNet Services have all engaged in various levels of business restructuring and efficiency programs that are aimed at becoming more efficient.

The downside to relying on the top four distributors is that CitiPower, Powercor and United Energy share common management, and also share common ownership with SA Power Networks. This means that these businesses likely share similar costs and services, such as corporate overheads and contracting, and likely share similar initiatives to improve productivity. As noted in section 2.1, if we were to use the revealed productivity growth of an individual firm to forecast that same distributors' productivity growth, this would reduce its incentive to improve productivity. This likely applies equally to distributors that have common ownership, such as CitiPower, Powercor, United Energy and SA Power Networks.

These incentive issues can be partially overcome by expanding the number of distributors within the selection of the frontier. This can include relying on the top five distributors as measured in 2017 or 2014, which would add either Energex or AusNet Services. However, this has the disadvantage of including more catch-up into the productivity growth estimate, which would likely overstate the shift in the efficient frontier.

In this context, we consider that appropriate caution needs to be taken when relying upon opex productivity growth to forecast opex productivity growth into the future. This includes relying upon other information to inform the opex productivity growth forecast, and selecting an estimate of opex productivity that is on the lower end of the relevant range.

Conclusion

Opex partial factor productivity provides a measure of opex productivity in electricity distribution. It accounts for all opex inputs used by distributors (labour and non-labour) and considers multiple outputs delivered by the electricity distribution sector.

These longer term estimates of electricity distribution productivity are negative from 2006-2017. However, we have concerns that the measured productivity over this period is significantly impacted by the increased regulatory obligations relating to safety and reliability imposed on the sector prior to 2011. This suggests that the negative productivity measured likely understates the productivity achieved by the electricity distribution sector over this period of time when compared on a like-with-like basis.

To minimise the effects of these regulatory changes, we examined electricity distribution productivity over 2011–2017. The opex productivity results suggests productivity in the range of 0.35 and 0.97 per cent. These estimates:

75 AER, *2018 Distribution network service provider benchmarking report*, 30 November 2018, p 16

- reflect a reasonable estimate of the productivity growth achieved by distributors in recent year, with limited effects of material step-changes and abnormal years
- reflect the growth in the industry frontier, having excluded catch-up effects by focusing only on those distributors ranked in the top four
- incorporate 2017 data which is the most recent available data
- rely on a transparent methodology as set out in our 2018 annual benchmarking report and Economic Insights' further analysis.[76]

While these productivity estimates minimise the effects of regulatory changes and reflect more recent information, the annual rate of productivity growth is based on a relatively short time period and a small sample of distributors used to proxy the frontier. The resultant productivity growth rates varies significantly as the time period changes and as different distributors are selected.

We also acknowledge that if we rely upon opex productivity growth from a small set of distributors sharing common ownership to forecast opex productivity growth, it may reduce the incentives on the top four distributors to pursue productivity gains. These distributors may also be able to influence future opex productivity results with their opex performances, and therefore the opex productivity forecasts set in subsequent periods.

Given this, we consider that it is not appropriate at this time to use opex productivity results deterministically to forecast productivity going forward. It is appropriate to examine productivity trends more broadly, including over the long-term and in comparator sectors. This broader approach of drawing on a wider range of information sources is also consistent with the recommendations of the Australian Competition Tribunal (2016).

We will continue to monitor opex productivity over time via our annual benchmarking reports. As we obtain a longer data set that is less affected by step changes and cyclicality, and we observe a greater number of distributors amongst the industry frontier, we will have more confidence to rely on the opex productivity results to set a productivity forecast.

We can also examine how the benchmarking and productivity results are affected by changes in capitalisation of costs and the movement in provisions, as well as consider ways to control for the significant step change events that occurred over 2006 to 2012 (subject to the availability of relevant data).

4.1.2 Econometric modelling results

Our annual benchmarking reports include the results of up to four econometric cost models. The time trend in our econometric analysis estimates the change in opex productivity over time not attributable to other variables in the cost function. The drivers of this time trend include changes in technology (including the use of labour), changes in process, or changes in legislative or regulatory obligations. This section examines the time trend component of our econometric models.

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76 See Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019.

Our opex cost functions for electricity distribution also treat the share of underground cables as an operating environment factor. These models generate a coefficient that estimates the change in opex from the growth in the proportion of network undergrounding. We discuss this undergrounding coefficient separately in section 4.2.

In our 2018 annual benchmarking report, we have four econometric models that each measure technical change over time using slightly different cost functions and estimation methods:

- Cobb-Douglas Stochastic Frontier Analysis (SFA)
- Cobb-Douglas Least Squares Econometrics (LSE)
- Translog LSE
- Translog SFA.

The econometric modelling published in our 2018 annual benchmarking report measure technical changes over 2006–17 and 2012–17.[77] As shown in Table 6, the time trend coefficients for these models indicated negative productivity growth over both periods.

Table 6 Estimated opex productivity growth from econometric time trend coefficients, common time trend, per cent

	Cobb–Douglas SFA	Cobb–Douglas LSE	Translog LSE	Translog SFA
2006–17	–1.8	–1.9	–2.0	N/A
2012–17	–1.5	–1.7	–1.8	–1.5

Note: Negative productivity is represented by a positive time trend coefficient from the econometric results.
Source: Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 13

Submissions from CitiPower, Powercor and United Energy, Endeavour Energy, AusNet Services and SA Power Networks stated that our econometric modelling time trends represent the best measure of electricity distribution productivity, and that we should rely on these to forecast productivity.[78] These submissions noted the rate of technical change measured by these models is negative over 2006 to 2017, and this lends support to the AER maintaining its status quo of zero per cent productivity growth.[79]

77 Our opex productivity review draft decision presented the results from the 2006-16 period, which was taken from our 2017 annual benchmarking report. On 30 November 2018, we published our 2018 annual benchmarking report which included results over the 2006-17 and 2012-17 time periods.

78 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 16,19; AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 4-5, 8; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 8

79 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 19; NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, p. iv-v;

Endeavour Energy also observed that the technical change remains negative when the estimation period is changed from 2006 to 2017 to 2012 to 2017, even though our opex partial factor results shows positive productivity growth for the Australian distributors over this later period.[80] This is used as a further evidence that an opex productivity growth forecast of zero is appropriate.

One of the reasons that the econometric time trends show negative productivity growth since 2012 is due to the influence of the international data in the time series. Our econometric models also include data from electricity distribution businesses in New Zealand and Ontario to help improve the robustness of estimates of the relationship between changes in opex and individual outputs (such as customer numbers and circuit length). However, this also affects the time trend. Economic Insights notes the time trend coefficients from 2012 onwards:[81]

> … could be explained by ongoing declines in productivity growth in the New Zealand and Ontario distributors outweighing the impact of positive opex productivity growth among the Australian distributors in estimating the coefficient of the common time trend.

CitiPower, Powercor, United Energy and SA Power Networks submitted that, to the extent the AER considers that the inclusion of international data is distorting the long-term time trend from the econometric models, the AER should provide evidence this is the case and consider alternative methods to improve the reliability of the data.[82]

To test this, we asked Economic Insight to re-estimate the econometric models using country-specific time trends. This allows us to identify the time trend specific to the Australian distributors only. This was suggested by NERA in its report, and also suggested by some parties at the workshop we held in November 2018. The productivity growth from the New Zealand and Ontario dataset remains negative. Table 7 shows that the Australian-specific time trends follow a similar trajectory to the opex MPFP growth rates. Productivity growth is negative on average from 2006 to 2017, and is positive from 2011 onwards. The productivity growth from the New Zealand and Ontario dataset remains negative.[83]

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80 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 2

81 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 12

82 CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 16; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 9

83 For detailed results, see Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 13.

Table 7 Estimated productivity growth from econometric time trend coefficients, Australian-specific time trend, per cent

	Cobb–Douglas SFA	Cobb–Douglas LSE	Translog LSE	Translog SFA
2006-17	–1.5	–1.3	–1.2	–1.2
2011-17	1.9	1.2	1.2	2.2
2012-17	3.1	2.9	2.7	3.4
2011-16	1.3	1.0	0.9	1.5

Note: Negative productivity is represented by a positive time trend coefficient from the econometric results.
Source: Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 13

We agree that estimating productivity using our econometric models is desirable because it is consistent with the models used to assess base year efficiency and forecast output growth, and hence an opex productivity forecast from them would be internally consistent. However, we consider that the time trends from the econometric models likely overestimate frontier productivity growth as they are based on the full sample and so include catch-up effects to varying degrees.

The time trend coefficients in the LSE models measure the average rate of residual productivity change across the distribution sector. This means it includes productivity change relating to the expansion of the industry frontier as well as catch-up to the industry frontier. Holding all else equal, the LSE models are likely to overstate productivity growth achieved by frontier businesses where there is significant efficiency catch-up within the industry.

In contrast, the time trend coefficients in the SFA models theoretically measure the change in the efficiency frontier as distinct from catch-up. However, the ability of the SFA model to separate frontier shift from catch–up will depend on its assumed error structure and the amount of noise in the data.[84] As shown in Table 7, in reality the SFA and LSE coefficients are similar and the growth rates across both models are similar to industry growth rates from our opex partial factor productivity model. In light of this, Economic Insights considers that the time trend coefficients in both sets of econometric models likely include elements of both frontier shift and catch-up in practice, and that this points to the need to draw upon a wider range of sources in forecasting productivity growth rates (including opex partial factor productivity).[85]

Conclusion

The Australia-specific time trends that we have estimated with the econometric models over the 2011–17 time period:

- are partly adjusted for the effects of the identified step changes within 2006–12
- may include catch-up exhibited by NEM distributors

84 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 16.
85 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 17.

- incorporate 2017 opex data which is the most recent available data
- relies on our econometric models which are transparent.

However, while the opex cost function results consistently show positive opex productivity growth from 2011 onwards, they are based on the whole sample of Australian distributors and so will include some degree of productivity catch-up as well as frontier shift (even for the SFA models in practice).

4.2 Undergrounding

The draft decision also considered the explanatory variable for the proportion of undergrounding included in the electricity distribution econometric models as an operating environment factor. We estimated that on average the electricity distribution industry reduced opex by 0.5 per cent per year due to increased undergrounding.

This is because underground cables are usually less costly to operate and maintain. Vegetation management is also not required and there are fewer failures to rectify because the cables are not as exposed to the elements and pests. Consequently, you would expect that if an electricity distributor increases the proportion of its network that is underground its opex would decrease, all else equal.

We considered undergrounding in addition to examining the electricity distribution opex productivity results (discussed above) and the gas distribution time trends from econometric models (see section 4.4.2) to inform our opex productivity growth considerations.

Although electricity and gas distribution share many similarities, practically all gas distribution pipelines are already underground. Given this, in the draft decision one option we considered was to add the productivity gains available to electricity distributors from ongoing undergrounding to the estimates of technical change in gas distribution. Our index-based opex productivity growth rates for electricity distribution already include the effect of ongoing increases in the share of undergrounding and so it is not necessary to add the impact of undergrounding. However, as noted above, our opex cost functions for electricity distribution treat the share of underground cables as an operating environment factor. This means the estimates of technical change from these models will not include the impact of ongoing increases in undergrounding.

We received submissions to the draft decision raising issues around if and how undergrounding should be taken into account, including:

- whether an industry or firm specific estimate is more appropriate
- if undergrounding should be included in the productivity or the output growth component of the rate of change
- the approach used to estimate the explanatory variable for undergrounding and whether a log-log or log-linear specification was more appropriate (primarily raised by NERA).

The coefficients on the undergrounding explanatory variables we have considered in this final decision are set out in Table 8.

Consistent with the analysis in section 4.1, we considered coefficients for the periods 2006–17 and 2012–17 but as the results are broadly consistent, we have only presented them for the longer period 2006–17. Further, because NERA questioned whether we should use a log-log or log-linear specification,[86] we have presented results for both functional forms. Table 9 sets out the average share of undergrounding for each firm and the industry average for the period 2006–17 as well as the average annual change relevant to the log-log and log-linear models. We have updated the information in Table 8 and Table 9 since the draft decision to reflect 2016–17 data and the results from our 2018 annual benchmarking report.

It is important to note that the interpretation of these coefficients differs between our log-log model and the log-lin model proposed by NERA. In the log-log model the coefficient shows the percentage change in opex from a one per cent change in the value of the share of underground itself. In this case an increase in the share of underground from 10 per cent to 11 per cent represents a 10 per cent increase in the share itself and an estimated coefficient of –0.15 means that for this 10 per cent increase in the share of undergrounding there is an estimated reduction in opex of 0.15 per cent. In the log-lin model the coefficient shows the percentage change in opex from a one percentage point increase in the share of underground. Therefore the increase in the share from 10 per cent to 11 per cent is treated as a one percentage point increase.

Table 8 Estimated coefficients of the proportion of undergrounding in alternative econometric models, 2006–17

Functional form	SFA Cobb–Douglas	LSE Cobb–Douglas	LSE Translog	Average
Log-log	–0.150	–0.182	-0.163	–0.165
Log-lin	–0.353	–0.632	-0.557	–0.514

Source: Economic Insights, *Memorandum to the AER opex team - Appropriate specification for the inclusion of the share of underground cables variable in opex cost function models - technical issues*, 28 February 2019, pp.16–21

86 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 22–24, 50–52.

Table 9 Proportion of undergrounding

	Average (2006–17), per cent	Average annual per cent growth in share (2006–17), (log-log model)	Average annual percentage point growth in share (2006–17), (log-lin model)
Ausgrid	35.4	1.3	0.5
AusNet Services	11.8	3.7	0.4
CitiPower	47.4	1.4	0.7
Endeavour Energy	32.2	2.6	0.8
Energex	31.0	2.6	0.8
Ergon Energy	4.7	7.5	0.3
Essential Energy	3.7	5.1	0.2
Evoenergy	52.0	1.4	0.7
Jemena	26.3	2.5	0.6
Powercor	6.5	5.4	0.3
SA Power Networks	18.4	1.9	0.3
TasNetworks	10.1	1.9	0.2
United Energy	20.6	2.7	0.6
Industry average	**12.8**	**3.3**	**0.4**

Source: AER analysis

Historically all distribution businesses have increased the underground proportion of their networks over time. All distributors have positive average annual growth in the share of undergrounding under both the log-log and log-lin functional forms. Across the industry, over the period 2006–17 the proportion of undergrounding itself has increased on average by 3.3 per cent each year and the percentage point growth in the share has been 0.4.

The following sections consider the issues raised in submissions about if, and how, undergrounding can be used to inform opex productivity growth.

4.2.1 Should undergrounding be considered in examining opex productivity

Most submissions did not suggest that undergrounding is not a potential source of opex productivity growth. That said, Ausgrid noted that undergrounding is not a productivity driver and is undertaken for a variety of reasons, including largely in response to regulatory

requirements in recent years.[87] Evoenergy also stated that undergrounding cannot be used to set a target productivity growth rate, noting the proportion of a network that is underground and the growth rate are a function of historic network design and growth.[88]

Underground lines are generally less costly to operate and maintain then overhead lines. This is because:

- There are virtually no vegetation management costs associated with underground lines.
- Underground assets are very difficult to inspect and maintain, meaning the asset management strategy is generally run to failure or reliance on predictive failure analysis to drive replacement. This significantly reduces opex compared to annual patrolling of lines and inspecting most poles at three yearly intervals.
- Emergency management costs are reduced as there are fewer assets exposed to contact with third parties, including trees, animals, wind-borne debris and lightning. Also when a fault does occur on an underground asset the repair costs can be significant, but large repairs are often treated as capex rather than opex.

Therefore, while undergrounding may be undertaken for a variety of reasons (for example, improved operational efficiency, legislative and regulatory requirements) we consider that irrespective of its driver it is a source of ongoing opex productivity growth.

4.2.2 Industry or firm specific undergrounding

Some submissions questioned whether all distributors would have equal opportunities, or abilities, for undergrounding, and to derive the associated opex productivity gains. They considered it preferable and more appropriate to inform opex productivity considerations with a firm specific estimate of the forecast change in undergrounding, rather than an industry average.[89] This reflects the view that it is unreasonable to expect a consistent level of undergrounding across all networks, or that there exists a target 'efficient' level of undergrounding. Some stakeholders also considered a firm specific approach would avoid the potentially perverse outcome of penalising a distribution business for acting efficiently if it did not achieve a target level of undergrounding that has no relevance to its own circumstances. Finally, submissions noted that a firm specific approach would ensure that the forecast of undergrounding is consistent with the growth in circuit length used as an output growth measure.

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87 Ausgrid, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p 2.

88 Evoenergy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5.

89 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 10; CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 17; NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 21-22; Ergon Energy and Energex, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 7; Ausgrid, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p 2; Jemena, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 2.

We consider there is merit in examining firm specific estimates of the forecast change in undergrounding to inform our opex productivity considerations. This responds to the concerns that some distributors (such as those with already high rates of undergrounding or low rates of output growth, including circuit length) may be set unreasonably high targets through the averaging process. Further, it is consistent with the Guideline where we note that the opex productivity forecast should be firm specific as it is intended to reflect the potential productivity change the distribution business can achieve in the next regulatory control period.[90] This includes taking into account forecast changes in specific business conditions, such as forecast changes in undergrounding.

Some distributors also questioned whether using a firm specific approach to determine opex productivity growth factors would reduce the incentive to increase undergrounding, even when it was efficient to do so, in order to minimise future productivity growth factors. However, this will depend on the drivers for undergrounding and whether they are external to the businesses (for example, as a result of legal or regulatory obligations) or not. It will also depend on how a distributor's past growth in undergrounding influences its undergrounding forecasts. If the forecasts are uninfluenced by past performance, then the distributor should have an incentive to adopt the efficient level of undergrounding. However, the more influence past performance has on the forecast rate of undergrounding the lesser the incentive there would be to undertake efficient undergrounding.

The impact of considering undergrounding on a firm specific basis, and the estimates of average reductions in opex due to increased undergrounding, is discussed further in the following section, where we examine the different approaches to specifying the share of undergrounding in the econometric models.

4.2.3 Appropriate functional form for the share of undergrounding in the econometric models

NERA submitted that the functional form used in the AER's econometric models (log-log) does not reflect the true relationship between underground share and opex.[91] It proposed a log-linear functional form. It considered that we should assume a one percentage point increase in undergrounding yields the same percentage opex savings, irrespective of the share already underground.

Our econometric models currently use a log-log functional form for undergrounding. This assumes that the first kilometre of undergrounding will produce larger opex savings than the next kilometre and so on. This reflects the view that a distribution business would likely target those parts of the existing overhead network with large amounts of vegetation, higher probabilities of lightning strikes, older infrastructure or otherwise problematic outage histories and put them at the top of its priority list for undergrounding as the opportunities arise. As a result there would likely be reduced marginal opex savings from each additional km of line converted to underground.

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90 AER, *Explanatory statement - expenditure forecast assessment guideline*, November 2013, pp. 69–70.

91 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 22-23, 50–51.

On the other hand, where undergrounding is largely occurring in greenfield areas, and new developments, it is likely the regulatory and planning considerations will be more important and there may be less scope for distributors to prioritise problematic areas for undergrounding. In this case opex savings per kilometre of line undergrounded are unlikely to vary as substantially and may be more constant or stable.

Economic Insights investigated the relative merits of the two alternative functional forms and concluded that the log-log functional form is more appropriate because it provides a better statistical fit to the data using a number of different tests as well as being more consistent with underlying economic theory.[92] Further, the log-log functional form produces more stable measures of undergrounding marginal effects (the change in opex when there is a one kilometre change in the length of underground cables) across the sample data.

While we consider the log-log functional form appears to be more appropriate based on available evidence, for completeness we have examined the implied opex reductions from increased undergrounding under both the log-log and log-linear functional forms, as set out in Table 8 and Table 9.

At a firm specific level the results vary between firms. For the 2006–17 period, these results equate to an annual reduction in opex due to increased undergrounding of between 0.22 per cent per year (Ausgrid) and 1.24 per cent per year (Ergon Energy)[93] using a log-log functional form and 0.09 per cent per year (Essential Energy) and 0.44 per cent per year (Endeavour Energy) using a log-linear functional form.[94]

At the industry level, the results for the 2006–17 period equate to an estimated industry average reduction in opex due to increased undergrounding of 0.5 per cent per year using a log-log functional form and 0.2 per cent per year using a log-linear functional form.[95]

The above illustrates that, while the estimates do vary for different firms, and do depend on which functional form we use, there is evidence that ongoing undergrounding results in opex productivity improvements over time.

4.2.4 Inclusion of undergrounding in the productivity or output components of the rate of change

Endeavour Energy submitted that underground circuit length is an output factor and that undergrounding is better dealt with as part of the output growth forecast rather than the

92 Economic Insights, *Memorandum to the AER opex team - Appropriate specification for the inclusion of the share of underground cables variable in opex cost function models - technical issues*, 28 February 2019, p.10.

93 Ergon Energy, Essential Energy, Powercor and AusNet Services have annual reductions in opex due to increased undergrounding above 0.5 per cent per year, with all other distributors being below 0.5 per cent per year.

94 These firm specific results are based on taking the average of the product of the undergrounding explanatory variable for each econometric model (SFA Cobb-Douglas, LSE Cobb-Douglas, LSE translog) and the proportion of undergrounding for each firm, as detailed on table 9.

95 These results are based on taking the average of the product of the undergrounding explanatory variable for each econometric model (SFA Cobb-Douglas, LSE Cobb-Douglas, LSE translog) and the industry average proportion of undergrounding, as detailed on table 9.

productivity growth forecast in the rate of change.[96] AusNet Services also submitted that any adjustment for the growth in the proportion of undergrounding is more correctly characterised as an adjustment to the output growth forecasts, rather than as a shift in the efficiency frontier.[97] AusNet Services also noted output growth forecasts already account for opex increases due to increasing circuit length and this forecast should be refined to capture the impacts of both underground and overhead circuit length.

Economic Insights noted that the current log-log specification of the opex cost function includes the log of the share of underground as an operating environment variable. Because the share is the ratio of underground length to total length, this is equivalent to including the log of underground length minus the log of the total length.[98] As a result, estimating a model that includes total length and underground length as separate outputs, and no underground share operating environment variable, produces exactly the same result as the current specification which includes total length as an output variable and the share of underground as an operating environment variable.

While the end results would be exactly the same, we note that undergrounding could be included as either part of the output forecast component of the rate of change or as part of the productivity forecast component. The question of where to include the allowance for undergrounding in the rate of change is an issue that requires further consideration.

4.2.5 Conclusion

We consider that undergrounding is one source of ongoing opex productivity growth for distributors. Undergrounding leads to lower opex irrespective of the reasons it is undertaken. This is supported by our econometric modelling. While our draft decision examined this from an industry average perspective, we consider there is merit in examining firm specific estimates. On this basis, and accounting for the different possible functional forms, over the 2006–17 period the firm specific annual reductions in opex due to increased undergrounding range from:

- 0.2 per cent to 1.2 per cent per year (log-log)
- 0.1 per cent to 0.4 per cent per year (log-linear).

Using firm specific undergrounding estimates to inform opex productivity growth forecasts would provide a reasonable estimate of part of the underlying productivity growth achievable for that firm. However, as noted above, this is likely to be only one potential source of productivity. It would be possible to add productivity from undergrounding to the estimates of technical change from our opex cost function models to form a more complete view of opex productivity growth. However, our index-based opex productivity growth rates, and the other more general measures of productivity discussed in the following sections, already include the effect of undergrounding and so it is not necessary to add in a firm specific

96 Endeavour Energy *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 2.

97 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 10.

98 Economic Insights, *Memorandum to the AER opex team - Appropriate specification for the inclusion of the share of underground cables variable in opex cost function models - technical issues*, 28 February 2019, p 11-15.

undergrounding impact. Given this, while undergrounding supports the case for a positive productivity estimate, care is required in how it is taken into account to form an overall view of productivity achievable by a frontier firm. We discuss this further in section 5.

While needing to be mindful of the above issue, we note that using firm specific undergrounding estimates to inform opex productivity growth:

- would be unlikely to include catch-up effects
- may risk create perverse incentives for distribution businesses, depending on how undergrounding rates are forecast
- reflects the most recent available data
- is based on a transparent methodology.

4.3 Labour productivity performance

We have also examined labour productivity growth across all Australian industries and the utilities sector.[99] In the draft decision we identified the ABS quality adjusted labour productivity for all industries and utilities as being relevant. This was because labour costs are a large proportion of opex costs and the utilities sector includes electricity distribution. We also noted that for our current round of distribution determinations (for the ACT, NSW, the Northern Territory and Tasmania), Deloitte Access Economics (DAE) had forecast labour productivity growth for utilities[100] that may give us some indication of forecast productivity growth over the forecast period.

We received submissions raising various issues about these estimates and forecasts, including:

- that they may include catch-up effects
- that they do not take into account the impact of capex
- that they do not include data for 2017–18
- various specific criticisms of the DAE forecasts.

Submissions also proposed different possible approaches to estimating and forecasting labour productivity.

We have set out the labour productivity estimates and forecasts we have considered in this final decision in Table 10. This includes the additional approaches proposed by CEPA and BIS Oxford in their submissions, and reflects the most recent data available, including for 2017–18 which is an update from the draft decision, and time periods based on the productivity growth cycles identified by the ABS.

99 Electricity, gas, water and waste services.
100 In the draft decision, this was incorrectly called quality adjusted labour productivity growth forecasts.

Table 10 Labour productivity growth estimates and forecasts, per cent

Labour productivity measure	Source	Measure	1998–99 to 2003–04	2003–04 to 2011–12	2011–12 to 2017–18	Forecast (2020+)
Labour—all industries[101]	ABS	Quality adjusted labour productivity	2.0	1.0	1.1	
Labour—utilities[102]	ABS	Quality adjusted labour productivity	–1.3	–4.8	0.3	
Labour—selected sectors[103] [104]	ABS using CEPA approach	Quality adjusted labour productivity	0.9	0.4	0.9	
DAE—utilities[105]	DAE	Gross Value Added / Persons employed				1.5
BIS Oxford—utilities	BIS Oxford	Gross Value Added / Persons employed				0.9

Source: ABS 5620.0.55.002 Estimates of Industry Multifactor Productivity, Australia; Deloitte Access Economics, Labour Price Growth Forecasts - prepared for the Australian Energy Regulator, 19 July 2017, p 29, BIS Oxford Economics, *Forecasting productivity growth for electricity distributors - prepared for Endeavour Energy*, December 2018, p. 11-12

Labour is only one component of opex and information provided by the distributors shows that labour costs account for around 60 per cent of opex.[106] Given this, we consider any estimates or forecasts in Table 10 should be multiplied by this weight to estimate opex productivity growth. We examine this in the following sections.

The labour productivity estimates and forecasts in Table 10 are generally positive, except for the ABS labour utilities estimate for the period 1999–2012 when there was declining productivity. As noted by Productivity Commission, there is an inherent measurement problem in the ABS productivity statistics as it fails to capture multiple output dimension (see section 4.3.34.3.3 for further discussion).[107] This suggests that the measured productivity

101 Quality adjusted hours worked captures both changes in hours worked and changes in quality (for example, changes in education and experience) and the measure of output is gross domestic product at the economy wide level.

102 Quality adjusted hours worked captures both changes in hours worked and changes in quality and the measure of output is gross value added at the industry level.

103 The sectors are: construction, financial and insurance services, rental, hiring and real estate services, professional, scientific and technical services, administration and support services. Note that this is an unweighted measure.

104 A measure with four sectors was also considered, excluding rental, hiring and real estate services given the volatility of this sector which is subject to housing market fluctuations. The results of this measure are higher, but broadly similar to, the five sector measure.

105 This reflects the average of the utilities forecasts for Australia over the period 2019–20 to 2023–24.

106 The exact weight is 59.7 per cent.

107 Productivity Commission, *Productivity in Electricity, Gas and Water: Measurement and Interpretation, Staff Working Paper*,

decline under-estimates true productivity changes in the sector. The Productivity Commission identified the following causes more specific to the electricity subsector:

- Cyclical investment: network infrastructure investment is lumpy as it changes significantly during boom and contractions, particularly for the purpose of augmentation and renewal of supply capacity. The additional capacity put in place during the first decade of the 2000s was expected to underpin output growth in the medium term, not just to meet short-term needs. It remains unclear whether there has been any excessive or unnecessary investment in new infrastructure.
- Output measurement: the measured output is an aggregate volume measure reflecting key production components e.g. aggregate electricity production for electricity supply and (real) gas value added for gas supply.
- Shifts to higher-cost technologies: the continued shift away from large coal-fired power to higher-cost lower-capacity power station using gas or renewable energy sources has reduced measured productivity, at least until some period of comparative stability in the mix of supply sources is established.
- Unmeasured quality improvements: changes to the standards or regulations governing the operation of the utilities have increased production costs without any concomitant change in the measured output.

Cyclical investment and shifts to higher-cost technologies reflect industry changes during the period that resulted in increasing capital and labour inputs and thus lower productivity. These negative impacts are either temporary or can structurally change the productivity level, but they do not necessarily lead to future productivity declines. In this regard, historical productivity performance in this sector is not necessarily the best indicator for the future. Therefore, it is necessary to also look at comparator sectors for long-term trends. This may include considering the all industries productivity performance.

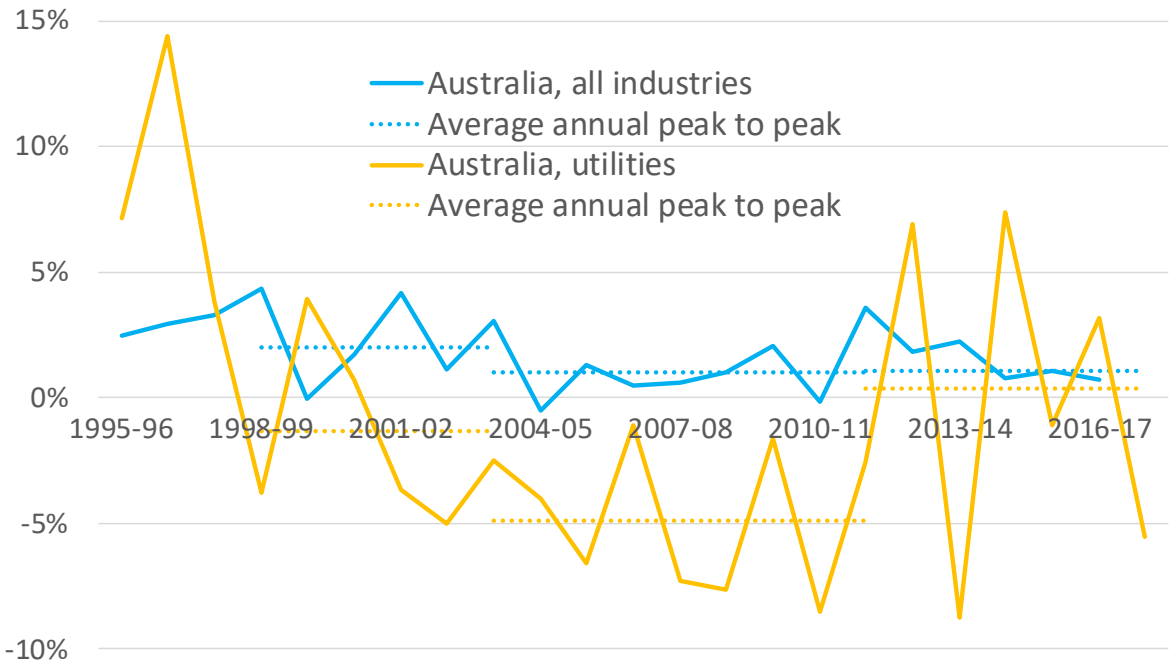
While the ABS labour utilities estimate is slightly positive for the 2012–18 period, and provides some evidence of a positive trend, the ABS considers this productivity growth cycle is not yet complete.[108] Most recently, utilities labour productivity declined 5.6 per cent in 2017–18, lowering the average growth rate over the 2012–18 period.[109] There has been significant variability in the annual labour utilities productivity growth rates over this period, as well as more generally. This can be seen in Figure 5, which includes quality adjusted labour productivity for all industries and the utilities industry.

March 2012, pp. xix-xxi.

108 As noted in CEPA's submission, in the most recent release of the ABS data series, it changed its view of the productivity growth cycle. see http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/5260.0.55.002Main+Features12016-17?OpenDocument

109 In the draft decision it was reported as 2.0 per cent for the period 2011-12 to 2015-16. AER, *Draft decision - Forecasting productivity growth for electricity distributors*, November 2018, p 20.

Figure 5 Quality adjusted labour productivity: year to year change



Source: ABS and AER analysis

The all industries labour productivity estimate is reflective of productivity being achieved in the broader market sector. Where appropriate it can be used as a proxy for specific sectors. We note that the labour utilities estimate appears to follow the same broad pattern as the all industries estimate over the productivity growth cycles. Labour productivity fell for both series over the period 2003–04 to 2011–12, before rising in the period from 2011–12 to 2017–18. While this suggests that market sector wide drivers for productivity change have some influence on the utilities industry, the historical relationship does not appear to be strong given labour productivity in the utilities sector declined significantly relative to the all industries over the two periods 1998–99 to 2003-04 and 2003-04 to 2011–12.

As with the other productivity information being considered, and reflecting the issues raised in submissions, there are issues and limitations that must be taken into account when examining labour productivity growth across the above estimates and forecasts. We set these out in the sections below.

4.3.1 Labour productivity growth estimates may include catch up

In our base-step-trend approach to assessing opex we make a firm-specific efficiency adjustment to base opex where 'catch-up' to the frontier is required. We include our best forecast of the shift in the efficiency frontier in the trend. Given this, it is important that labour productivity growth estimates and forecasts do not include 'catch-up' to the frontier but rather just the frontier shift.

AusNet raised this in its submission specifically in relation to labour productivity growth and CEPA raised it more generally.[110]

When examining the ABS labour utilities estimates, we acknowledge that if some of the inefficient distribution businesses have improved efficiency of their operation since 2011–12 then this may capture some 'catch-up' effect and be contributing to the slightly positive estimate. This is because the utilities sector encompasses all electricity distribution businesses.[111] As a result it may mean productivity growth is over-estimated for the efficient utilities. Similarly, as the DAE and BIS labour productivity forecasts are averages across the utilities sector, then there may also be a component of 'catch-up' in those estimates. The selected sector labour productivity estimate is unlikely to include the impact of 'catch-up' effects in the electricity distribution sector.

While catch-up is something we should be mindful of, we do not consider that labour productivity estimates give an inherently biased estimate of opex productivity growth..

4.3.2 Labour productivity growth estimates do not account for capex

In their submissions, AusNet and Endeavour Energy raised concerns that the analysis in the draft decision did not account for the capex used to achieve labour productivity improvements, particularly in terms of labour-saving or labour-enhancing investment, or increased undergrounding.[112] BIS Oxford also submitted that due to the direct correlation between opex and capex, productivity growth should be measured across the entire electricity sector and applied to a whole entity (that is, not just to opex).[113]

When examining productivity, we generally have regard to capital inputs, i.e. capital stock and not the level of capex. Therefore, while capex may change over time, it is the level of capital inputs that informs labour productivity as the capital stock already in place enables efficiencies to be achieved. Given this, we do not consider that it is necessary to specifically account for the capex used to achieve labour productivity improvements. Further, sources of productivity gains are multifaceted. They can arise in either disembodied technical changes, such as new organisational techniques, or embodied in the form of better capital inputs and intermediate inputs.

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110 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 11; CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, pp. 16, 22-23.

111 Productivity Commission, *Productivity in Electricity, Gas and Water: Measurement and Interpretation, Staff Working Paper*, March 2012, pp. 14 and 23. According to the Productivity Commission , in terms of industry value-added outputs, electricity distribution accounted for 47 per cent of the electricity supply industry in 2006-07, while the latter accounted for 64 per cent in the Electricity, Gas and Wastewater sector in 2009-10.

112 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 11; Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 9.

113 BIS Oxford Economics, *Forecasting productivity growth for electricity distributors, prepared for Endeavour Energy*, December 2018, p 9.

4.3.3 Outputs and inputs used to estimate labour productivity growth

The ABS labour productivity estimates (all industries and utilities) in Table 10 measure outputs per unit of labour input taking into account:

- Gross domestic product for all industries and the value of gross outputs net of intermediate inputs consumed for utilities (gross value-added)
- Quality adjusted hours of work which captures changes in standard working hours in a week, overtime, leave, and part-time / full-time status as well as changes in number of staff employed and accounts for changes in the education and experience of employees.

In addition, the DAE and BIS forecasts also use gross value-added output, but measure labour inputs based on the number of employed persons.

The above output measures are relatively simple and in terms of electricity distribution largely reflect the amount of electricity supplied over the grid. This means they fail to capture the multiple dimensions of the services provided by distribution businesses (e.g. customers connected, network length and capacity required by customers) as well as improved reliability and security of the network over time. As a result, with growing networks reaching more customers and providing necessary capacity and better quality services, in comparison to relatively flat or decreasing energy supplied, the likely consequence of using these measures is under-estimation of output growth, and as a result, under-estimation of the true productivity change. That is, it will place too much weight on throughput measures and too little, if any, weight on faster growing outputs such as customer numbers, system length and capacity and reliability.

In terms of inputs, quality adjusted hours of work are generally preferred as an input measure given they take into account of changes in quality. Given this, when input measures such as the number of employed persons are used (as is the case for the DAE and BIS forecasts) an adjustment is advisable to reflect any labour quality change that have occurred.

It is also noted that the above inputs and outputs are different to those used in our electricity distribution productivity modelling and consequently we need to be mindful that quality adjusted labour productivity does not reflect the same outputs and inputs we use when we forecast the opex rate of change.

4.3.4 Selected sector labour productivity growth forecasts

In its submission responding to the draft decision, CEPA set out an alternative approach for developing a labour productivity growth estimate.[114] CEPA did not consider it appropriate to use the ABS labour utilities productivity growth estimate to inform opex productivity growth considerations because:

- the estimate shows significant volatility, particularly for recent years

[114] CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, pp. 24-32.

- there is a risk of embedding historical performance as the distribution businesses make up a material part of the sector
- there are a number of state-owned companies in the sector that may not face the same shareholder / competitive pressures to achieve productivity gains as privately-owned companies.

CEPA developed its alternative estimate, shown in Table 10, using the ABS labour productivity of five sectors that it argued conduct similar activities to those of electricity distribution businesses. Based on the unweighted average across the five sectors, and using the most recent full business cycle (2003-04 to 2011-12) and the complete data series (1998-99 to 2017-18), it estimated a range of labour productivity growth of 0.5 per cent to 1.2 per cent. Further, CEPA stated that because this is based on value-added outputs, it will capture improvements in intermediate inputs since reductions in the level of intermediate inputs increase value-add. Therefore, CEPA submitted that it is appropriate to adjust this range for the labour proportion of opex (60 per cent) resulting in an opex productivity growth rate of 0.3–0.7 per cent.

Ofgem has adopted a similar approach to determine on-going efficiency adjustments for totex in its price control (referred to as RIIO) decisions.[115]

We consider this alternative approach is reasonable given:

- the sectors are selected on the basis of similar activities to electricity distribution
- the performance in these sectors is exogenous to electricity distribution, meaning there would be no pervasive incentives for electricity distribution businesses
- there is no evidence to suggest the sectors are not subject to competitive pressures which would drive productivity improvements
- it is unlikely to include the impact of 'catch-up' effects in the electricity distribution sector.

However, there are some limitations with this alternative measure. This includes that it is based on gross value-added across these sectors and as a result may lead to an underestimate of output growth and therefore productivity growth. In addition, a weighted measure would provide a better estimate, particularly given the similarities between the construction sector and electricity distribution. That said, the construction sector can be particularly affected by industrial disputes, which may contribute to year-on-year fluctuations in the measure.

4.3.5 DAE and BIS labour productivity forecasts

As noted above, in the draft decision we presented labour productivity growth forecasts (2019-20 to 2023-24) for the utilities sector developed by DAE (see Table 10). Several submissions raised concerns with these forecasts and in particular that:

[115] Ofgem, *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix*, 17 December 2012, pp.15-16 ; Ofgem, *RIIO-ED1, Final determinations for the slow-track electricity distribution companies - Business plan expenditure assessment*, 28 November 2014, p.158; Ofgem, *RIIO-ED1, Draft determinations for the slow-track electricity distribution companies - Business plan expenditure assessment*, 30 July 2014, p.123.

- there is insufficient information provided about the basis for DAE's forecast (such as the output and employment forecasts or weights used)
- the DAE forecast appears to rely on economy wide forecasts without establishing why this is relevant to the utilities sector
- it is assumed an economic cycle methodology has been applied (as opposed to an annual methodology) which the AER has previously rejected
- DAE's estimates have historically suffered from upward bias.[116]

DAE has provided further details in relation to its forecasting methodology.[117] This outlines how and why the economy wide forecasts inform the utilities sector forecasts and notes that an annual methodology is used to determine the forecasts.

BIS Oxford submitted its own labour productivity growth forecast (2019–20 to 2023–24)[118] which we have also presented in Table 10. We note there is limited information about the basis for the BIS Oxford forecast, but that similar to the DAE forecast it uses gross value-added for the output measure and employed persons for the input measure.

BIS Oxford also considers productivity growth in the electricity sector will be within the generation sub-sector, not distribution and transmission, reflecting the move towards renewable energy. The case for this is not clear. While there is arguably significant change occurring in generation, it is not clear how this will translate to increased productivity. For example, if significant labour is being employed to increase capacity, but that increased capacity is not yet online, this would reduce productivity. However, given renewable energy is quite quick to install, this may not be a significant issue.

As both the DAE and BIS Oxford forecasts use relatively simple output measures, it is likely the output and labour productivity growth forecasts are under-estimated for the same reasons as outlined above. They also both rely on employment as the input measure, rather than the preferred quality adjusted hours.

To partially address the concerns about the output and input measures, an option is to adjust both the DAE and BIS Oxford forecasts to reflect gross output and a labour quality component. We have modelled this at a high level to produce adjusted BIS Oxford and DAE opex productivity forecasts of 0.3 and 0.7 per cent respectively.[119] We based this on:

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116 Endeavour Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, pp. 2, 25 -27; BIS Oxford Economics, *Forecasting productivity growth for electricity distributors - prepared for Endeavour Energy*, December 2018, pp. 3, 10; SA Power Networks, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 4; NERA Economic Consulting, *Assessment of the AER's proposed productivity assumptions, prepared for CitiPower, PowerCor, SA Power Networks and United Energy*, 20 December 2018, pp. 44-45; Citipower, PowerCor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 18.

117 Deloitte Access Economics, *Note on labour productivity*, 1 March 2019

118 BIS Oxford Economics, *Forecasting productivity growth for electricity distributors - prepared for Endeavour Energy*, December 2018, pp. 11-12.

119 These are calculated as: BIS Oxford (0.9 - 0.4) * 0.6 = 0.3 and DAE (1.5 -0.4) * 0.6 = 0.7

- Converting from value-added output to gross output by adjusting for the share of labour in the labour and intermediate inputs. For simplicity an adjustment of 0.6 is made reflecting the labour share of opex as used in our benchmarking models
- A 'labour quality adjustment' component of 0.4 per cent per year for the utilities sector reflecting an estimate of 0.44 per cent per year for the period (1998–99 to 2016–17) and 0.39 per cent per year for the period (1998–99 to 2017–18).[120]

4.3.6 Time periods for examining labour productivity growth

Consistent with the information presented in the draft decision, CEPA's submission notes that the ABS's most recent labour productivity release identified two complete cycles (1998–99 to 2003–04 and 2003–04 to 2011–12) and an incomplete cycle (2011–12 to 2016–17).[121] While noting these cycles for the whole market sector, CEPA did not consider there is any strong reason why they would apply to the AER's analysis given the choice of outputs and the method used to measure productivity is very different to the ABS' approach.

Both the ABS and Productivity Commission consider productivity trends are best measured over productivity growth cycles. This is because by measuring average annual multi-factor productivity growth between cyclical peaks, the effects of cyclical factors such as changing capacity utilisation over a business cycle[122] and labour productivity that may cause year-to-year fluctuations to deviate from long-term trend, are minimised.[123]

In any event, the time periods for the ABS labour productivity cycles are reasonably similar to the time periods used in section 4.1 to examine the electricity distribution productivity growth information from the opex MPFP and econometric models.

In this regard, quality-adjusted labour productivity in the utilities industry appears to follow a similar pattern as opex MPFP. As observed in the draft decision, quality-adjusted labour productivity declined between 2003–04 and 2011–12, after which it has shown signs of positive growth. Opex MPFP for electricity distribution displays the same pattern, with performance declining from 2006–07 to 2011–12 and then improving significantly from 2012. We would expect to see this correlation given that electricity distribution is a significant proportion of the utilities industry and labour is a major component of opex.

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120 This is calculated by examining the difference between the geometric means for quality adjusted labour productivity and gross value added / employed persons over the period 1998 to 2017 or 2018.

121 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 18.

122 In BIS Oxford Economics, *Forecasting productivity growth for electricity distributors - prepared for Endeavour Energy*, December 2018, pp. . 13 it argues the 'classical productivity' approach assumes full utilisation of capacity and hence is only relevant to the market sector. However, both ABS and Productivity Commission indicate that by definition of changing capacity utilisation there are periods in the business cycle where capacity is not fully utilised in the market sector.

123 See for example, Australian Bureau of Statistics, *Australian System of National Accounts: Concepts, Sources and Methods, 5216.0*, 2014, p. 427; Productivity Commission, *Shifting the Dial: 5 Year Productivity Review, Supporting Paper. No. 1 Productivity and Income – The Australian Story*, 3 August 2017, p. 5.

4.3.7 Conclusion

It is useful to consider labour productivity growth over complete cycles. The labour productivity estimates and forecasts available to us suggests opex productivity in the range of 0.3 per cent to 0.7 per cent.

However, care must be taken in using these estimates and forecasts given the various issues noted above. This includes that the time period covered may include 'catch-up' effects and therefore the estimates may over-estimate the labour productivity achievable by efficient businesses. On the other hand, the labour productivity growth measures do not capture multiple output dimensions in the utilities sector, including quality and reliability of services, output and thus under-estimate the labour productivity achievable by efficient businesses.

In summary, we consider using labour productivity growth estimates, and specifically the selected (similar) sector measure, to inform our opex productivity growth factor:

- Would provide a reasonable estimate of the underlying productivity growth achievable, particularly given the relatively long data period it is estimated over, noting that it will potentially under-estimate the achievable labour productivity as a result of the output measures not capturing multiple output dimensions
- May include catch-up effects, although this is likely to be minimised given the relatively long data period and be less prevalent for the selected (similar) sectors estimate in contrast to the utilities estimate
- Is unlikely to create perverse incentives for distribution businesses
- Reflects the most recent available data
- Is based on a transparent methodology.

4.4 Other Australian sources of data on productivity

In the draft decision we examined the productivity achieved in the Australian gas distribution sector. Submissions raised various issues about this evidence, as discussed below, and also suggested other relevant Australian information should be taken into account. Specifically, the Productivity Commission's analysis of multifactor productivity growth in the electricity industry and productivity growth in electricity transmission and the water sector. The following sections examine each of these information sources.

4.4.1 Electricity supply industry

In its submission to the draft decision, the CCP proposed another relevant source of productivity data developed by the Productivity Commission.[124] In 2012, the Productivity Commission published multifactor productivity (MFP) analysis of the Australian electricity industry as a whole. The Productivity Commission estimated that electricity industry productivity grew by 1.3 per annum on average between 1974–75 and 2009–10.[125]

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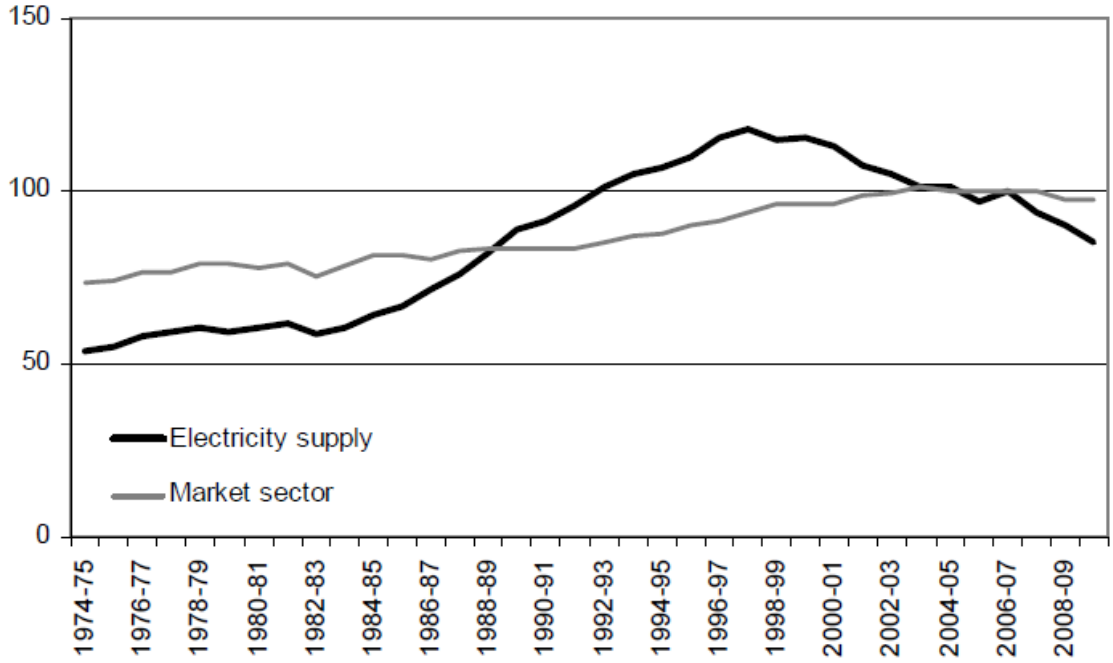
124 CCP, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, pp. 17–18.

125 Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper*,

Figure 6 shows the productivity trend from the Productivity Commission report. This shows that the electricity industry experienced moderate growth from 1974–75 to 1985–86 (2 per cent per annum) and rapid growth from 1985–86 to 1997–98 (4.9 per cent per annum), followed by a decline in MFP from 1997–98 to 2009–10 (–2.7 per cent per annum).[126]

Figure 6 Multifactor productivity in electricity supply and the market sector, 1974–75 to 2009–10, Index 2006-07 = 100, Productivity Commission



Source: Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation*, Staff working paper, March 2002 (Figure 4.1)

The Productivity Commission explained that the negative MFP growth in the electricity supply industry after 1997–98 was due to:[127]

- growing relative peak demand for electricity during summer which led to further capacity investment but which lowered average capacity utilisation
- a shift to higher cost underground electricity cabling
- a move away from large coal-fired power stations towards generally higher cost gas-fired power and renewable energy sources
- augmentation and renewal of electricity supply infrastructure.

These issues primarily affect capital productivity. However, it also explained that improvements in the reliability of electricity supply — particularly those in response to

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126 Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper*, March 2002, p. 20.

127 Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper*, March 2002, p. 31.
Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper,* March 2002, pp. xx–xxi.

change in regulatory standards and operating conditions — generally required more inputs to achieve but did not show up as an increase in the volume of output.[128]

These findings are consistent with our understanding of the factors that have distorted our opex partial factor estimates in the later years of the 2006–12 period.

We note that the Productivity Commission examined the electricity supply industry as a whole, which consists of electricity generation, electricity transmission and distribution and electricity market services. The industry productivity growth rates may not precisely measure the productivity growth achieved specifically in the electricity distribution industry.[129] However, we consider that this information is informative and the best available long term measure of productivity in the electricity industry. This is a useful crosscheck given electricity distribution contributes the highest share of output, employment and net capital expenditure within the electricity supply industry.[130]

In terms of the factors we are considering to inform the weight we place on this information, the Productivity Commission estimate:

- provides some information about the underlying productivity growth achievable within the electricity distribution sector, but is limited by the fact that it only covers the period up until 2009 and therefore does not reflect the most recent data
- may include catch-up effects as it covers part of the period when electricity distribution businesses were being privatised
- is unlikely to create any perverse incentives for distribution businesses to pursue productivity gains
- is based on a transparent methodology.

4.4.2 Electricity transmission

In its submission to the draft decision, AusNet Services proposed that we consider productivity trends in the electricity transmission industry.[131] AusNet Services stated that electricity transmission is better proxy for electricity distributors because:[132]

- there is some substitutability between the workforce for electricity distributors and electricity transmission businesses, so drivers of labour productivity factors are closely related

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128 Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper,* March 2002, p. xx.

129 The Productivity Commission's MFP analysis also relies on the ABS's definition of MFP as the ratio of output (value added) to the combined inputs of labour and capital. This uses different inputs and outputs compared with our opex MPFP analysis.

130 Productivity Commission, *Productivity in electricity, gas and water: Measurement and interpretation, Staff working paper*, March 2002, p. 23.

131 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 8

132 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 8

- output measures used by the AER (particularly customers/end users, demand and energy throughput) are consistent between electricity distribution and electricity transmission when aggregated to the industry level
- speed of technological change is comparable, as advancements often have applications in both electricity distributors and electricity transmission providers
- electricity transmission industry has had a faster pace of legislative change than gas distribution, which is more reflective of 'steady-state' electricity distribution legislative change.

AusNet Services noted that the AER does not produce econometric models for the transmission industry and that available transmission opex partial factor productivity results could be used. However, it concludes that it is inadvisable to use transmission industry productivity in a material manner and could only be used as an upper bound.[133]

We agree that electricity transmission industry could be a useful source of productivity to inform our estimate of electricity distribution productivity. Electricity transmission also forms part of the broader utilities sector, which we have examined as part of our labour analysis and also forms part of the whole of electricity supply chain that was examined by the Productivity Commission.

However, as we outline in our 2018 annual benchmarking report for transmission network service providers, compared to electricity and gas distribution networks there have not been many top-down benchmarking studies of transmission networks.[134] Consequently, benchmarking and productivity analysis for transmission networks using total and partial factor productivity analysis is still in a relatively early stage of development. The small number of electricity transmission networks in Australia (five) also means that we also have a relatively small sample size to measure productivity growth.

This means that we do not consider that it is appropriate at this point in time to rely on the productivity trends from electricity transmission.

4.4.3 Gas distribution

In our draft decision, we looked at time trend estimates for gas distributors. We considered this information useful because:

- the gas distribution sector shares many similarities with the electricity distribution sector
- past productivity performance has been more stable in gas distribution than for electricity distribution and has not been subject to the same regulatory changes
- we have technical change estimates for gas distributors estimated using econometric models similar to those we use for electricity distribution.

133 AusNet Services, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 20 December 2018, p. 8

134 AER, *2018 Transmission network service provider benchmarking report*, 30 November 2018, p. 5

Table 11 shows the estimated productivity trends of four of the most recent gas distribution econometric studies submitted to us, which were conducted in 2015 and 2016. These reflect the time trend coefficients from each model. On average, across the four studies, opex reduced by 0.5 per cent each year, holding everything else constant.

Table 11 Estimated productivity growth rates from econometric time trend coefficients, gas distribution, per cent

Report	Number of outputs	Number of specifications / estimation techniques	Minimum	Maximum	Average
ACIL Allen 2016	One	Three	0.26	0.73	0.43
Economic Insights 2015	Two	Two	0.69	0.71	0.70
ACIL Allen 2016	Two	Three	0.26	0.62	0.45
Economic Insights 2016	Two or three	Six	0.52	0.64	0.59

Source: Economic Insights, *Relative opex efficiency and forecast opex productivity growth of Jemena Gas Networks*, 25 February 2015; Economic Insights, Gas *distribution businesses opex cost function*, 22 August 2016; ACIL Allen Consulting, *Opex partial productivity analysis*, 20 December 2016.
Note: Positive productivity is represented by a negative time trend coefficient from the econometric results.

The Economic Insights models relied on data from between 9 and 11 Australian gas networks and between 2 and 3 New Zealand gas networks, and covers the period from 1999 to 2015. The ACIL Allen models relied on data from nine gas networks covering 10 years. The Economic Insights models in particular provide a longer time series than our electricity distribution models.

The comparability of productivity growth within gas and electricity distribution

In its report, CEPA noted that, in its experience, the gas network sector can provide another point of reference for potential productivity growth. It states that there are a number of similar activities across the networks, such as business support and regulatory compliance.[135] However, it notes that electricity distributors undertake different activities to the gas networks, for example vegetation management around overhead lines and electrical engineering.[136]

NERA also stated that there may be similarities in labour force between electricity and gas network businesses, and the supply of utilities services to similar users.[137] However, NERA recommended that the use of gas productivity is not appropriate because:[138]

135 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 14.
136 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 14.
137 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 27–28.

- gas and electricity industries face fundamentally different cost inputs and conditions, especially in relation to the prominence of overhead line conditions for electricity (such as vegetation, weather and bushfires) which gas networks do not face
- electricity distributors reach rural customers that do not have access to reticulated natural gas, meaning that electricity distribution companies are more rural on average
- the gas productivity models may also include efficiency catch-up in the productivity forecasts.

AusNet Services also argued that the electricity industry differs from gas industry in two key aspects:[139]

- the transformation of the role of the electricity distribution networks due to expected additional penetration of distributed energy resources, which will add additional costs, whilst putting downward pressure on energy delivered.
- Significant legislative change has driven increases in safety and vegetation management expenditure in electricity distribution and will continue to impact on productivity.

In contrast, Economic Insights stated that:[140]

> In principle gas distribution productivity is likely to be a very useful comparator for electricity distribution productivity. Both of these network industries are highly capital–intensive with very long–lived, sunk assets. Both supply key forms of energy to a mixture of domestic, commercial and industrial users. Both have faced some challenges in recent years on the demand side with electricity networks subject to rapidly increasing prices and increasing competition from rooftop solar and gas deliveries subject to rapidly increasing prices from export competition. However, gas distribution has not been subject to a period of major step changes resulting from transition between required reliability standards as electricity distribution has been.

Having considered the views of submissions and Economic Insights, we are of the view that differences in inputs and operating environments between gas and electricity networks does not preclude gas sector productivity as a useful comparator. There are significant similarities between gas and electricity networks:

- in terms of non-specialist technical staff that make up a large proportion of operating expenditure (such as HR, administration, business management, finance, ICT systems)
- both supply energy to similar customers using long-lived and relatively stable assets
- both are regulated under similar regulatory incentive regimes.

We recognise that a key source of difference between gas and electricity distribution is that gas networks are almost entirely underground, whereas electricity networks are predominantly above ground. Electricity networks therefore face costs relating to vegetation management and maintenance, and higher regulatory costs relating to bushfires.

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138 NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 27–30.

139 AusNet Services, *AusNet Services' submission to the AER draft decision paper on forecasting productivity growth for electricity distributors*, 20 December 2018, p. 9.

140 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 18.

In contrast to submissions, we consider that these operating differences can be a benefit to relying upon productivity growth from gas distributors. The fact that the gas distribution industry has not been subject to regulatory changes of the same magnitude as the electricity distribution industry, and is not subject to annual variability (for example, due to weather and bushfires), means it may provide a more stable estimate of underlying productivity achieved by a utility in Australia. This particularly overcomes the concerns that our electricity distribution opex partial factor productivity and econometric time trends are distorted by the effects of significant regulatory changes, as discussed in section 4.1.

Furthermore, the gas distribution sector faces greater competitive pressure than electricity distribution because it is more of a fuel of choice, it provides an estimate of what productivity growth an efficient and prudent network provider may achieve in a competitive market.

The robustness of the gas distribution productivity results

Gas productivity measurement has a very long history within Australian gas price regulation, and forms the basis from which Economic Insights electricity distribution benchmarking and productivity models were developed.[141] Economic Insights notes that the gas econometric models include similar output specifications to the electricity distribution models—all include customer numbers as an output and Economic Insights also includes network length and throughput, as well as a relatively detailed treatment of operating environment factors.[142] Economic Insights concludes:[143]

> Although the electricity and gas models are not the same in all respects, they are sufficiently similar for the gas distribution models to provide a useful source of information for appropriate forecast opex productivity trends for electricity distribution.

CEPA and NERA submitted that the gas models form ACIL Allen and Economic Insights include some statistically insignificant coefficients on the time trends -- in particular that the time trends in the ACIL Allen models are not statistically different from zero, and positive productivity is estimated only by chance.[144] CEPA submit that the statistically insignificant results should be replaced by zero, which results in a range of productivity results of 0 to 0.7 per cent.[145] The average productivity within this range is 0.35, compared to an average of 0.50 from all models.[146]

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141 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 18.

142 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 18.

143 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, pp. 18–19.

144 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, pp. 14–15; NERA Economic Consulting, *Assessment of the AER's Proposed Productivity Assumptions, Prepared for CitiPower, Powercor, SA Power Networks and United Energy*, 20 December 2018, pp. 28–29.

145 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 15.

146 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 15.

Economic Insights responded to the submissions from NERA and CEPA that the time trend coefficients in the gas distribution models that are not statistically significant should be ignored:[147]

> In economic modelling, there are two approaches to treating variables that do not produce statistically significant coefficients. One school of thought—and that apparently advocated by NERA and CEPA—is that statistically insignificant coefficients should be dropped from the model and/or ignored. We do not support this approach. The other school of thought is that the model specification should be based on underlying economic theory—and not statistical significance alone—and even statistically insignificant coefficients still provide useful information. That is, an insignificant estimate is better than a zero estimate—as long as the high standard error is noted.

It also noted:[148]

> The gas distribution models have relatively small databases compared to the electricity distribution models and so it is not surprising that some coefficients show as being not significant in the gas distribution models. The ACIL Allen (2016) models have smaller databases than the Economic Insights (2015, 2016) models so it is also not surprising that the ACIL Allen models again produce more insignificant estimates. But this does not mean that those estimates are of no value and should be ignored.
>
> Another way of looking at this is that implicitly two options are being considered—either include all estimates to create an average trend estimate or drop the insignificant ones and use the remaining subset to create an average trend estimate. The latter can be viewed as a more extreme weighted average (with extreme weights of 0 or 1). There is no case for adopting this more extreme option.

Conclusion

In summary, we consider using the gas distribution sector productivity estimates to inform opex productivity growth factor:

- would provide a reasonable estimate of the underlying productivity growth achievable within the electricity distribution sector reflecting the similarities we consider exist between the gas and electricity distribution industries
- provide a more stable estimate of underlying productivity achieved by a utility in Australia, particularly as the gas distribution sector has not been subject to regulatory changes of the same magnitude as the electricity distribution sector
- potentially has some catch-up effects, but this is unclear and likely less significant than electricity distribution because gas distribution is primarily privatised
- is unlikely to create any perverse incentives for distribution businesses to pursue productivity gains given it is exogenous
- reflect relatively recent data (up until 2015 for the Economic Insights models)
- is based on a transparent methodology.

147 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 19.
148 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p. 19.

4.4.4 Water

Australian water networks may be another appropriate comparator sector given they have network characteristics similar to those of electricity and gas networks.

Stakeholders including CEPA, Energex and Ergon Energy suggested that we incorporate information from the Australian water industry to inform our forecast of opex productivity for electricity distributors. CEPA suggested that information from the water industry can act as a crosscheck, rather than be used as the sole source of information relied on by the AER.[149] Furthermore, CEPA suggested there is merit in working with Australian sources since it avoids inconsistencies with data on working conditions, input prices, and wages.[150]

Recent regulatory decisions made by the Independent Pricing and Regulatory Tribunal (IPART), the New South Wales water regulator, incorporated a 0.25 per cent per annum continuing efficiency target in its opex forecasts for Sydney Water Corporation and Hunter Water Corporation for the 2016–17 to 2019–20 period.[151, 152] IPART adopted the 0.25 per cent per annum continuing efficiency target recommended by its consultant, Atkins Cardno, on the basis that it was the factor applied by the United Kingdom's Water Service Regulation Authority (Ofwat) in its 2009 review of prices for water companies in England and Wales. Atkins Cardno considered that the expenditure review of Sydney Water should be based on international comparators using water utilities with similar operating characteristics because this is the most effective way to compare the performance of Sydney Water with other water utilities of similar size, networks and assets and operating environments.[153]

The Economic Regulation Authority (ERA) in Western Australia recommended a 0.75 per cent per annum efficiency target for aggregate opex when it considered the efficient costs and tariffs for the services of the Water Corporation, Aqwest and Busselton Water for the five-year period commencing 1 July 2018.[154] In addition to IPART's continuing efficiency target of 0.25 per cent per year outlined above, the ERA took into account the 1.0–1.5 per cent per annum efficiency target applied to SA Water in 2016 and the 1.0 per cent per annum total efficiency target applied to all Victorian water businesses' aggregate operating expenditure in 2013.

The water supply and electricity distribution industries both supply utilities services to similar customers using long-lived and relatively stable assets and are subject to price reviews by government. However, the primary activities of the water industry differ from those of the electricity distribution industry as they include operations of dams, desalination plants and filtration plants. The water industry firms catch, store, purify and supply water. The scope of their activities are much more varied compared to the electricity distribution businesses.

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149 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p. 33.

150 CEPA, *Analysis supporting Ausgrid's, Evoenergy's and Jemena's submission to the Australia Energy Regulator's review of its approach to forecasting operating expenditure*, 20 December 2018, p.7.

151 IPART, *Review of prices for Sydney Water Corporation, Final report*, June 2016, p. 110.

152 IPART, *Review of prices for Hunter Water Corporation, Final report*, June 2016, p. 53.

153 Atkins Cardno, *Sydney Water Corporation—Expenditure review, Final report*, 21 December 2015, p. 31.

154 Economic Regulation Authority, *The efficient costs and tariffs of the Water Corporation, Aqwest and Busselton Water, Final report*, 10 November 2017, p. 237.

Also, we note that urban water supply businesses (both retail and wholesale) are still government-run, which may impact their incentives to achieve ongoing productivity gains in contrast to privately run businesses.[155]

In terms of the factors we are considering to inform the weight we place on this information for forecasting opex productivity growth, the water sector productivity estimates:

- may provide some information about a reasonable estimate of the underlying productivity growth that may be achievable in the electricity distribution sector, reflecting the similarities we consider exist between the water and electricity distribution industries. However, further review would be required to determine if the water sector has been subject to regulatory changes, and the timing of these, in the same way as the electricity distribution sector has been.
- are unlikely to create any perverse incentives for distribution businesses to pursue productivity gains given they are exogenous
- do not appear to reflect relatively recent data (particularly to the extent these estimates use the Ofwat 2009 review of prices as their underlying basis)
- do not have a transparent methodology about how the estimates are derived.

4.5 Overseas electricity distribution productivity

In response to the draft decision, some submissions suggested that the approaches to, and forecasts for, productivity growth in other international jurisdictions should be examined.[156]

Given this, in addition to the productivity performance of the Australian electricity distribution sector, we have also examined the performance of electricity distribution overseas, as well as the productivity growth forecasts set by international regulators. We consider that there is merit in examining productivity growth overseas where electricity distribution systems are similar in design and operation to Australia, and where networks are regulated in a similar way.

We set out below, the productivity growth observed internationally. Electricity distribution productivity growth has been positive in the United Kingdom and the United States, but negative in New Zealand and Ontario Canada. However, the United Kingdom and United States data cover longer periods of time and likely provide a better estimate of the underlying productivity trends. We have not assessed whether the New Zealand and Ontario distributors have faced significant changes in regulatory or business conditions similar to the Australian distributors.

155 Water Services Association of Australia and Infrastructure Partnerships Australia, *Doing the important as well as the urgent: Reforming the urban water sector*, November 2015, p. 4.

156 Ergon Energy and Energex, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 5; MEU, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p.14.

4.5.1 United Kingdom electricity distribution

On 21 December 2018, the Office of Gas Electricity Markets (Ofgem) published a report prepared by the University of Cambridge's Energy Policy Research Group (EPRG), which examined the total factor productivity growth in electricity and gas networks since 1990.[157] Ofgem provided data to EPRG covering the United Kingdom's 14 electricity distributors for the period 1990–91 to 2016–17. EPRG examined five different total factor productivity models:

- The first model included customer numbers, energy deliveries and network length as outputs and produced an average annual productivity growth estimate of 1.1 per cent for the 27–year period from 1990 to 2017.
- The second model adds customer minutes not supplied and the number of interruptions as inputs and produces an average annual productivity growth rate of 2.0 per cent.
- The third model adds energy losses as input and produces an average annual productivity growth rate of 1.9 per cent. However, this model relies on a shorter sample period (1990 – 2005 and 2015–2017) due to missing data.
- The fourth model does not include energy losses as an input compared to the third model, but includes peak demand as an output. This produces an average annual productivity growth rate of -0.2 per cent.
- The fifth model, which Economic Insights considers to be most similar to its own econometric models, includes customer numbers, energy deliveries, network length and peak demand as outputs, and customer minutes not supplied and the number of interruptions as inputs. [158] This model estimates an average annual productivity growth rate of 0.9 per cent but relies on available data from 2012-13 to 2016-17.

Economic Insights advised that: [159]

> While the EPRG models cover both opex and capital, they provide a conservative guide to likely longer term opex productivity growth rates. This is because capex in constant prices (which is the measure of capital input used) trends upwards somewhat over the period whereas opex trends downwards over the period as a whole (EPRG 2018, p.34). Given EPRG's total productivity growth (which uses opex and capital) is positive, then using just opex would produce a higher partial productivity growth rate. This is because the total productivity is a weighted average of the opex and capital partial productivities. The capital input quantity's upward trend will be dragging the weighted average (or total) productivity down so it must be being offset by partial opex productivity growth that is higher than that for total productivity.

Economic Insights concludes that:[160]

> The average annual productivity growth rates EPRG finds both over the longer term 27–year period and the more recent 5–year period are consistent with the average

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157 Energy Policy Research Group University of Cambridge, *Productivity growth in electricity and gas networks since 1990, Report prepared for the Office of Gas and Electricity Markets*, 21 December 2018.

158 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, pp.11-12

159 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p.11.

160 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p.12.

annual growth rate of Australian DNSP opex productivity reported above for the five and six–year periods from 2011 onwards of around 1 per cent.

For the current network price control for electricity distributors, 1 April 2015 to 31 March 2023 (RIIO-ED1), Ofgem accepted the businesses' proposed ongoing efficiencies, which ranged from 0.8 per cent to 1.1 per cent. It had originally intended to set the efficiency assumption consistent with its price control for gas distribution, which was 1 per cent, informed by industry averages of partial factor productivity measures in comparable sectors from 1970 to 2007 (which ranged from 0.5 per cent to 2.8 per cent).[161]

For the period starting from 2023, Ofgem has proposed using the EU KLEMS dataset to assess productivity trends in the United Kingdom.[162] Ofgem proposes focusing on those sectors that have similarities with network companies, for example those that have significant asset management roles, and to exclude sectors (such as the electricity and gas sector) whose time series are heavily influenced by the increases in productivity realised after privatisation.[163]

4.5.2 New Zealand electricity distribution

The Commerce Commission in New Zealand forecasts electricity distributors' opex differently to our base-step-trend approach. When forecasting total opex, the Commerce Commission does not provide explicit allowance for specific cost increases in the form of step changes. Therefore, we take caution in interpreting the Commerce Commission's opex productivity growth forecast.

In making its final decision for the electricity distribution services default price-quality path determination for the regulatory period 2015–2020, the Commerce Commission adopted an opex partial productivity growth of –0.25 per cent per annum.[164] The Commerce Commission engaged Economic Insights to measure the long-run productivity growth rate and the opex partial productivity growth rate for the electricity distribution industry.[165] Economic Insights' opex partial productivity analysis produced positive productivity growth rates over the 1996–2014 period (0.45 –1.70 per cent per annum) but negative productivity growth rates over the 2004–2014 period (-1.40 per cent to -0.45 per cent per annum).[166]

Economic Insights advised that:[167]

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161 Ofgem, *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix,* 17 December 2012, pp.15-16.

162 The KLEMs dataset an EU-level analysis for capital (K), labour (L), energy (E), materials (M) and service (S) and is an initiative founded by the European Commission. It creates a database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states from 1970 onwards.

163 Ofgem, *RIIO-2 Sector Specific Methodology*, 18 December 2018, p. 141.

164 NZ Commerce Commission, *Opex projections model - EDB DPP 2015-2020*, 27 November 2014.

165 Economic Insights, *Electricity Distribution Industry Productivity Analysis: 1996–2014*, *Report prepared for Commerce Commission,* 30 October 2014.

166 Economic Insights, *Electricity Distribution Industry Productivity Analysis: 1996–2014, Report prepared for Commerce Commission*, 30 October 2014, p. iii.

167 Economic Insights, *Electricity Distribution Industry Productivity Analysis: 1996–2014, Report prepared for Commerce Commission*, 30 October 2014, p. iv.

> All else equal, failure to allow for the effect of past reset opex step changes in subsequent resets will lead to EDBs being over–remunerated as the measured opex productivity growth rate will underestimate the actual opex productivity growth rate. The opex partial productivity growth rate used in the rate of change formula needs to reflect productivity growth excluding step changes or else, if measured opex productivity is used, negative step changes may be required to equate the net present value of the actual opex requirements and the allowance resulting from application of the rate of change formula. To avoid negative step changes, this points to the use of a forecast productivity growth rate higher than measured from historic data spanning more than one regulatory period.

Consequently, the Commerce Commission adopted a -0.25 annual opex partial productivity growth, taking into account Economic Insights' analysis, the historical changes in partial productivity for New Zealand and overseas distributors but also the Commerce Commission's future expectations of productivity growth at that time.[168]

The Commerce Commission is currently considering forecasting opex partial productivity growth of zero to set the default price quality paths for electricity distribution businesses from 1 April 2020.

4.5.3 Ontario Canada electricity distribution

The Ontario Energy Board (OEB) sets electricity distributors' rates differently compared to our building-block model. Most Ontario distributors are subject to a five-year price cap incentive-ratemaking methodology where the OEB sets rates for the test year on a traditional cost-of-service basis, and then having resultant rates adjusted in years two through five via a formula that incorporates inflation, a productivity factor and a stretch factor. Therefore, the OEB relies on total factor productivity trend to set productivity forecast. We take caution in interpreting this data as we do not have further information to decompose the total factor productivity into opex and capex partial productivity.

In 2014, the OEB used a zero productivity growth forecast when it set the electricity distributors' regulatory rate adjustment parameters for the period 2014 to 2018. [169] The OEB determined that the productivity factor would be based on Ontario electricity distribution industry TFP trends using index based calculations. It had estimated average annual industry total factor productivity (TFP) growth of 0.19 per cent between 2002–2011 but –0.33 per cent between 2002–2012.

The OEB stated that it did not believe it appropriate to project and entrench declining productivity into the future. The OEB stated that setting a productivity benchmark for the industry that would not encourage distributors to achieve and share productivity gains would be counter to facilitating a culture of continuous improvement. The OEB therefore set the productivity factor used in its rate-adjustment formula to zero.[170]

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168 NZ Commerce Commission, *Default price-quality paths for electricity distribution businesses from 1 April 2020 - Issues paper*, 15 November 2018, pp. 59 and 62.

169 OEB, *Report of the Board – Rate setting parameters and benchmarking under the renewed regulatory framework for Ontario's Electricity Distributors*, December 2013, pp. 15- 17.

170 OEB, *Report of the Board – Rate setting parameters and benchmarking under the renewed regulatory framework for Ontario's Electricity Distributors*, December 2013, pp. 15- 17.

4.5.4 United States electricity distribution

Economic Insights noted that there have been a number of total factor productivity studies conducted of US electricity distribution businesses.[171]

In 2018, Pacific Economics Group reviewed longer term US electric and gas utility productivity studies. Pacific Economics Group reported that for a wide range of US decisions, the average annual 'acknowledged productivity trend' for electricity distribution businesses is 0.60 per cent and for gas distribution businesses is 0.63 per cent. It also noted its own most recent research on US electricity distribution productivity trends produced average annual growth estimates of 0.45 per cent for the period 1980 to 2014 and of 0.43 per cent for the more recent 1996 to 2016 period.[172]

4.5.5 Conclusion

We have examined the approach to forecasting productivity growth, and the resulting estimates, for electricity distribution across various international jurisdictions. In the United Kingdom and United States, the regulators have set positive productivity forecasts that are greater than 0.5 per cent (1.0 per cent in the United Kingdom and on average 0.6 per cent in the United States). New Zealand currently has a productivity forecast of -0.25 per cent, but is considering moving to zero in the next regulatory period, which is consistent with the forecast currently in place in Ontario Canada.

Given there is varying evidence about electricity distribution productivity growth forecasts in other jurisdictions, it is not clear we can place significant weight on these information sources. In terms of the factors we are considering to inform the weight we place on this information:

- It is unclear whether the international evidence we have would provide a reasonable estimate of the underlying productivity growth achievable within the Australian electricity distribution sector, particularly given its variability
- Estimates the shift in the efficiency frontier, and the extent to which it excludes catch-up effects
- These estimates would be unlikely to create any perverse incentives for distribution businesses to pursue productivity gains given they are exogenous
- The estimates reflects relatively recent data, but some of the data sets are dated
- The estimates are based on a transparent methodologies as they are generally derived from total factor productivity or opex partial productivity estimates.

171 Economic Insights, *Memorandum to the AER Opex Team - Forecast Opex Productivity Growth*, 4 February 2019, p.12.
172 Pacific Economics Group Research LLC, *MRI Design for Hydro–Quebec Distribution, Report prepared by Mark Newton Lowry and Matt Makos for AQCIE–CIFQ, Madison*, 5 January 2018, p. 41.

5 What is our forecast of the opex productivity growth factor?

In this final decision we consider that an opex productivity growth factor of 0.5 per cent per annum is reasonable for an electricity distributor on the efficiency frontier. This is based on our consideration of all the information sources available, and their strengths and weaknesses against the factors that we are using to establish the weight we place on each of them (as set out in section 3).

Table 12 summaries the results from each information source, including our evaluation of them against our factors, as previously presented in section 4. This shows that there is not a clear single information source or estimate that meets all our factors. We do not consider we can rely on a single information source to forecast opex productivity growth. In this circumstance, relying on sensible judgement and the various available information sources is reasonable. This is consistent with our draft decision.[173]

The use of multiple information sources, rather than a reliance on a single model, is consistent with previous findings from the Australian Competition Tribunal about forecasting efficient opex.[174] In previous NSW determinations, the Tribunal directed that:[175]

> … the AER is to make the constituent decision on opex under r 6.12.1(4) of the National Electricity Rules in accordance with these reasons for decision including assessing whether the forecast opex proposed by the applicant reasonably reflects each of the operating expenditure criteria in r 6.5.6(c) of the National Electricity Rules including using a broader range of modelling, and benchmarking against Australian businesses, and including a "bottom up" review of Ausgrid's forecast operating expenditure.

On multiple occasions, the Tribunal was of the view that the AER was incorrect to rely on the results of a single information source as the primary basis for its decision, rather than considering a broader range of modelling, or using a combination of methods.[176] Our decision on forecasting opex productivity growth is consistent with these views.

Our forecast of 0.5 per cent per annum for the productivity growth factor gives weight to estimates and forecasts from gas distribution and labour productivity growth estimates in a number of relevant sectors of the economy. These estimates are not directly based on the

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173 AER, *Draft decision - Forecasting productivity growth for electricity distributors*, November 2018, p. 25.

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

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

176 Federal Court of Australia, *Australian Energy Regulator v Australian Competition Tribunal (No 2)* [2017] FCAFC 79, [292]; *Applications by Public Interest Advocacy Centre Ltd and Essential Energy* [2016] ACompT 3, direction 1(a). The Tribunal's decision was upheld by the Full Federal Court. For more details, see: *Australian Energy Regulator v Australian Competition Tribunal (No 2)* [2017] FCAFC 79, [471].

observed productivity of electricity distributors but provide a good estimate of the productivity growth that might be expected of an electricity distributor on the efficiency frontier. Moreover, our productivity growth factor of 0.5 per cent per year is consistent with the measured productivity of electricity distributors since 2011.

Other sources of information further lend support to our estimate of 0.5 per cent, such as longer term productivity within the entire electricity supply chain and overseas studies of electricity distribution productivity.

To rely on productivity growth estimates from outside the electricity distribution sector is consistent with the approach used by other international regulators. In particular, Ofgem does not use data from the energy sector to set productivity forecasts for gas and electricity. Instead, Ofgem relies upon the productivity growth from a wide range of industries that are relevant to energy. This is because they consider that productivity growth in the UK electricity, gas and water supply sector is likely to include material catch-up due to the increased efficiency that followed privatisation.

The remainder of this section explains the reasons for our decision in more detail.

Table 12 Summary of available productivity estimates

	Electricity distribution	Electricity distribution	Electricity distribution (undergrounding)	Gas distribution	Labour productivity	Electricity supply chain	Water	International electricity
Estimation method	Opex PFP	Econometric time trend	Econometric coefficient	Econometric time trend	Gross Value Added	Multi Factor Productivity	Efficiency target	Total Factor Productivity
Productivity estimates (%)	0.35 - 0.97	1.2 - 2.2	0.1 - 1	0.43 - 0.7	0.3 - 0.7	1.3	0.25-1	0 - 1
Time period measured	2011-17	2011-17	2011-17	1999-2015	1999-2018	1975-2010	Variable	Variable
Factor 1: Underlying productivity growth	Unclear	Unclear	Yes	Yes	Potentially	Potentially	Potentially	No
Factor 2: Excludes catch-up	Yes	No	Yes	Potentially	Potentially	Limited	Unclear	No
Factor 3: Most recent data	Yes	Yes	Yes	No	Yes	No	No	Yes
Factor 4: Preserves incentives	No	Potentially	No	Yes	Yes	Yes	Yes	Yes
Factor 5: Transparent methodology	Yes	Yes	Yes	Yes	Partially	Yes	No	Yes

Source: AER analysis

5.1 Reasons for our opex productivity growth factor

Broadly, we consider that a productivity estimate will best satisfy our factors when it is based on long-term, consistent data that covers productivity growth cycles. This will better estimate the underlying productivity trend because it minimises the effects of cyclical fluctuations and year-to-year variations, including step changes. It is also likely to limit the effect of productivity catch-up. This was a key issue raised by most submissions to the draft decision, which led to concerns about a proposed productivity forecast that placed weight on information sources over a relatively short timeframe (e.g. 2012-16).

We also consider that it is important to preserve the incentives on electricity distribution businesses to pursue productivity gains over time. We are mindful that if we rely deterministically on our opex partial factor productivity analysis over the short recent period, this may reduce the incentives the frontier distributors have in pursuing productivity gains. We use measures of productivity that are not directly related to productivity achieved by electricity distributors in recent years to inform our forecast, thereby delinking the nexus between the electricity distributors' productivity performance and the productivity growth forecast.

CitiPower, Powercor and United Energy submitted that the AER should ensure that there is no double counting in its forecast productivity measure by adjusting for economy wide productivity already accounted for in the consumer price index.[177]

We do not consider there is an issue with double counting in forecast productivity growth. The forecast productivity growth, output growth and input price changes incorporated in our opex forecasts are specific to electricity distribution. These may differ from economy-wide productivity change, output growth and input price changes, leading to an outcome different from the economy-wide output price changes in the form of CPI. There is no need to adjust the sector-specific productivity for economy-wide productivity and there is no double counting.

Historical electricity distribution productivity growth supports positive productivity going forward

Our measures of electricity distribution productivity supports a positive opex productivity growth going forward. However, our measures have limitations and some caution should be applied when using these results to inform an opex productivity forecast.

Our opex partial factor productivity and econometric models rely on a relatively long data set from 2006 to 2017. The productivity estimates of this period of time is negative. However, as noted in section 4.1.1, we have concerns that the data prior to 2012 is significantly impacted by the increased regulatory obligations relating to safety and reliability imposed on the sector over this period. This includes more strenuous regulatory obligations relating to vegetation

[177] CitiPower, Powercor and United Energy, *Submission to the AER Opex Productivity Growth Forecast Review Draft Decision Paper*, 21 December 2018, p. 12.

management that affected some of the more efficient distributors in the NEM. These obligations affect the productivity results because they led to increased expenditure but no change in measured outputs such as customer numbers, circuit length and maximum demand.

This means that the decline in productivity measured by our models likely understates the underlying productivity growth achieved by the electricity distribution sector since 2006. Without having a longer data set which may 'wash out' the effect of regulatory changes, we examined electricity distribution productivity from 2011-2017. Specifically, we examined:

- Opex partial factor productivity analysis results from the period 2011–2017, which estimates positive productivity of between 0.35 per cent and 0.97 per cent. This reflects an estimate of the productivity growth from the frontier because we limit our analysis to the top four distributors (as ranked by their relative productivity in 2017).
- The rate of technical change (i.e. productivity) estimated in Economic Insights' econometric models for the Australian electricity distribution sector, which estimates positive productivity of between 1.2 per cent and 2.2 per cent.

These provides some support for a positive productivity growth estimate and is consistent with an opex productivity growth rate of 0.5 per cent.

However, the opex partial factor productivity estimates rely upon a relatively short and variable time period and a sample of commonly-owned businesses to proxy the industry frontier. The resultant productivity growth rates varies significantly as the time period changes and as different distributors are selected. Furthermore, if we were to rely on this estimate deterministically to forecast productivity, it may reduce the incentives on specific frontier businesses to pursue future productivity gains into the future.

This suggests that it may not be appropriate at this time to use these estimates deterministically to forecast opex productivity growth going forward.

The productivity growth estimated in the econometric models (the time trends specific to Australian distributors) also rely on a relatively short sample period, and potentially include catch-up effects (as outlined in section 4.1.2). Given this, we have also placed only limited weight on the econometric productivity estimates.

Gas and labour productivity establish 0.5 per cent productivity growth

Opex productivity estimates from gas distribution econometric models and labour productivity analyses are between 0.3 and 0.7 per cent. These estimates support a productivity growth factor of 0.5 per cent per year.

The gas distribution and labour productivity estimates and forecasts are based on relatively long data sets — from between 1999 to 2015 or 2017. This is longer than the data set available for electricity distribution in Australia. These measures also perform well against the other factors that we are using to establish how much weight to apply to each information source available to us.

Gas distribution productivity is a useful comparator because there are significant similarities between gas and electricity distribution in terms of their labour force, capital base, customers

served and network services provided, and regulatory regime (as outlined in more detail in section 4.4.2). In comparison to electricity distribution, gas distribution has not been affected by material step changes and changes in regulatory obligations to the same magnitude. It is also considered to be subject to some competitive pressure.

Our labour productivity estimates are useful because we have relied upon a range of sources that include labour productivity in the utilities sector (which includes both electricity and gas distribution), as well as other industries that perform similar functions to electricity distribution. The benefit of looking at sectors other than utilities is that they are not biased by the effects of step-changes and other events that are specific to electricity distribution.

As we discuss in section 4.3.1, our labour productivity measures for the utilities industry, including the DAE and BIS Oxford Economics' forecasts, may include some catch-up effects from the electricity distribution industry. This is because electricity distribution is the largest single industry within the ABS utilities index, contributing 30 per cent of industry value-added outputs. However, the labour productivity measure of the selected non-utilities sectors is not likely to be affected by these potential catch-up effects as much. The productivity results from both the utilities sector and selected non-utilities sectors measures fall within the same range (0.3 – 0.7) which suggest that the impact of any catch-up effects in the utilities sector measures may be minimal.

We consider the selected non-utilities sectors measure is a reasonable measure of productivity as it is based on a relatively long data period and it represents sectors that undertake similar activities to electricity distribution, and there are likely competitive pressures in these sectors compared to electricity distribution.

Another strength of using gas and labour productivity (selected non-utilities sector) estimates and forecasts is that they are not based on productivity achieved by specific electricity distribution businesses. There is little scope for individual businesses to affect productivity forecasts by changing their opex performance. This allows us to preserve the incentive electricity distribution businesses have in pursuing productivity gains under our ex ante regulatory framework.

The gas distribution and labour productivity estimates are broadly consistent (between 0.3 and 0.7). This lends support to an opex productivity growth factor of this magnitude.

Taking into account all of the above, we are of the view that we can give considerable weight to gas distribution and labour productivity estimates to form a view on a reasonable opex productivity growth estimate.

We note that an annual productivity growth factor of 0.5 per cent, as supported by the gas and labour productivity estimates, is not inconsistent with our electricity distribution productivity analyses:

- It is at the lower end of the range of estimated opex partial factor productivity growth rates for frontier distributors from 2011 to 2017
- It is less than the econometric time trends estimated for the period from 2011 to 2017. This reconciles with our findings that the econometric time trends are likely include the effects of catch-up.

This broadly lends support to our estimate as being productivity growth that may be reasonably achievable by distributors.

Network undergrounding is a source of productivity growth for firms

Network undergrounding is one source of ongoing opex productivity growth for distributors because underground network requires less maintenance expenditure compared to overhead network, irrespective of the reasons that a business undertakes undergrounding.

While our draft decision examined the productivity growth of undergrounding from an industry average perspective, we consider there is merit in examining firm specific estimates as argued in stakeholders' submissions. Accounting for the different possible functional forms for estimating the undergrounding coefficient in our econometric models, over the 2006–17 period the firm-specific annual reductions in opex due to increased undergrounding range from:

- 0.2 per cent to 1.2 per cent per year (log-log)
- 0.1 per cent to 0.4 per cent per year (log-linear).

These estimates are firm specific and do not reflect a productivity estimate for a frontier firm. Further, as our index-based opex productivity growth rates and the utilities labour productivity estimates include all sources of productivity, they are likely to include some impact from increased undergrounding. This is less likely to be the case for the time trend estimates from the gas distribution econometric models (since they are predominately already underground), and the selected sector labour productivity estimates, where the improved productivity from increased undergrounding could be considered an additional productivity source.

We are using a range of information sources to inform our opex productivity growth factor of 0.5 per cent per year, and some of these information sources take into account the impact of increased undergrounding. As a result, we consider undergrounding supports the case for positive productivity, but that at this stage given the information sources we are relying on we cannot incorporate it as an additional source of productivity. This is a conservative approach and minimises the possibility of any double counting.

Other productivity studies support positive productivity growth

In addition, as a cross-check for the reasonableness of our opex productivity growth forecast, we have considered productivity from other sources as suggested by some stakeholders:

- The regulatory precedents made in the water industry and overseas electricity distribution sectors, as suggested by some stakeholders. The firms in these sectors provide utility services similar to Australian electricity distributors and are subject to highly regulated environments. They provide some indication of what reasonable productivity growth is expected of regulated utilities service providers.
- The Productivity Commission's long-term multifactor productivity growth rates estimated in the Australian electricity supply industry over the period 1975–2010.

The Productivity Commission estimated annual productivity growth of 1.3 per cent achieved across the whole electricity supply chain in Australia from 1975 to 2010. This is the longest available data set for measuring productivity growth.

The Productivity Commission's estimate provides us with additional useful information in support of a positive productivity factor because it a long term estimate and measures the electricity supply industry. While it may include elements of catch-up within electricity distribution, this is likely washed out by using a long term data set. However, it is based on total factor productivity, rather than opex partial productivity, and does not account for productivity growth after 2010. It is also influenced by productivity growth exhibited in the electricity generation and retail sectors, which we do not consider to be comparable sectors for electricity distributor.

Recent studies in the United Kingdom has estimated long term total productivity growth of about 1 per cent from 1991 to 2017 in the electricity distribution sector. This broadly aligns with productivity measured by the Productivity Commission in Australia. However, historical productivity growth has been negative in New Zealand and Ontario Canada. Hence, there is no consistency from the international productivity estimates.

Despite being based on long data sets, we think the Productivity Commission estimates and international information should be applied cautiously as they do not measure opex productivity growth and we lack information about the drivers for negative productivity growth measured in particular jurisdictions. We consider the total factor productivity studies conducted in the United Kingdom provides evidence that opex productivity growth is likely to be positive and our reasons are set out in section 4.5.1. It supports our view that our productivity growth factor of 0.5 per cent per annum is not unreasonable.

Finally, the productivity growth from the Australian water sector may provide some information about a reasonable estimate of the underlying productivity growth that may be achievable in the electricity distribution sector, reflecting the similarities we consider exist between the water and electricity distribution industries. However, further review would be required to determine if the water sector has been subject to regulatory changes, and the timing of these, in the same way as the electricity distribution sector has been.

5.2 The difference between our draft and final decision

In this final decision, consistent with our draft decision, we have continued to adopt an approach that places most weight on gas distribution and labour productivity analyses, takes into account the measured productivity growth of electricity distributors in recent years, and also considers productivity growth from undergrounding. However, we have revised the productivity estimates from several information sources after considering the views from submissions and conducting further analysis. This includes:

- lower labour productivity growth estimates and forecasts
- updated econometric time trends for electricity distribution, including Australian specific time trends
- updated opex partial factor productivity growth rates, including revised estimates of the frontier and additional time periods

- expanded estimates of productivity growth from undergrounding, including estimates of firm-specific growth rates.

We also considered other information sources such as historical productivity from the whole electricity supply chain in Australia, water industry productivity, and international jurisdictions.

6 Implementation

We propose to use the opex productivity growth factor decided in this review process in our determinations for each electricity distributor, starting with the 2019–24 distribution determinations in April 2019.

We have listed the relevant determinations in Table 13.

Table 13 Relevant distribution determinations

Distributor	Regulatory control period commencing
Ausgrid	1 July 2019
AusNet Services	1 January 2021
CitiPower	1 January 2021
Endeavour Energy	1 July 2019
Energex	1 July 2020
Ergon Energy	1 July 2020
Essential Energy	1 July 2019
Evoenergy	1 July 2019
Jemena	1 January 2021
Powercor	1 January 2021
SA Power Networks	1 July 2020
TasNetworks	1 July 2019
United Energy	1 January 2021

We do not expect that we will need to update this productivity factor prior to 2021 unless we identify significant change in the underlying economic drivers of opex that may affect electricity distributors' abilities to generate productivity gains. This should provide some predictability for electricity distributors in preparing their regulatory proposals.

In relation to the revenue proposals currently under consideration, we will publish final decisions on these revenue proposals in April 2019. Prior to this we will provide distributors with an opportunity to submit their views on whether a different productivity growth factor should be applied in their individual circumstances. However, it is important to note that the productivity growth factor is meant to capture the productivity growth of a distributor on the efficiency frontier and not specific to individual distributors. We recognise that some distributors have proposed a higher percentage for productivity growth. We do not consider that this is inconsistent with this decision but rather that it likely captures what the individual distributor considers it can reasonably achieve. The key factor is whether a distributor's total opex forecast meets the criteria set out in the NER.

7 Appendices

Appendix A — Summary of stakeholders' submissions

Appendix B — Past step change events that affected our measured productivity growth

Appendix A — Key issues raised in stakeholder submissions and the AER's responses

Key issues raised in submissions	The AER's Response
The AER's review process is unsatisfactory	
Stakeholders including Evoenergy, Spark Infrastructure, Endeavour Energy, Jemena Electricity Network, SA Power Networks, Energy Networks Australia, CitiPower, Powercor and United Energy expressed similar concerns about our review process, noting that: 1. the review deviates from the AER's standard consultation process as the AER went straight to a draft decision without conducting its usual steps of consultation, raising broader concerns about procedural fairness 2. it has been shorter than the process for other reviews, with less scope for participation 3. the timing coincided with the AER's regulatory tax approach review consultation process and for some distributors, the period in which they must prepare their revised proposals 4. the AER had given pre-eminence to the Consumer Challenge Panel's (CCP) views in coming to its draft decision while distribution businesses were not consulted 5. the draft decision for this review was released before the AER 2018 Benchmarking Report and the AER did not provide guidance on how the updated data will be used in its final decision. The CCP also considered that this review process has been shorter than the process for other reviews, with less scope for participation by stakeholders, and	Given the sector wide implications of setting the productivity growth factor in our opex forecasting approach, we determined it was most appropriate to consider this issue outside but in parallel to the 2019–24 distribution determinations. This would enable all industry stakeholders to make submissions and inform the best estimate of the opex productivity growth factor. Stakeholders and consultants have made substantial submissions to us following our draft decision and we have taken these submissions into account in reaching our final decision. We consider that the consultation process has provided for procedural fairness based on the nature of the issue under consideration. This is not a matter of having to identify or make a case that there is a material benefit in departing from the status quo as some networks have argued. We are not reconsidering the mechanism used to arrive at an efficient opex forecast, namely the base-step-trend approach as set out in the Expenditure forecast assessment guideline. Rather, we are updating the productivity growth factor to be used in the trend parameter of our opex forecast based on a range of information sources. Our intention is to include a productivity growth factor of 0.5 per cent per year into the trend parameter of our opex forecast which we use to assess the revenue proposals currently under consideration. We will provide

greater opportunity to participate at an earlier stage would have been welcomed. However, the CCP argued that the standard set by the rate of return guideline review is not considered the benchmark for a variety of reasons. Further, undertaking this review has increased the transparency and consistency of the AER's determination on trend productivity assumptions and created additional opportunities for stakeholder involvement.	stakeholders with an opportunity to submit their views on whether a different forecast should be applied in individual circumstances. However, it is important to note that the productivity growth factor is meant to capture the productivity growth expected of a prudent and efficient distributor, which does not relate specifically to the individual distributors' circumstances but is required of all distributors in the sector under business-as-usual operations in our efficient opex forecast. We recognise that some distributors have proposed a higher percentage for productivity growth. We do not consider that this is inconsistent with our productivity growth forecast but rather that it likely captures what the individual distributor thinks it is reasonably able to achieve. The key factor is whether a distributor's total opex forecast meets the criteria set out in the NER.
ETU expressed its concerns with the AER's lack of effort in meaningfully engaging stakeholders other than industry stakeholders, such as workers representatives.	Our consultation process has been made publicly available to all affected stakeholders with all notifications posted on our website
The incentive effects of our productivity growth forecast	
SA Power Networks stated that we did not articulate the problem we were trying to 'solve via pre-emptive productivity adjustments'. It further claimed that we did not substantiate the view that, 'without pre-emptive productivity adjustments, the regulatory framework provides insufficient competitive pressure on distributors'.	Forecasting productivity growth or total opex is not a problem we are trying to solve. It is what we are tasked to do under the NER. The NER requires us to forecast opex for an efficient costs of a prudent distributor. Forecasting productivity growth is part of the assessment in determining what opex an efficient and prudent distributor would require to deliver distribution network services. It is not the purpose of our productivity growth forecast to impose competitive pressure on distributors that would not otherwise occur, but rather capture the productivity growth an efficient and prudent distributor is expected to achieve, ensuring that our opex forecast reasonably reflects the NER requirements. See section 2.1 of the final decision.
PIAC considered that the EBSS is designed to share efficiency benefits beyond a baseline expectation of productivity growth. As such, the EBSS will continue to	PIAC's interpretation is consistent with what is set out in the Expenditure forecast assessment guideline. The productivity growth factor captured in

incentivise productivity beyond the baseline by allowing distribution network service providers to retain 30 per cent of the benefit of those additional productivity gains.	the trend parameter of the efficient opex forecast is to measure the productivity growth an efficient and prudent is expected to achieve, and is what we should require of distributors in the sector under business-as-usual conditions. This is because consumers should only be required to compensate individual distributors for the efficient costs of a prudent distributor and not all the costs individual distributors are expected to incur. The incentive framework provides an individual distributor with the incentive to improve its efficiency beyond the productivity growth we expected of it. See section 2.1 of the final decision.
SA Power Networks stated that network users would receive 100 per cent of the forecast productivity growth, plus 70 per cent of the extra productivity growth the distributor achieves. It stated that the network users would receive 170 per cent of the benefits of the productivity gain and this would not be in line with the incentive framework. In saying this, SA Power Networks suggested that distributors would be worse off for making productivity gains beyond those forecast, since network users would benefit more than the productivity gain.	If a distributor outperform the productivity growth forecast, the network users keep a 100 per cent of forecast productivity growth, but will share the remaining opex savings with the distributor under the efficiency benefit sharing scheme (EBSS). The network users do not receive benefits more than the total productivity growth the distributor has made. SAPN's argument goes to whether distributors should be entitled to a share of all the productivity grains they have made. The incentive framework is not meant to provide for a sharing mechanism for the productivity growth that is expected of the distributor and that would otherwise occur under business-as-usual operations. The EBSS provides a consistent sharing of the productivity gains the distributor makes beyond that we have forecast and which would result in lower total opex compared to our opex forecast. See section 2.1 of the final decision.
Endeavour Energy stated that forecasting productivity growth would create a high powered incentive because the distributor would 'bear the full cost of failure'.	To the extent that a distributor is not able to achieve the forecast productivity growth, all else equal and with an EBSS in place, this overspend would be shared between the distributor (30 per cent) and network users (70 per cent), consistent with all other efficiency gains and losses. Altering the productivity growth forecast should not change how the EBSS shares unforeseen efficiency gains and losses and would not result in the distributor 'bearing the full cost of failure'. See section 2.1 of the final decision.

CitiPower, Powercor and United Energy stated that basing productivity growth forecasts on recent efficiency savings made by distributors will 'claw back' the financial rewards achieved from profit maximising behaviour. This will lead to less efficient behaviour, higher risk profiles, and higher costs to consumers.	We agree that using the revealed productivity gains of an individual distributor to forecast productivity growth would reduce its incentive to improve productivity. This is because the benefits derived from the actual productivity growth would be negated by the productivity forecast set for the following period. It is for this reason that we do not intend to use the revealed productivity gains of a distributor to forecast productivity growth for that distributor. See section 2.1 of the final decision.
Both Endeavour Energy and the Electrical Trades Union raised concerns that an inappropriate productivity growth forecast could negatively impact safety or service levels.	The purpose of this review is to identify the level of productivity growth that can be achieved by a prudent and efficient distributor, while maintaining the reliability and safety of its networks. Based on the available evidence, we do not consider our productivity growth forecast of 0.5 per cent per year is inappropriate or would lead to an opex forecast that is insufficient for a prudent and efficient distributor to maintain a reliable and safe network. We set a revenue allowance that incorporates an efficient forecast of opex. Once the revenue allowance is set, the distributor has discretion to reallocate costs to deliver safe and reliable services. We would not expect an efficient and prudent distributor to put returns ahead of safe and reliable services. In many cases we have observed that distributor have outperformed the revenue allowance while being able to deliver safe and reliable services. See section 2 of the final decision.
Feedback on the AER's electricity distribution productivity analyses	
AusNet Services, Endeavour Energy, CitiPower, Powercor and United Energy submitted that the AER should rely on its econometric models for electricity distribution, measured over the long term, as this would be internally consistent with the opex forecasting approach and can reduce the impact of outliers and one-off productivity events. Evoenergy and Jemena submitted that the historical measured productivity decline does not mean there has not been productivity growth. It may mean that	We agree that it is desirable to take a longer time period when estimating an underlying trend. However, as noted in section 4.1 of our final decision, we consider that the measured productivity over the 2006–2017 period is significantly impacted by the increased regulatory obligations relating to safety and reliability imposed on the sector prior to 2011. The historical decline in productivity does not mean that there has not been productivity growth.

electricity distributors are producing outputs not specified in the AER's models. Therefore, forecasting productivity using the econometric time trends would ensure consistency with the measurement of outputs, including those not accounted for in the models. NERA stated that the AER's econometric modelling, the SFA models in particular, better captures frontier shift without needing to select specific firms. NERA suggests that if the AER cannot rely on the econometric data due to the influence of international data, it can use dummy variables.	We agree that estimating productivity using our econometric models is desirable because it is consistent with the models used to assess base year efficiency and forecast output growth, and hence an opex productivity forecast from them would be internally consistent. However, we consider that the time trends from the econometric models likely overestimate frontier productivity growth as they are based on the full sample and so include catch-up effects to varying degrees. Hence, while in theory the SFA model should better estimate the shift in the frontier, the results based on the existing data likely include some catch-up. This is informed by Economic Insights' advice. As a general rule, when conducting trend analysis the more data the better. However, the data available has to be consistent and reflect business as usual circumstances. In this case the 2006–12 time period reflects unusual circumstances and as such provides a distorted estimate of future productivity growth possibilities. As such we have used a shorter time period to estimate the trend. This time period is more likely to reflect business as usual conditions. We have also drawn on other information from other sources to arrive at our productivity growth forecast of 0.5 per cent per year.
AusNet Services, Ausgrid, Endeavour Energy, Evoenergy, Spark Infrastructure, CitiPower, Powercor and Untied Energy submitted that the short time period is sensitive to section of the start and end-points. They state that the AER's choice of 2012-17 produces bias results as this period of high productivity growth is not representative of business-as-usual operating environment and overstates what can be achieved. NERA and HoustonKemp argued that the 2012-17 period is too short to account for volatility. The CCP argued that a long period is desirable, but the length of the data series is not the only factor. The estimate of productivity should exclude the effect of prior significant step-changes or catch-up.	There are a number of ways to address the issue of material step changes affecting the productivity trend over the 2006-17 period. This includes: • Providing additional output variables in the productivity models. • Re-estimating the trend by excluding the costs associated with the step changes. • Focusing the productivity measurement on the period following the step changes period. We have focused on forecasting productivity using productivity measured on the period following the step change period. The other approaches will likely be difficult and time consuming to develop and require relatively significant further engagement with industry and potentially additional data

	collection, including extensive recasting of data. This was not possible within the time available to complete this review. As set in section 4.1, we have considered both 2011-17 and 2012-17 as possible time periods that better reflects business-as-usual opex productivity growth within the sector and for those frontier distributors. However, we agree that the average productivity growth varies significantly as the time period changes and hence it is sensitive to the choice of starting and ending years, as well as the choice of distributors used in the sample. We have attempted to reduce the risk that either the 2011-2017 or 2012-17 period is atypical or that the start and end points reflect unusual circumstances by measuring productivity growth using a range of methods. This includes regression analysis. However, despite this, we recognise that the annual rate of productivity growth is based on a relatively small data set. In this context we consider it is not appropriate at this time to use opex productivity results deterministically to set an opex productivity growth factor. It is appropriate to examine productivity trends more broadly, including over the long-term and in comparator sectors.
AusNet Services, Endeavour Energy, CitiPower, Powercor and United Energy were of the view that the AER's opex MPFP analysis in its draft decision is likely to over-estimate the shift in the efficient frontier because of the selected frontier firms (i.e. firms that are not materially inefficient), which likely includes catch-up. Therefore, the estimates derived from opex MPFP analysis should be regarded as an upper bound of the AER's productivity growth forecast. NERA noted that the AER had used an unweighted average of its selected frontier firms, rather than a weighted average. The CCP stated that there is no best approach to selecting the frontier group of firms. It considers the AER should give the most weight to the opex MPFP analysis because it is the best, most relevant and simplest proxy for opex productivity growth.	We agree with submissions that our draft decision likely did not strictly measure growth in the frontier because it includes some distributors that exhibited catch-up. In section 4.1 of our final decision we have expanded our analysis of the efficient frontier by comparing five different groupings of distributors. In arriving at our final decision, we consider that productivity achieved by the top four distributors should ensure that the productivity measure does not include catch-up. Economic Insights also calculated productivity using a weighted-average based on the aggregate inputs and aggregate outputs of each of distributors in each of the above groupings. This addresses concerns raised by several submissions that our draft decision relies upon an unweighted average of individual distributor's opex productivity growth rates.

Endeavour Energy stated that the AER has not specified the regulatory obligations introduced between 2006-12 and quantified the impact of those step changes. SA Power Networks similarly states that the AER did not identify the obligations it wants to exclude from 2006-12 or why these were unique compared to other changes. The CCP outlined the impact of past step changes and regulatory obligations in its submissions. The CCP stated that the estimate for trend productivity should exclude the effect of past significant step changes and 'catch-up' efficiency gains.	As set out in section 4.1 and appendix A of our final decision, we have specified the regulatory obligations which we consider to have affected our measurement of distributor's productivity over the 2006-17 period. However, we do not have necessary information to quantify the impact of these regulatory obligations apart from the amount we had approved as step changes in the past. We note that these regulatory obligations may not be the only contributor to distributors' productivity decline but they are likely to be a material contributor given their magnitudes and they cannot be ignored in estimating a reasonable productivity growth forecast.
The AER's approach in estimating productivity growth associated with network undergrounding	
Energy Queensland, Ausgrid and Jemena questioned the reasonableness of expecting all electricity distributors to achieve a target level of undergrounding. Evoenergy, NERA, Ausgrid and Jemena submitted that the AER's draft decision approach would create perverse outcome of penalising a distributor if it did not achieve a target level of undergrounding that has no relevance to its own circumstances.	As set out in section 4.2 of our final decision, we consider there is merit in examining undergrounding on a firm specific, rather than industry average basis. We have estimated the implied range of firm specific opex savings from an increased share of undergrounding (based on historical growth over the period 2006-17).
Both CCP and MEU noted that network undergrounding only represents one source of productivity improvement and therefore the AER should not limit its productivity forecast to just the proportion of undergrounding that occurs.	As set out in section 4.2 of our final decision, we consider undergrounding network is one, but not the only, source of productivity irrespective of its drivers. While we consider undergrounding supports the case for a positive productivity growth forecast, we do not consider the results can be applied consistently across the sector at this point in time. We have therefore not relied on the undergrounding results to forecast productivity growth in our final decision.
AusNet Services, Ausgrid, Jemena, Endeavour Energy, NERA, CitiPower, Powercor and United Energy submitted that a business-specific forecast for undergrounding effects is preferred because this would at least ensure that it is consistent with the growth in circuit length measure used as an output growth	As reflected by the analysis undertaken by Economic Insights, and noted in section 4.2, there is no difference between including undergrounding as a part of the output forecast component or as part of the productivity forecast component of the rate of change.

measure in the opex model. Endeavour Energy states that undergrounding is better dealt with as part of output growth forecast.	
Endeavour Energy stated that the growth in the proportion of undergrounding achieved by non-frontier firms may have only been so as part of their catch-up improvements. AusNet Services submitted that the AER should examine whether its approach of adjusting productivity for the proportion of undergrounding is robust and how to separate frontier shift and catch-up using econometric models.	Undergrounding is included in the electricity distribution econometric models as an operating factor and therefore enables the implied range of opex savings from an increased share of undergrounding to be separately estimated from other efficiency / productivity savings. In using the results from these models this should mean that productivity results related to undergrounding are separate to catch-up improvement.
CCP also suggested that it would be useful to examine the consistency of the relevant parameter estimates across the regression models and the robustness of the parameter estimates. Energy Queensland noted that due to the inclusion of overseas data, the coefficient on undergrounding in econometric models may not accurately represent the scope for productivity savings from undergrounding.	We have examined the operating environment coefficient for undergrounding across SFA Cobb Douglas, LSE Cobb Douglas and LSE Translog models and presented these in section 4.2. They are broadly consistent across the log-log functional form and are all statistically significant.
Endeavour Energy stated that the coefficient on undergrounding is measured over the full 2006-16 period, which is inconsistent with the other measures relied upon. It further adds that the proportion of undergrounding may have been impacted by the jurisdictional licence conditions or the Victorian Bushfire Royal Commission findings.	We have examined the operating environment coefficient for undergrounding over the 2006-17 and shorter 2012-17 period. The results are broadly consistent and so we have only presented results for the 2006-17 period in section 4.2 of our final decision. Further, as noted above, we consider productivity is one, but not the only, source of productivity irrespective of its drivers.
NERA recommended that the undergrounding coefficient should be re-calculated using a linear, rather than logarithmic, approach. This is because using a logarithmic function to measure undergrounding implies that distributors with more undergrounding will increase their share of undergrounding at a faster rate than those with a lower share.	The appropriate functional form for including undergrounding in the electricity distribution econometric models is examined in section 4.2. Economic Insights has investigated the relative merits of a log-log and log-linear functional for and concluded that the log-log functional form is more appropriate because it provides a better statistical fit to the data using a number of different tests. Further, the log-log functional form produces more stable measures of undergrounding marginal effects (the change in opex where there is a one kilometre change in the length of underground) across

	the sample data.
Alternative approaches to forecasting labour productivity growth	
BIS Oxford Economics stated that the wage price index (WPI) cannot be adjusted for productivity as it reflects pure price changes and does not measure variations in the quantity or quality of work performed. Further, that it does not reliably measure the changes in total labour costs which an enterprise incurs as it does not reflect the changes in skill levels. BIS Oxford Economics considers the average weekly ordinary time earnings (AWOTE) is better in reflecting changes in both the level of earnings per employee and the composition of the labour force.	We have not specifically examined this issue in the final decision as it appears to relate more to the price growth component of the rate of change rather than the productivity growth component.
BIS Oxford Economics, Endeavour Energy, NERA and SA Power Networks submitted that there is insufficient information provided about the basis for Deloitte Access Economics (DAE) estimate (e.g. forecasts for output and employment or weights used) for comment to be provided. Endeavour Energy noted that given the size and frequency of DAE's estimates for average labour productivity compared to those reported by the ABS, it is concerned that DAE's methodology suffers upward forecasting bias. CitiPower, Powercor and United Energy stated that the DAE's forecast appears to rely on economy wide forecasts without establishing why this is relevant to the utilities sector.	Further information has been provided in a note from DAE's how it forecasts labour productivity, including in relation to the weights and reliance on economy wide forecasts.
Ausgrid submitted that in relation to the AER's reliance upon ABS productivity data from 2012–17 in its draft decision, ABS productivity data should only be considered (for labour productivity analysis) on the basis of full productivity cycles or a very long time period	Following feedback from Ausgrid and other stakeholders, in section 4.3 of the final decision we have examined the labour productivity trends over the productivity growth cycles identified by the ABS – two complete cycles (1998-99 to 2003-04 and 2003-04 to 2011-12) and an incomplete cycle (2011-12 to 2016-17). We note that these time periods are reasonably similar to the time periods used to examine the electricity distribution productivity growth information from the opex partial factor productivity and econometric models.

BIS Oxford Economics submitted that the ABS quality adjusted labour productivity utilities index using the latest data has declined over recent years and demonstrates year on year volatility. It states that the average annual quality-adjusted labour productivity growth for utilities has fallen by an average of -0.4 per cent over the past five years from 2012-13 to 2017-18 inclusive.	We have updated the labour productivity analysis in section 4.3 for the latest year of data (2017-18) available from the ABS.
Ausgrid, Evoenergy and CEPA submitted that the quality adjusted labour productivity for Australia, for the utilities sector is not appropriate. CEPA suggest that the AER should develop an alternative labour productivity estimate using sectors that are less susceptible to the issues captured in the ABS' utilities sector. CEPA selected five sectors that are similar to components of distributors' opex activities to estimate an unweighted average of labour productivity.	We have examined CEPA's non-utilities sectors labour productivity estimate in section 4.3 and relied on it in section 5 setting our opex productivity growth forecast.
CCP suggested that the labour productivity forecasts be extended to all costs including non-labour inputs. On the other hand, NERA submitted that the AER's labour productivity approach requires constant productivity growth in other inputs.	We do not consider it appropriate to extend the labour productivity forecasts to the non-labour inputs, but rather we have examined other information sources to inform us about the full extent of productivity that may occur in the electricity distribution sector.
Energy Queensland stated that some efficient business will find it harder to realise productivity gains than others due to different labour-mixes of labour and capital inputs or environmental factors. It questions whether different productivity forecasts should be determined individually.	We acknowledge that different electricity distribution businesses will have different labour mixes, but note that to the extent we were to incorporate different labour mixes then we would also need to take into account the any potential productivity benefits being passed through in non-labour costs. We also note that labour productivity is only one information source that we have examined in establishing opex productivity growth forecast for the electricity distribution sector.
AusNet Services submitted that the DAE's labour productivity forecast is likely to include both catch-up and frontier shift, and does not account for any capex necessary to achieve productivity improvements.	As set out in section 4.3, we have examined whether DAE's and the other labour productivity forecasts considered are likely to include catch up as well as frontier shift. We acknowledge that this may be the case if some of the inefficient distribution businesses have improved efficiency of their operations, which could result in an over estimation of productivity using these forecasts. Section 4.3 also examines other limitations associated with the labour productivity measures which could result in under estimation of

	productivity. In particular, that the output measures used to estimate labour productivity rely on energy supplied and do not take into account the multiple dimensions of the services provided by distribution businesses. We have also examined the relationship between capex and productivity improvements in section 4.3. We note that when examining productivity we generally have regard to capital inputs, i.e. capital stock and not the level of capex. Therefore, while capex may change over time, it is the level of capital inputs that informs labour productivity as the capital stock already in place enables efficiencies to be achieved.
The AER's reliance on gas distribution productivity growth	
Energy Networks Australia, Endeavour Energy and Spark Infrastructure stated that there is a lack of justification for the AER's assumption that the gas productivity trends would be related to or indicative of future electricity distribution opex productivity. Energy Queensland, AusNet Services, SA power Networks, NERA, Ciitpower, Powercor and United Energy outlined the differences between electricity and gas distribution industries, including: • different technical skills required to maintain and run networks • additional penetration of distribution energy resources and the transformation of the role of the electricity network • significant legislative change that increases safety and vegetation management expenditure • different cost inputs and conditions, especially in relation to the prominence of overhead line conditions for electricity and the scale of electricity networks into rural regions. However, NERA recognised that there may be some similarities in labour force between electricity and gas network businesses, and the supply of utilities services to similar users.	As set out in section 4.4.3 and section 5.1, we consider that there are similarities between gas and electricity distribution in terms of their labour force, capital base, customers served and network services provided, and regulatory regime. Both electricity and gas distribution businesses incur a large proportion of their opex as labour costs and in maintaining distribution network infrastructure assets. In addition, we find gas distribution to be a useful source of productivity information gas distribution has not been affected by material step changes and changes in regulatory obligations to the same magnitude as to electricity distribution. Therefore, productivity trend observed in the gas distribution industry is more reflective of the business-as-usual operations of a distribution business. The gas distribution industry is also considered to be subject to some competitive pressure as gas can be considered as a fuel of choice.

AusNet Services and Jemena stated that the gas econometric model specifications and the data underlying those models differ from the model used to set other elements of the distributors opex forecast.	We cannot rely deterministically on electricity distribution econometric models to forecast productivity growth at this point in time due to the underlying data issues, so we have looked to other sources of productivity growth estimates, including the gas distribution econometric models. This approach will inevitably involve examining data and models different to those used to set other elements of the distributors' opex forecasts. While it is preferable to use consistent model and data to set opex forecast, we must nevertheless consider alternatives when this is impracticable. We note that we use revealed costs and bottom-up assessments, rather than econometric models, to forecast base opex and step changes. The gas econometric models include similar output specifications to the electricity distribution models— all include customer numbers as an output and Economic Insights (2016) also includes network length and throughput, as well as a relatively detailed treatment of operating environment factors. See section 4.4.3 of the final decision.
NERA, CiitPower, Powercor and United Energy stated that many of the coefficients in the gas econometric models are not statistically significant, meaning that gas productivity forecasts may not be statistically robust.	We agree with Economic Insights' advice that model specification should be based on underlying economic theory rather than statistical significance alone. Statistically insignificant coefficients still provide useful information about the relative drivers of opex, as long as the high standard error is observed. See section 4.4.3 of the final decision.
NERA, CitiPower, Powercor and United Energy submitted that the AER may double count productivity improvements by combining gas distribution productivity growth estimates with an undergrounding coefficient from electricity-specific econometric models. This means that the AER cannot simply add the two together without re-estimation.	In our final decision, we have not used the undergrounding coefficient from our electricity-specific econometric models in a deterministic way. This includes not combining gas productivity with productivity from undergrounding. However, given that gas distribution networks are predominantly underground, the productivity from gas distribution should not include any of the productivity benefits of undergrounding that benefit electricity distributors. See section 4.4.3 and section 5 of the final decision.
The AER should consider productivity growth from other sectors and jurisdictions	

AusNet Services submitted that we should also consider electricity transmission productivity growth if gas is going to be used, but advised against using either in any material way.	We do not consider that it is appropriate at this point in time to rely on the productivity trends from electricity transmission because productivity analysis for transmission networks is still in a relatively early stage of development, and there are only a small number of electricity transmission networks in Australia (five) to measure a productivity trend. In contrast, the gas distribution econometric modelling relies upon data from 9 and 11 Australian gas networks and between 2 and 3 New Zealand gas networks
MEU suggested that labour productivity for Australia, utilities is volatile and includes industries which are not as capital intensive as distribution. MEU submits that the all industries measure has been above zero and positive for the past two decades.	All industry measures also include industries that are not as capital intensive as distribution. Therefore, we did not consider it appropriate to rely on the labour productivity measure for all industries in Australia in our consideration.
Energy Queensland suggested that evidence from other sectors such as water and transport should be considered. Ausgrid, Jemena and CEPA suggested that the AER examine precedent from current ongoing efficiency challenges set by regulators in other sectors in Australia, and internationally.	We have considered, to the extent data are available, these additional information sources in our final decision. See section 4.4 of the final decision.
Energy Queensland stated that while the AER uses New Zealand and Ontario in its econometric models it is unclear why these countries and businesses have not been considered as comparators for productivity proposes. MEU suggested that the AER should investigate the productivity of electricity networks in overseas jurisdictions.	We have considered, to the extent that they are available, these additional information sources in our final decision. See section 4.5 of the final decision.
CCP pointed to the Productivity Commission's total factor productivity estimate for the electricity sector of 1.3 per cent using a long term time series of 34 years to 2008-09.	We have considered this additional information source in our final decision. See section 4.4 of the final decision.
MEU suggested that qualitative data from senior management of large capital-intensive firms operating in competitive sectors would provide the AER with a better understanding of how it might be able to impose the pressures of	This would require us to consider further what data we can collect and how they may assist us to derive a productivity growth forecast. This is beyond the scope of this review.

competition onto monopoly networks.	
Other considerations the AER needs to have	
Energy Queensland and AusNet Services raised that increasing regulation and changes to industry dynamics may support a negative productivity forecast and should be taken into account as a part of the AER's 'holistic' approach.	To the extent that there are significant changes in the driver of electricity distributors' opex, these are typically assessed as step changes under our assessment framework. Electricity distributors must provide evidence to demonstrate that such changes have a material impact on their opex.
BIS Oxford Economics stated that productivity growth from the move towards renewable energy will not be reflected across the electricity distribution and transmission sectors.	While this may be true, renewable energy is not necessarily the only source, or even a relevant source, of productivity growth that electricity distributors can achieve. The majority of our information sources that we have relied on to forecast productivity growth do not appear to capture the productivity growth related to renewable energy.
Energy Queensland submitted that by focusing solely on opex PFP, the risk exists that the AER might create perverse incentives for businesses to overcapitalise. Additionally, overseas regulators generally set productivity targets based on TFP. MEU stated that the AER needs to more closely analyse the impacts on productivity through capital investment as this should increase productivity. BIS Oxford Economics stated that due to the direct correlation between opex and capex, productivity growth should be measured across the entire electricity sector and applied to a whole entity (i.e. not just to opex).	The productivity growth forecast we set is used to forecast total opex. Our regulatory framework does not rely on a total expenditure forecast. It would therefore be inappropriate to incorporate a total factor productivity forecast in our opex forecast.
CitiPower, Powercor and United Energy submitted that the AER should ensure that there is no double counting in its forecast productivity measure by adjusting for economy wide productivity already accounted for in the consumer price index.	We do not consider there is an issue with double counting in forecast productivity growth. The forecast productivity growth, output growth and input price changes incorporated in our opex forecasts are specific to electricity distribution. These may differ from economy-wide productivity change, output growth and input price changes, leading to an outcome different from the economy-wide output price changes in the form of CPI. There is no need to adjust the sector-specific productivity for economy-wide

	productivity and there is no double counting.
ETU suggested that the AER's benchmarking is flawed as it tries to compare network companies against each other when there are many differences between distributors for various reasons. ETU stated that the AER issuing opex determinations based on arbitrary formulae will create perverse incentives or unintended consequences that compromise safety.	There are operating environment differences between electricity distributors, but the services they provide or the output they deliver and the regulatory framework they are subject to are largely the same. Our benchmarking and our assessment of a distributor's specific operating environment provide a high level indication of the distributors operating efficiency, which affects our assessment of its base opex. This is a separate assessment to forecasting opex productivity growth, which aims to estimate the shift in the efficient frontier, i.e. productivity improvement an efficient and prudent distributor can achieve. While the differences in the distributors' operating environments may lead to differences in efficient base opex amounts, they do not preclude the distributors from deriving any productivity gains or achieving productivity growth expected of an efficient and prudent distributor. Our regulatory framework allows a distributor to allocate its resources at its own discretion to activities that it consider prudent and efficient, such as addressing safety concerns within its network. The distributor must comply with all its regulatory obligations, including safety standards, while being incentivised to find productivity gains to outperform our opex forecast. Our opex forecast provides at least the efficient costs a prudent and efficient distributor requires to deliver network services while complying with its regulatory obligations. Our opex forecast, regardless of being higher or lower, does not enforce what a distributor would spend to satisfy its regulatory obligations.

Appendix B — Past step change events that affected our measured productivity growth

The reported opex amounts that we use to estimate opex productivity growth include all past major step changes, including regulatory obligations. With the dataset we have, we cannot distinguish the actual costs associated with major new regulatory obligations from the base opex requirements that the distributors usually incur under business as usual conditions.

There is a downward bias in our opex partial factor productivity analysis and econometric model results because we do not currently adjust for past material step changes in the historical opex data. Step change events increase opex (inputs) but not the outputs we measure in our benchmarking analyses. If we were to base our productivity growth forecast on the measured productivity growth in our opex partial factor productivity analysis and econometric models, it implies that the forecast period will contain similar material step change events as those experienced in the past, which does not accord with our actual expectation. Also, our opex assessment framework typically accounts for such events with the inclusion of step changes in our opex forecast.

As demonstrated below, the estimated costs for the past step change events within the 2006–12 period were material. That is not to say these past step change events are the only contributing factor to the measured productivity decline in our productivity analyses. However, they are not so insignificant that we can ignore in assessing whether the measured productivity decline reasonably reflects future productivity growth under business-as-usual circumstances. Therefore, we are not satisfied that productivity growth forecasts that rely on 2006–12 data, and which would entrench the effects of past material step change events, would reasonably reflect the realistic expectation of the cost inputs required to achieve the opex objectives.

Victorian distributors' opex within the 2006–2012 period

In our 2011–2015 Victorian distribution determinations, we provided the Victorian distributors a total of $378 million for step changes ($2010).[178] Many of the step changes related to new regulatory obligations arising under the National Framework for distribution network planning and expansion, the Electricity Safety (Bushfire Mitigation) Regulations 2013, the Electrical Safety (Management) Regulations 2009 and the Electricity Distribution Code.[179]

Of particular relevance is the additional vegetation management and bushfire mitigation requirements imposed by the Electricity Safety (Electric Line Clearance) Regulations 2010. For these new requirements we provided opex step changes totalling $211.7 million ($2010).[180]

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178 AER, *Victorian distribution determination final decision 2011-2015 – Appendices, Appendix L*, October 2010, p.447.

179 AER, *Victorian distribution determination final decision 2011-2015 – Appendices, Appendix L*, October 2010, p.447.

180 This includes the new step change amounts we approved for CitiPower and Power pursuant to the Australian Competition Tribunal's directions following a limited merits review.

Table 1 below shows the step changes that we approved specifically for the Electricity Safety (Electric Line Clearance) Regulations 2010 obligations.

Table 1 Electricity Safety (Electric Line Clearance) Regulations 2010 step changes ($million, 2010)

Distributors	2011	2012	2013	2014	2015	Total
Citipower*	1.3	3.9	4.9	3.3	3.1	16.5
JEN	2.3	2.2	1.6	1.6	1.6	9.3
Powercor*	9.0	20.7	25.4	9.4	8.2	72.8
SP AusNet	12.8	15.3	17.2	17.6	17.8	80.7
United Energy	7.4	7.4	5.7	5.9	5.9	32.4

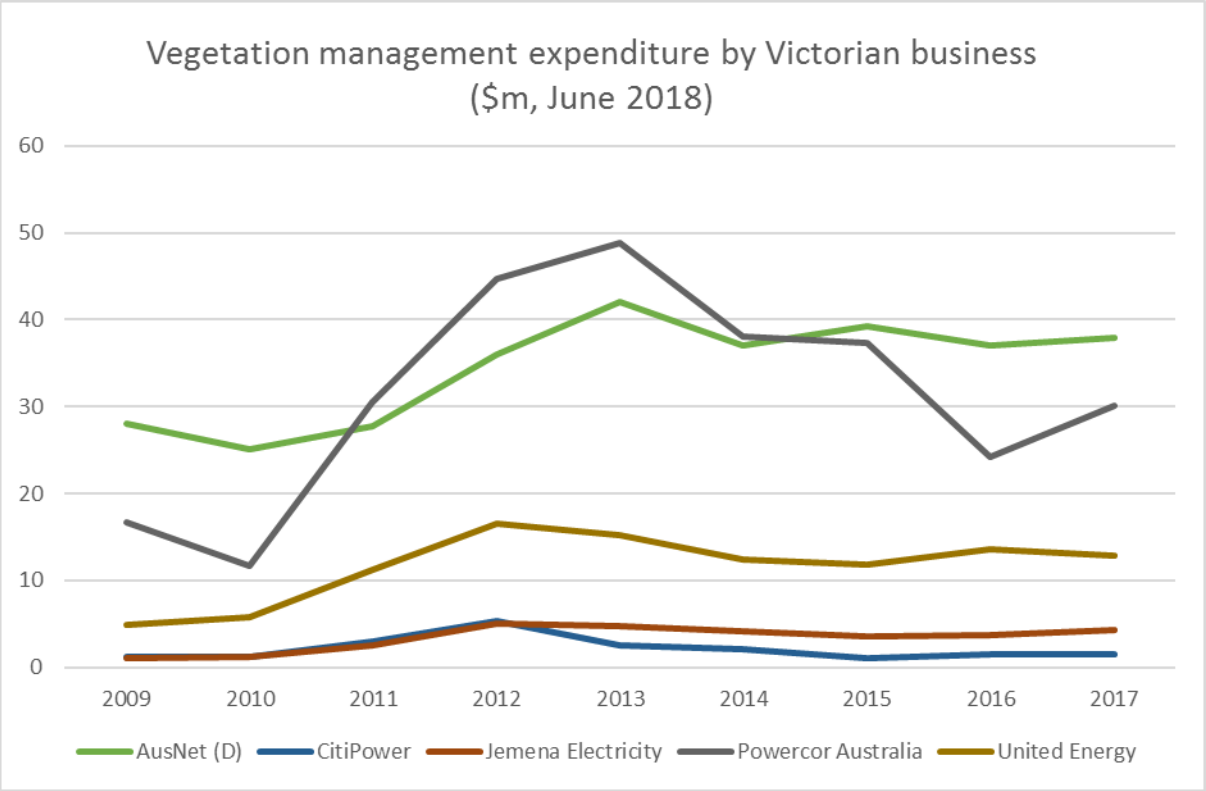
* The AER remade its decision with respect to the Electricity Safety (Electric Line Clearance) Regulations 2010 step changes for CitiPower and Powercor pursuant to the Australian Competition Tribunal's directions following a limited merits review.

Source: AER 2011–15 final determination for Victorian distributors, October 2010; AER Final decision for CitiPower and Powercor Vegetation Management Forecast Operating Expenditure Step Change 2011–15 (Pursuant to Orders of the Australian Competition Tribunal in Application by United Energy Distribution Pty Limited (No 2) [2012] ACompT 8, August 2012

Note: Includes real cost escalation

We observe in Figure 1 that there were significant increases in the Victorian distributors' vegetation management expenditure following Victorian Bushfire Royal Commission (VBRC), which then led to the introduction of more stringent bushfire mitigation and vegetation management requirements for Victorian distributors. Consistent with the allowed step changes, vegetation management expenditure was greater in the earlier years of the 2011–2015 regulatory control period.

Figure 1 Victorian distributors' vegetation management expenditure ($million, 2017-18)



Source: AER analysis

Assuming that the cost of complying with the new bushfire mitigation responsibilities was consistent with the amounts provided as step changes, the average increases in opex over the 2011–15 regulatory control period were material (see Table 2).

Table 2 Electricity Safety (Electric Line Clearance) Regulations step changes expressed as percentages of 2009 base year costs, per cent

Distributors	2011	2012	2013	2014	2015	Average
Citipower	3.50	10.51	13.21	8.89	8.36	8.89
JEN	4.97	4.75	3.46	3.46	3.46	4.02
Powercor	6.94	15.97	19.60	7.25	6.33	11.22
AusNet Services	10.66	12.74	14.32	14.65	14.82	13.44
United Energy	8.03	8.03	6.18	6.40	6.40	7.01

Source: AER analysis

We have also allowed Powercor and SP AusNet to pass through additional opex within the 2011–15 regulatory control period with respect to their new regulatory obligations arising

from the recommendations in the Victorian Bushfire Royal Commission. These cost pass throughs arose from the Energy Safe Victoria's (ESV) acceptance of Powercor's and AusNet Services' revised electricity safety management schemes, which required Powercor and AusNet Services to install specific assets in their networks to reduce the risk and incidence of bushfires in Victoria.[181]

Table 3 sets out the opex we approved to be passed through in recognition of the additional regulatory obligations imposed on Powercor and AusNet Services.

Table 3 AER's approved opex in Powercor's and AusNet Services' Victorian Bushfire Royal Commission pass through applications ($million, 2012)

Distributors	2011	2012	2013	2014	2015	Total
Powercor		4.23	3.61	3.07	2.53	13.43
AusNet Services	0.30	1.31	4.07	3.54	2.74	11.97

Source: AER Final decision – Powercor cost pass through application for costs arising from the Victorian Bushfire Royal Commission, March 2012; AER Final decision – SP AusNet cost pass through application for costs arising from the Victorian Bushfire Royal Commission, October 2012

Table 4 presents the opex pass through amounts as a percentage of Powercor and AusNet Services' 2009 base year costs for comparative purposes.

Table 4 The AER's approved VBRC opex pass through amounts expressed as percentages of 2009 base year costs, per cent

Distributors	2011	2012	2013	2014	2015	Average
Powercor		3.86	3.01	2.55	2.08	2.30
AusNet Services	0.25	1.00	3.25	2.83	2.16	1.90

Source: AER analysis.

Notwithstanding that the actual costs the distributors incurred would have varied from the forecast step change costs to some degree, it is clear that the introduction of these significant regulatory obligations had a material impact on the distributors' opex. Without accounting for these step changes in our measurement of historical productivity, these opex increases would be captured as a decline in productivity.

Queensland distributors' opex within the 2006–2012 period

Network problems which occurred in early 2004 prompted the Queensland Government to appoint an Independent Panel to undertake the Electricity Distribution and Service Delivery

181 AER, *Final decision – Powercor cost pass through application for costs arising from the Victorian Bushfire Royal Commission*, March 2012; AER, *Final decision – SP AusNet cost pass through application for costs arising from the Victorian Bushfire Royal Commission*, October 2012

Review (the EDSD Review) in March 2004. The Independent Panel made a number of recommendations to address reliability problems in the Queensland networks, including establishing network planning standards, minimum service standards (MSS) and guaranteed service level (GSL) payments. In December 2004, a number of the EDSD Review's recommendations were codified in the Electricity industry code made under the Electricity Act 1994 (Industry code).

As of 1 January 2005, the Industry code required the distributors to comply with new service obligations, in the form of minimum service standards and guaranteed service levels, and a requirement to publicly release network management plans.

In its final determination for the 2005–10 regulatory control period, the Queensland Competition Authority (QCA) forecast an increase in Energex's opex of $142.9 million ($2004–05) and an increase in Ergon's opex of $81.9 million ($2004–05) as a direct result of EDSD review requirements.[182] Compared with the total opex forecasts QCA had determined for Energex ($1.27 billion) and Ergon ($1.24 billion) over the 2005–10 regulatory control period, the EDSD Review step change costs were not insignificant. [183]

Further, the QCA allowed for an increase in Energex's opex of $39.5 million ($2004–05) and an increase in Ergon's opex of $101.6 million ($2004–05) for wage increases arising from new enterprise bargaining agreements (EBAs). The EBAs were designed to implement aspects of the EDSD Review by providing an allowance to attract and retain employees. The forecast opex included increases for both internal staff and contract staff.

The increase in Energex's opex forecast for the 2005–10 period was also due to Energex's underspending in previous regulatory control period. QCA explained: [184]

> BRW's analysis shows that a major part of the forecast increase in opex is required simply to return Energex to more appropriate levels of expenditure. For example, the opex that BRW has forecast for Energex in 2005–06, which is 28 per cent higher than Energex's opex in 2003-04, brings it broadly back in to line with opex levels for comparable distributors. In addition, BRW has allowed for a significant increase in corrective maintenance expenditure to make up for previous under-spending by Energex, particularly in the areas of service cable, sub-transmission line and pole top inspections, as well as thermoscanning and vegetation management. However, BRW has not proposed as much as Energex for catch-up spending in these areas.

As a result of the EDSD Review, the Queensland distributors have invested significantly in their capex and opex programs since 2006.

In December 2012, the Independent Review Panel (IRP) established by the Queensland Government found that the reliability standards had driven excessive costs and resulted in a degree of over-engineering of the networks. The IRP made recommendations to reduce the degree of prescription of network standards and to improve the Queensland distributors' operational efficiency.[185]

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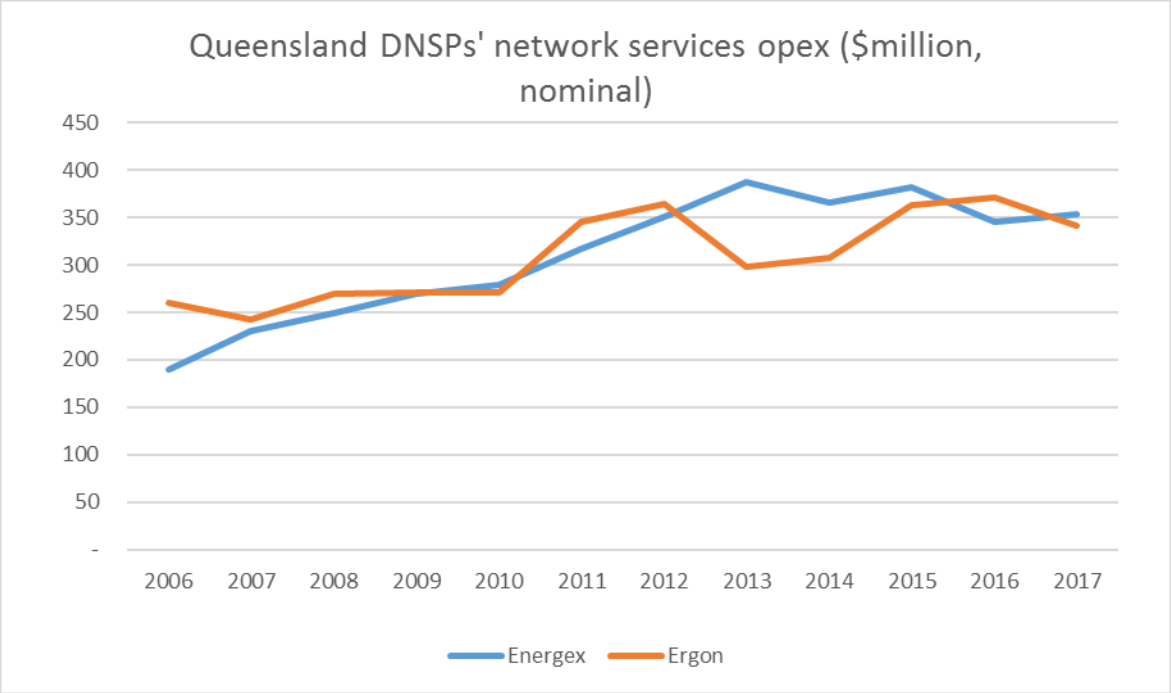
182 QCA, *Final Determination, Regulation of Electricity Distribution*, April 2005, pp. 151 and 157.
183 QCA, *Final Determination, Regulation of Electricity Distribution*, April 2005, p.iii.
184 QCA, *Draft Determination, Regulation of Electricity Distribution*, December 2004, p.126.
185 Independent Review Panel on Network Costs, *Electricity Network Costs Review Final Report*, December 2012.

Figure 2 shows the upward trend in Queensland distributors' past opex performance up to around 2013 before the Queensland government adopted the IRP's recommendations to reduce the degree of prescription of network networks. We do not have a breakdown of the opex increases to ascertain what proportion of the opex increases are attributable to the reliability standards requirements or other factors such as output growth increases. While our econometric modelling accounts for output growth, it is not adjusted for the opex incurred for the unusual volume of works the Queensland distributor had to undertake to meet the reliability standards prior to 2012.

Figure 2 Queensland distributors' network services opex excluding feed-in tariffs ($million, nominal)



Source: AER analysis

The Queensland distributors' unusual opex requirements in the period up to 2013 have clouded the underlying productivity growth the Queensland distributors could achieve absent the regulatory obligations arising from the EDSD Review. Energex and Ergon incurred substantial capex and opex to meet the new, more stringent reliability requirements.

NSW distributors' opex within the 2006-2012 period

Changes to Ministerial licence conditions in 2005 and in 2007 placed considerable pressure on NSW distributors to deliver a significant volume of capital works in the years leading up to and during the 2009-14 regulatory period. Their actions appeared to have been based on setting goals to be largely compliant with the 2007 Ministerial licence conditions by 1 July 2014.

In August 2005, the NSW Government introduced the Design, Reliability and Performance Licence Condition for NSW distributors relating to reliability performance (the 2005 Licence Condition).

The 2005 Licence Condition imposed the following new obligations upon the distributors:

- minimum and average reliability standards, specified by feeder type
- minimum network design planning criteria
- guaranteed customer service standards (GCSS), requiring the distributors to make payments to customers (on application) if they experience more than a certain number or duration of interruptions in a given year.

All NSW distributors applied for a pass through for the costs associated with the introduction of the 2005 Licence Condition.

The Independent Pricing and Regulatory Tribunal of New South Wales' (IPART) reviewed the proposed pass throughs and assessed the efficient costs associated with the 2005 Licence Condition.[186]

Table 5 outlines the distributors' opex resulting from the 2005 Licence Condition, as determined by the IPART. Consequently, the IPART approved about $188.7 million ($2005–06) in opex pass-throughs for the NSW distributors to implement the 2005 Licence Condition.

Table 5 Opex resulting from the 2005 Licence Condition ($million, 2005-06)

Distributors	2004-05	2005-06	2006-07	2007-08	2008-09	Total
Ausgrid (formerly EnergyAustralia)		3.7	14.2	19.3	23.3	60.4
Endeavour Energy (formerly Integral Energy)		0.3	1.5	1.4	1.4	4.6
Essential Energy (formerly Country Energy)			42.1	41.9	43	127

Source: AER analysis

The 2007 Licence Conditions, which amended the 2005 Licence Condition, required the distributors to be as compliant as reasonably practicable in relation to all network elements by 1 July 2014.[187] In our 2009–14 distribution determination for the distributors, we confirmed that the NSW distributors would significantly increase investment in their network security and reliability of supply in line with their licence conditions in that forecast period.[188]

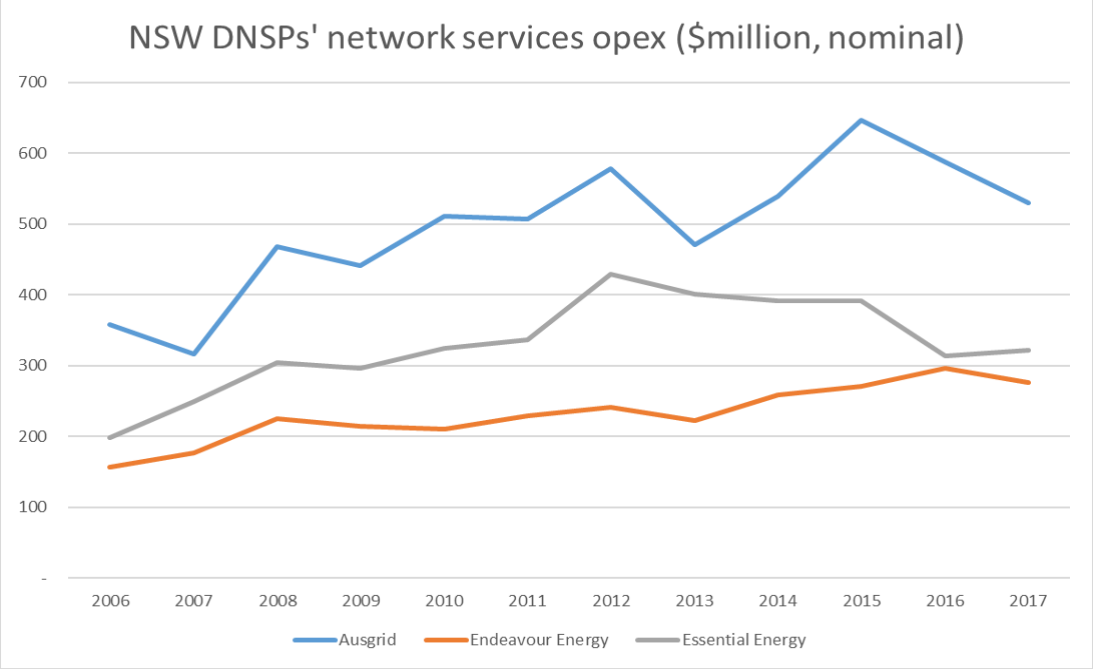
186 IPART, *Final Decision - Statement of reasons for decision – NSW Electricity DNSPs – Applications for a cost pass through*, 6 May 2006.

187 Design, Reliability and Performance Licence Conditions for Distribution Network Service Providers, 1 December 2007, clause 14.2.

188 AER, *Final decision – NSW distribution determination 2009-10 to 2013-14*, 28 April 2009, p.xi.

Similar to the Queensland distributors, the NSW distributors have incurred significant capex and opex to comply with their licence conditions. Figure 3 shows the NSW distributors' network services opex in the 2006–17 period.

Figure 3 NSW distributors' network services opex in the 2006–17 period



Source: AER analysis

In our final decision for the distributors' 2014–19 distribution determinations, we examined the opex increases driven by the licence conditions. Our review of the NSW distributors' historical opex revealed that the NSW distributors had invested in their networks substantially to comply with the licence conditions by 2014 and were left with stranded labour upon the completion of their capex programs.[189]

The IPART's 2010 review of the productivity performance of State Owned Corporations found that the NSW distributors' labour productivity declined by between 27 and 29 per cent over 2001–02 to 2008–09. IPART observed that the NSW distributors submitted that the 2005 Licence Condition was a factor driving increased labour inputs.[190]

We note that in our opex partial factor productivity analysis, we have excluded the NSW distributors in our estimate of productivity growth because throughout the 2006-17 period, their opex performances did not reflect business as usual conditions. The NSW distributors made substantial investments in their networks due to the reliability standards requirements in 2006–12. Following 2013, all NSW distributors invested in business restructuring and incurred significant redundancy costs and transformation costs to generate efficiency savings.

189 AER, Draft decision Ausgrid distribution determination – Attachment 7 – Operating expenditure, November 2014, p.7-26.
190 IPART, Review of the Productivity Performance of State Owned Corporations Other Industries — Final Report, July 2010, pp. 52-56