Attachment 1.05

Frontier Economics - Review of AER's econometric models and their application in the draft determination for Networks NSW

January 2015

Ausgrid revised regulatory proposal attachment

Review of the AER's econometric benchmarking models and their application in the draft determinations for Networks NSW

A REPORT PREPARED FOR NETWORKS NSW

January 2015

Review of the AER's econometric benchmarking models and their application in the draft determinations for Networks NSW

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Executive summary

Benchmarking can be a powerful tool that is used commonly in regulatory proceedings to inform the cost allowances the regulator sets in determining price controls. Frontier Economics (Frontier) has supported regulators in many jurisdictions including Austria, Belgium, Germany, Great Britain and the Netherlands in developing benchmarking models that can be relied upon for regulatory purposes. And we have assessed numerous other benchmarking exercises on behalf of clients that own and operate regulated networks, and on behalf of investors.

Consequently we recognise fully the challenges involved in building these models, populating them with data, making the necessary adjustments to the model (either to the data or the choice of cost drivers) to facilitate meaningful comparisons, and drawing appropriate inferences that can inform further analysis and the determination of the price control.

We further recognise that benchmarking will not be completely accurate – there are many reasons why the efficiency estimates derived from a modelling exercise will not be a perfectly accurate representation of relative efficiency across the sample of companies. Consequently, in order for this potentially powerful tool to be applied for the benefit of customers, we recognise that it needs to be applied carefully and judiciously.

In this case the Australian Energy Regulator's (AER's) estimation of the benchmarking models and its application of the results to setting the Australian Distribution Network Service Providers' (DNSPs') price controls imply a level of confidence in the modelling results that goes far beyond what is reasonable, because are significant limitations in the data and modelling used by the AER. We discuss each in turn.

Modelling flaws

The AER's adviser on benchmarking, Economic Insights (EI) has an impressive knowledge of the relevant benchmarking techniques. However, it has failed to apply suitable due diligence to the data. The reliability of benchmarking analysis is highly dependent on the quality and consistency of the data employed. Data errors and inconsistencies between networks may result in a failure to make like-for-like comparisons, which may in turn result in highly distorted assessments of relative efficiencies.

EI has also failed to investigate other model specifications and other techniques that may have led it to question the robustness of its results. The AER's approach fails to measure up to the recommendations by Coelli et al (2003), to practitioners and regulators, about the importance of sensitivity testing using different models and techniques before results from benchmarking analyses are applied to derive efficiency adjustments to regulated firms' allowed costs:[1]

> "When a regulator uses a method such as DEA or SFA to measure the efficiency of individual firms and plans to use this information as part of the process of setting firm-specific X-factors, the inefficient firms will put the empirical results under intense scrutiny. The regulator may want to be reasonable, but firm. This book has shown that the areas of uncertainty can be significant and that the best a regulator should expect is to be able to put a number on the table for discussion; however, that number should be robust.
>
> One way to do this is to demonstrate the sensitivity of the efficiency scores to various changes in the model. You could start by trying models with different sets of variables, for example, using labor measured in physical or value units and electricity output divided into residential and business customers. You could also try different methodologies, such as PIN, DEA, or SFA. Furthermore, you can try dropping some of the frontier (efficient) firms to see how stable the frontier is. If all these activities have little influence on the efficiency score, then the largest efficiency score obtained for each firm can be used in a fairly confident manner.
>
> When conducting your empirical analysis of performance, be sure to allow plenty of time for feedback and comments from the stakeholders, that is, the development of the efficiency models should be an inclusive process. You should show the firms and other stakeholders draft versions of the efficiency analyses and encourage them to criticize the variables selected, the way the variables have been defined and measured, and so on. If the firms believe a better model could be estimated, they should be encouraged to supply any extra data that are needed that would permit the new analysis. It is important that the stakeholders see the analysis as an iterative process and not as a "take it or leave it" situation."

1.1.1 Lack of international data comparability

The dataset used by EI includes data from Ontario and New Zealand in addition to the Australian DNSPs. As discussed in more detail in section 3 of this report, the international data are not reliably comparable to the data provided by the Australian networks for a number of reasons. In particular, pooling together data from Australia with Ontario and New Zealand is inappropriate for the following reasons:

[1] Coelli, T., Estache, A., Perelman, S., Trujillo, L. (2003), A Primer on Efficiency Measurement for Utilities and Transport Regulators, World Bank Development Studies, Washington DC: World Bank.

- The comparability issues between Ontario, New Zealand and Australia owing to substantial differences in respect of scale, population density, network characteristics, weather, and terrain;
- Apparent inconsistencies in the definition and basis of preparation of the data from Ontario, New Zealand and Australia, which have the potential to materially confound EI's analysis and which have not been investigated adequately;
- Apparent errors in the data reported by networks in Ontario and (to a lesser extent) New Zealand; and
- The AER's/EI's failure to capture and control adequately for these differences.

The consequences of the significant differences in operating environment across the sample is that the business models applied by the businesses are likely to be very different – for example, an Ontarian business operating in a harsh wintry environment will have a completely different business model to achieve a given level of security of supply than a rural Australian network operating over an enormous service region. In turn, this will mean that the relationship between costs and cost drivers is quite different across the two jurisdictions, and is not amenable to being captured by a relatively small number of high level explanatory factors combined with country dummy variables (as per EI's approach).

In addition to the differences in network characteristics that exist, it is clear that there is no consistency in the cost data across the sample, as is acknowledged by EI itself:[2]

> "**We cannot be certain that we have exactly the same opex coverage across the three countries** so we have included country dummy variables for New Zealand and Ontario to pick up differences in opex coverage (as well as systematic differences in operating environment factors such as the impact of harsher winter conditions in Ontario)." [Emphasis added]

In our view, it is inappropriate for EI to assert that it cannot be certain it has comparable opex coverage across the three countries and then proceed to develop a model that is used mechanistically to justify very deep expenditure cuts. There is no clear evidence in the EI report that it has confirmed that the cost data have been collected on a consistent basis and that all differences in reporting protocols, which may include but may not be limited to differences in capitalisation practices, transfer prices, depreciation schedules and so forth, have been harmonised to an even proximately acceptable level of consistency.

2 Economic Insights, Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs, 17 November 2014, p.31.

Failure to adjust for these differences, before combining data from different jurisdictions, would give rise to distorted measures of relative inefficiency, and simply including dummy variables is an inadequate way of controlling for specific differences between networks and between countries. The inclusion of dummy variables simply adjusts for differences in cost levels between the three jurisdictions (i.e. by altering the intercept term of the regression line), without allowing for any fundamental differences between the relationship between costs and cost drivers (i.e. the estimated slope coefficients of the regression line are unaffected by the inclusion of dummy variables alone).

Unless a careful due diligence process is undertaken, the measures of the networks' relative efficiencies may be distorted by uncontrolled factors. Undertaking such checking is typically a very involved process. Our own checks suggest that the opex reporting categories for Ontarian networks are detailed, narrow and extensive, and the reporting guidelines for New Zealand networks are also very prescriptive and detailed. By contrast, in Australia the opex reporting categories are far fewer in number and are necessarily very broad. This raises important doubts about data comparability, which may extend to the boundary between opex and capex. Large questions remain about the consistency of definitions of the data between the three jurisdictions, and we have not seen any analysis from EI or the AER that investigates the issue of consistency of reporting between countries.

1.1.2 The dominant role of the international data in determining EI's model

EI acknowledges in its report that its models cannot be made operational in the absence of the international data in the sample:[3]

> "After a careful analysis of the economic benchmarking RIN data we concluded that there was insufficient variation in the data set to allow us to reliably estimate even a simple version of an opex cost function…
>
> …We thus concluded that to obtain robust and reliable results from an econometric opex cost function analysis we needed to look to add additional cross sectional observations which meant drawing on overseas data, provide largely comparable DNSP data were available"

The Australian data sample is embedded within a much larger sample in EI's analysis, comprising data from New Zealand and Ontario, Canada, in order to generate a sufficiently large variation in the data to enable identification of measured inefficiency from which the inter-Australian variation in efficiency can be inferred. As shown in Table 1 below, the Australian DNSPs account for only

[3] Economic Insights, Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs, 17 November 2014, p.28 - 29.

19% of the preferred sample. The New Zealand DNSPs account for 26%, and the Ontarian DNSPs account for 54%, more than half of the sample.

Table 1: Number of companies in EI's sample

	Australia	New Zealand	Ontario
Number of companies	13	18	37
Proportion of EI's sample	19.1%	26.5%	54.4%

Source: EI dataset

On this basis, we might expect the Ontarian and New Zealand networks to drive materially EI's results for the full sample, notwithstanding their clear lack of comparability with the Australian networks. Yet absent those data there is no evidence to suggest that the EI model describes well the Australian data. Indeed, we find explicit statistical evidence to suggest that it is inappropriate to pool the data from these three countries as EI has done, owing to significant differences in underlying differences between the relationship between costs and cost drivers.

We also note that EI's model delivers a quite different set of efficiency results for the Ontarian companies compared to the model that the regulator in Ontario, the Ontario Energy Board (OEB), itself estimated and relied upon recently to set efficiency factors. This suggests, at a minimum, that the results from the EI model should be treated with caution. We must presume that EI's results should be regarded as less reliable than those generated by the model that the OEB applied in its own jurisdiction, given the close knowledge the home regulator can be expected to have of the companies it regulates. The efficiency scores for the Ontarian networks implied by EI's analysis are not recognisable when set against those derived by the OEB.

1.1.3 Failure to consider alternative explanations of heterogeneity

Both across the full international sample, and within the Australian sample, AER/EI have presumed that the entirety of the residual variation they find, after accounting for idiosyncratic error, may be ascribed to inefficiency. A similarly strong assumption also underpins their MFTP analysis, although we do not comment extensively on that analysis in this report. This is a very strong assumption, made without alerting the reader, and one which we consider to be unsupported by the available evidence.

In addition to the problems associated with ensuring that there is data comparability, the magnitude of the differences between the companies in the sample should motivate a cautious interpretation of the benchmarking results.

We have already discussed above the significant differences between the Ontario, New Zealand and Australian networks relating to scale, population density, network characteristics, weather, and terrain. Within the Australian sample itself there is an unprecedented degree of heterogeneity of circumstance. For example, the two largest Australian DNSPs are Essential Energy and Ergon Energy. Essential Energy serves an area (775,520 km²) significantly greater than the land area of France (547,700 km²) and almost three times as large as the entire land area of New Zealand (263,300 km²), while Ergon Energy serves an area (1,698,100 km²) significantly greater than the land area of France, the UK (241,900 km²) and Spain (498,800 km²) combined and nearly twice the land area of Ontario (917,741 km²).[4] By contrast, CitiPower serves an area (157 km²) that is orders of magnitude smaller. These differences alone ought to give the AER pause to consider whether it is sensible to treat such different networks as if their characteristics may be captured by a small set of common explanatory factors. In our view the EI's model will fail to control adequately for important differences that arise as a result of differences in service area and customer density.

In fact the remaining variation for each company in the sample (after accounting for idiosyncratic error) will be comprised of a combination of genuine and intrinsic differences in operating circumstances (i.e. 'latent heterogeneity') and relative managerial inefficiency. In contrast to EI, given the material differences in cost structure we have found, and the failure to ensure data consistency across and within countries in the sample, we consider it highly likely that the majority of the remaining variation is in fact explained by latent heterogeneity. This view is supported by our investigation of the "true" fixed and random effects models first proposed by Greene[5] and, in respect of the Australian members of the sample, also by some simple Data Envelopment Analysis.

1.1.4 Issues and problems with the Australian data

Problems with the dataset used by EI are not limited to the international data. We consider that there are further problems with the Australian data.

A key limitation of the AER's RIN data is that it is based on eight years of back-cast information, which may not reflect actual outturn information for the DNSPs. The AER's guidelines specify that if a DNSP cannot populate an input cell in the Templates with Actual information, it must provide the '*best estimate*' it can. Because the back cast dataset requires DNSPs to populate input cells going

4 Land area values for France, New Zealand, Spain and UK were obtained from the World Bank World Development Indicators (Table 3.1); land area data for Ontario were obtained from Statistics Canada. 'Land area' is defined by the World Bank as "…a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the definition of inland water bodies includes major rivers and lakes."

5 Greene, W. (2005), Reconsidering heterogeneity in panel data estimators of the stochastic frontier model, Journal of Econometrics 126(2), 269-303.

back a number of years, the AER acknowledges that DNSPs are likely to have estimated some data.[6] Going forward, however, the AER proposes to collect RIN data from the DNSPs annually, based on outturn information.

If historic data does not exist on a consistent basis then it is inevitable that back-casting will be required. However, it is simply not realistic to expect that the back-casted data will be reported on a consistent basis across the DNSPs for a number of reasons:

- The quality of historical records kept by different networks is likely to vary considerably.
- It may not be possible to retrieve certain data from legacy information systems that have since been superseded. And, it may be difficult for a given network to marry together data from old and new systems in a seamless way if the way in which information has been recorded has changed over time (e.g. with changes in IT systems).
- Key personnel with important institutional knowledge may have moved on.
- Networks may have faced time and resourcing constraints in compiling the RIN data to the AER's timetable, and may not have had sufficient opportunity to undertake the full due diligence required when back-casting several years of historical information, which is no trivial exercise.
- Even with extensive consultation on the RIN templates, and the reporting guidance available from the AER, there is likely to have been considerable variation between networks in the interpretation of reporting requirements, and practices surrounding the classification of data into ambiguously-defined reporting categories. These challenges are likely to be especially large when networks are completing RIN data for the first time, and have had not had the benefit of learning and improvement over time.

A review of the DNSPs' Basis of Preparation documentation shows that many DNSPs did indeed have to estimate data for certain variables because good historical information on those variables were not available. Some DNSPs put strong caveats around the benchmarking RIN data they submitted to the AER and expressed concern that the data were not reliable enough to be used for benchmarking purposes. Further, some networks cautioned the AER against drawing strong conclusions using data that, in their opinion, were not sufficiently robust or fit-for-purpose.

Nevertheless, it appears that the AER has not taken sufficient time to check the data, and resolve any potential inconsistencies. The process of verifying the accuracy and consistency of data intended for benchmarking purposes needs to

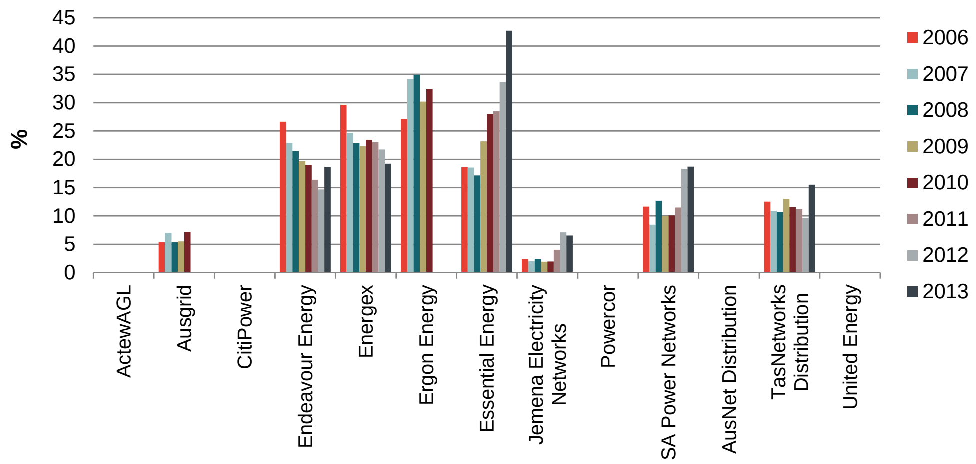
[6] AER (2013), 'Economic benchmarking RIN for distribution network service providers – Instructions and Definitions', November, Pages 4 – 5.

be careful, unrushed and undertaken collaboratively between the regulator, the industry and other stakeholders. Because the robustness of benchmarking analyses is so dependent on the quality and consistency of the data used, unless a careful and considered due diligence process is undertaken, it is difficult to be confident in the benchmarking results.

The serious difficulties inherent in the data preparation - and the amount of work that is required to create a consistent dataset - are simply not acknowledged in the AER's benchmarking analyses.

We have not had the opportunity to undertake an exhaustive audit of the RIN data within the very limited time available to prepare this report, but it is clear from the reported data on vegetation management costs and provisions, for example, that significant problems of comparability may exist. On vegetation management costs, for example, Figure 1 shows that five DNSPs – ActewAGL, CitiPower, Powercor, AusNet Distribution and United Energy – report no expenditure on vegetation management, yet all the networks reported vegetation management spans between 2009 and 2013.

Figure 1: Vegetation management costs as a proportion of opex



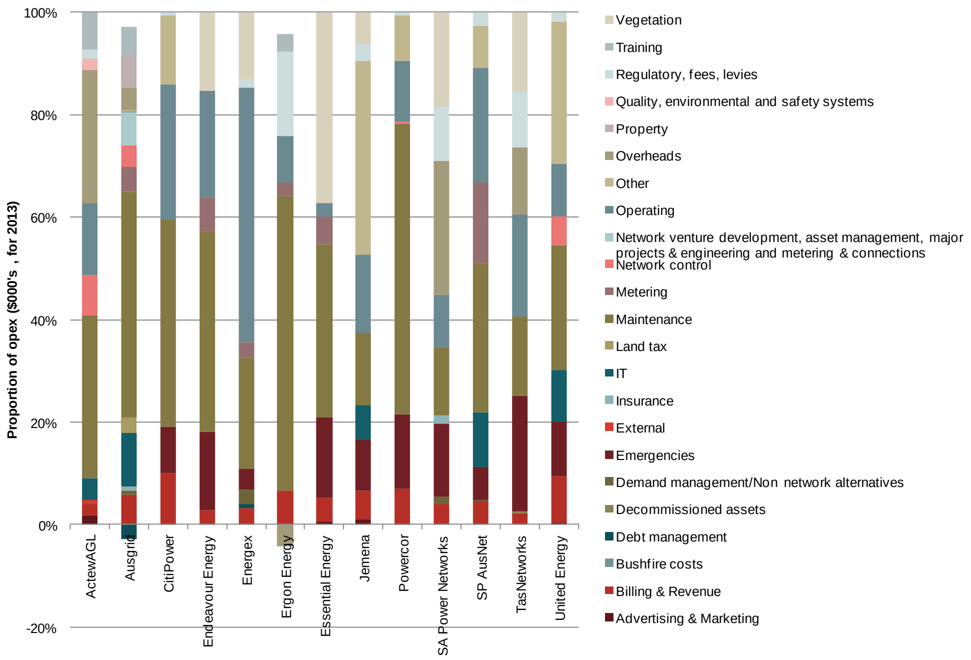
Source: AER RIN data

It is not clear to us whether this means that certain DNSPs have failed to report vegetation management costs incurred, reported these costs elsewhere, or simply not incurred these costs (e.g. because local authorities take responsibility for vegetation management). As the Figure above shows, vegetation management can be a large cost for some networks, so omission or misclassification of these costs could have important implications for the benchmarking analysis. EI's report does not investigate this issue.

In our view, there is a lack of clarity associated with the guidelines issued by the AER with respect to how the DNSPs should complete the RIN templates. This contrasts sharply with regulatory practice in Europe (in particular Great Britain), where regulators issue detailed guidelines for the reporting of costs, specifying exactly how to allocate costs between opex and capex, and exactly which costs are controllable and uncontrollable (and therefore included or excluded from the benchmarking of controllable opex). Ofgem issues clear and detailed regulatory reporting guidelines to the distribution network operators (DNOs) in Great Britain.

Figure 2 below reports total opex reported by DNSPs for 2013 alone, split proportionally into 23 opex categories.[7] The extent of variation in the proportions of different cost categories, across DNSPs, is immediately striking. Moreover, these material differences in how opex is reported also give rise to a related concern in respect of whether costs may be being consistently allocated across the boundary between opex and capex.

Figure 2: Proportional split of opex categories, by DNSP



Source: AER RIN data, Frontier analysis

This marked variation may be due to at least two reasons:

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7 The actual number of categories within which DNSPs have reported opex, between 2006 and 2013, is very large (i.e. nearly 160 uniquely-named categories). In order to present the data graphically in the Figure above, we had to aggregate together 'similar' costs into a more manageable number of categories. This aggregation was done purely for presentational purposes.

- Firstly, this may be evidence of the inconsistency in the way DNSPs report the same costs. If benchmarking is conducted on a measure of opex that has not been reported consistently by all networks, the results of any benchmarking are likely to be unreliable. This is because any networks that have overstated network operating costs, owing to their reporting practices, will appear less efficient than they actually are, and any that have understated network operating costs will appear more efficient than they actually are.
- Secondly, this may be evidence of genuine operational differences between networks, which manifests as differences in cost structures, with obvious implications for the validity of the purported benchmarking.

Should the majority of these reported differences arise from differences in the ways in which networks are actually operated, this would provide yet further evidence of the extensive heterogeneity of circumstance that exists in the Australian sample. It would also cast further doubt on the wisdom and reasonableness of benchmarking opex, in the face of material differences in business model.

The AER appears to have acted precipitously in proceeding to benchmark mechanistically using the data that are presently available. This approach is in marked contrast to typical regulatory practice elsewhere, such as in Great Britain. In Great Britain, where benchmarking has been applied for many years, there has been a significant and co-ordinated effort from both the regulators and all the network companies in the industry to compile a consistent and reliable dataset for benchmarking. This need became obvious at DPCR3 (in support of a price control running from 2000 to 2005), and since then Ofgem has spent a decade or more improving its cost reporting procedures to facilitate the benchmarking analysis that it considers necessary.

In our view the AER should have investigated these data issues carefully, and (a) resolved any major inconsistencies that have the potential to distort materially the benchmarking analysis; and (b) consider if/how any genuine differences in genuine operational differences between networks should be accounted for in any benchmarking exercise.

Even if the costs had been reported consistently, which appears not to be the case, there is a further problem with the comparability of operating costs because different DNSPs will have different approaches to managing their networks given the age of the assets that need to be maintained, their point in the investment cycle, the expected level of investment over the price control period, and the trade-off between opex and capex solutions that need to be made. These factors could be quite different for all the DNSPs. Experience from Great Britain suggests that some DNOs adopt an investment-heavy approach with an associated focus on keeping operating expenditures low, whilst other DNOs seek out innovative ways to avoid incurring capex by looking for opex-based solutions until it is necessary to make the investment. One of the main benefits of smarter grids is that it provides the information and the means through which investment can be deferred or avoided altogether. These complex interactions and trade-offs are not acknowledged at all in the analysis conducted by EI.

Application of the results to the price control determination

AER/EI's unstated assumption in respect of the interpretation of residual variation (i.e. that the entirety of it arises owing to managerial inefficiency) appears to have driven the mechanistic application of EI's results to determine proposed efficiency discounts.

The scale of inefficiencies identified by AER/EI – in the range 40% to 55% – are so significant, and the likely effect on future network sustainability so severe, that the AER would, in our opinion, be justified in applying them on the virtually one-for-one basis the AER proposes only if it were extremely certain about the robustness of the modelling results. Whilst the AER may feel some confidence in the robustness of its benchmarking analysis, due to the apparent convergence of results from a range of different models, we note that these various results are based on very closely related models, all of which are derived from the same data and all missing the same wider review of factors and sense checks. The AER did not, for instance, present any results from Data Envelopment Analysis (DEA), notwithstanding that the AER had signalled its Expenditure Forecast Assessment Guideline that DEA would be a technique that it would consider when conducting its benchmarking analysis. Hence, it is not surprising that the AER's results from the approaches considered appear consistent. As will become clear to the reader, the wider set of modelling approaches we have considered in this report suggest that AER/EI should have cast the net wider when seeking to corroborate the EI modelling results and doing so would have cast significant doubt on their findings.

In our view this indicates strongly that the AER has misdirected itself at this price control. The Australian data suggests widespread heterogeneity, but unfortunately the remedy that AER chose to adopt was to collect international data from a sample that did not share the same types of heterogeneity – the Ontario and New Zealand data that drive the international results generally relate to smaller companies, with different operational challenges that are met using different business models. As a consequence, even when the international data are added, there are still no effective peers to much of the Australian sample.

Given the modelling flaws, data concerns and the AER's inability to account adequately for the profound heterogeneity between Australian DNSPs we believe that the results contained in the EI report are entirely unreliable, and should play no role in the AER's final determinations. While we recommend strongly this first best solution to address the problems with the EI analysis, we would otherwise urge the AER to alternatively (or additionally) consider moderating materially further its application of the results in finalising its price control review. Regulators across the world have adopted a range of methods to achieve this, such as:

- using glide paths;
- combining their modelling results with company forecasts;
- locating the efficient frontier derived from benchmarking in a less onerous manner; or
- using benchmarking analysis to determine relative efficiency rankings then using those rankings to set pre-determined moderated efficiency adjustment factors for cohorts of networks.

The OEB in Canada, for instance, has used the last approach described since 2008. A notable difference between the AER's and the OEB's approach is that the OEB does not translate measured relative inefficiency between networks mechanistically into cost reductions. Rather, the OEB uses the efficiency rankings derived from its econometric benchmarking models to group networks into five distinct cohorts. The cohort judged to be most efficient faces an efficiency adjustment, known as a 'stretch factor' of 0% p.a. The cohort identified as least efficient is assigned a stretch factor of 0.6% p.a., which is materially less onerous than the efficiency discounts proposed by the AER. Importantly, the OEB views the stretch factors it sets as designed to encourage networks to become more efficient over time, and not punitive measures for inefficiency.

We note that EI has attempted a moderating exercise in its report, but we consider the steps taken entirely insufficient, largely because the adjustments are made from a base that we consider to be manifestly flawed and unreasonable, but also because the proposed 10% tolerance threshold is too small, covers too narrow a set of factors and is determined arbitrarily.

Given the limitations in the data presently available to AER, and the manifest and prodigious extent of heterogeneity of circumstance amongst the Australian DNSPs that would be challenging to control for even with very well developed data, we would urge AER to adopt a far more measured approach to determining efficiency discounts from benchmarking than it appears to have contemplated hitherto.

Remedies

Our specific recommendations for the AER (for its final determinations) are the following:

- Discard the international data from its sample.

- Rely only on Australian data.
- Rely on most recent evidence from 2013.
- Use simpler, less ambitious benchmarking techniques than the AER has used in the Draft Decision for NSW and ACT networks to undertake an **indicative** assessment of relative efficiencies.
- Given the weakness of any top down analysis that might be undertaken on the present data, triangulate any top down benchmarking by commissioning expert engineering advice (e.g. to review volumes and unit costs in the most important cost heads).
- Recognise explicitly that no benchmarking model is perfect, and that any modelling of this kind is subject to uncertainty (deriving from data limitations, heterogeneity in firm characteristics that is difficult to account for, model limitations and statistical noise).
- Having made an initial assessment of relative efficiencies, investigate through engagement with the businesses whether the networks identified as most efficient **and** least efficient (i.e. the 'outlier' companies) face unique circumstances not captured in the modelling that should nevertheless be accounted for in a proper efficiency assessment.
- Apply results with an appropriate degree of caution, recognising the significant practical challenges involved in performing benchmarking analysis, and taking account the need for ongoing refinement of RIN data reporting and consistency. The AER should take note of the caution with which regulators overseas, with more experience of conducting benchmarking analysis and access to more mature datasets, apply the results from their analysis to make efficiency adjustments to cost allowances. Examples of such regulators include the Ontario Energy Board in Canada and Ofgem in Great Britain.

As will be clear from this review we are critical of the AER's present benchmarking exercise. However, it is important to stress that the authors of this report are advocates of benchmarking as a review of Frontier's previously published work on the subject will reveal. We would encourage the AER to continue with benchmarking, as it is required to under the National Electricity Rules.

However, it is evident from the AER's first attempt at undertaking benchmarking analysis that there needs to be a step change in its work in this area. To ensure that benchmarking is a more robust and reliable exercise in the future, and drawing on lessons from other regulators worldwide who have more experience in the application of benchmarking, we outline the following recommendations for the AER.

- Improve regulatory reporting processes and the consistency of the Australian RIN data.
- Engage more with each network and with the industry as a whole about company-specific factors.
- Be less ambitious in the modelling techniques pursued, particularly given the apparent limitations on the data available.
- Seek further evidence through complementary benchmarking.
- Develop a regulator/sector work programme to design a richer set of cost driver variables/cost adjustments.
- Allow more time.
- Develop a less mechanistic application of benchmarking results.

1 Introduction

1.1 Background

On 27 November 2014 the Australian Energy Regulator (AER) published its Draft Decisions on the distribution determinations of, amongst other distribution network service providers (DNSPs), Ausgrid, Endeavour Energy and Essential Energy. The AER's final distribution determinations will apply to these DNSPs for the period 2015-19.

In developing its Draft Decisions, the AER has undertaken for the first time a comparative benchmarking analysis to aid its assessment of proposed expenditures by the DNSPs. This analysis has been conducted on the AER's behalf by Economic Insights (EI). EI's benchmarking analysis to assess opex efficiency has used the benchmarking Regulatory Information Notices (RIN) data submitted by 13 Australian DNSPs. In addition, in order to employ certain statistical techniques to estimate relative opex efficiency, EI has pooled the Australian RIN data with data on distribution networks in Ontario and New Zealand. Based on the findings its benchmarking study, EI has proposed recommended to the AER that the following reductions to base year opex levels:[8]

- 13% for Endeavour Energy;
- 33% for Ausgrid; and
- 35% for Essential Energy.

These are very material proposed cost reductions.

1.2 Terms of reference for this report

Endeavour Energy, Ausgrid and Essential Energy (referred to collectively as Networks NSW) have engaged Frontier Economics (Frontier) to:

- Comment on the intrinsic challenges in carrying out benchmarking analyses in the context of electricity distributors.
- Review and comment on the approach of the AER/Economic Insights to benchmarking, including: the data compiled; selection of models (composition, technical accuracy); the domestic and international data sets used; and the method of adjustments for factors outside of the modelling process itself.
- Comment on the use of benchmarking techniques in other jurisdictions, including any approaches taken where any benchmarking reveals apparently significant differences between the determined actual or hypothetical "benchmark" efficient operator and any of the relevant regulated entities.

8 Economic Insights, Economic benchmarking assessment of operating expenditure for NSW and ACT DNSPs, 17 November 2014, p.57.

- To the extent that there are any deficiencies in the benchmarking exercise that has been undertaken, comment on whether those deficiencies can be addressed, and if so, how.

Our instructions are reproduced in Annexe 3 to this report.

1.3 About the authors of this report

The authors of this report are Mike Huggins and Phil Burns, both of whom are Directors of Frontier's Energy Practice, and are based in Frontier's London office. Brief biographies of the authors are provided below, and more detailed CVs are provided in Annexe 4 to this report.

Mike Huggins

Mike has with over 20 years' experience in the energy sector. He is an expert on regulatory design and has advised numerous energy regulators, companies and investors on regulatory matters, including efficiency analysis. Mike has experience in applying a wide range of benchmarking techniques to measure relative efficiency, including regression techniques such as Corrected Ordinary Least Squares (COLS) and Stochastic Frontier Analysis (SFA) to cross section and panel data, as well as and linear programming techniques such as Data Envelopment Analysis (DEA).

Mike was involved at every stage of the first price control conducted by the Dutch regulator, in which DEA played a central role. He subsequently provided further advice on the ways in which regional differences between gas and electricity distributors service regions might be recognised in benchmarking and in regulatory settlements.

More recently Mike was the lead author of a report for Ofgem on the future role of benchmarking, a report commissioned as part of Ofgem's RPI-X@20 review. The report provided recommendations for both electricity and gas at the transmission and distribution levels, and its recommendations included a more prominent role for total cost benchmarking. Mike subsequently led a large scale econometric study commissioned by the electricity distribution industry and Ofgem to develop a total cost benchmarking model. This work has informed Ofgem's efficiency analysis at the ongoing RIIO-ED1 review.

Mike also advised Northern Ireland Electricity (NIE) during Regulatory Period 5 on how it could be benchmarked against the distribution network operators in Great Britain in the light of significant differences in cost reporting structures, providing a series of expert reports for submission to the Utility Regulator and the Competition Commission (now known as the Competition and Markets Authority). Mike also acted as an expert on behalf of NIE, on benchmarking issues, through its appeal before the Competition Commission.

Mike has previously worked as an Economist at the Energy Policy and Analysis Unit within the UK Civil Service. He holds a B.Sc. (Hons) in Mathematics from the University of Sheffield, and M.Sc. in Economics (Distinction) from Birkbeck College, London.

Phil Burns

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Phil has authored several peer reviewed articles on the subject of benchmarking and efficiency analysis for regulated networks utility regulation more generally.

Phil has worked closely with Mike Huggins on all the consulting assignments that Mike has undertaken that has involved benchmarking and efficiency analysis. As such, Phil has extensive experience in the application of a wide range of benchmarking techniques, and the interpretation and application of results from benchmarking analyses.

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Support with preparation of this report

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1.4 Structure of this report

The remainder of this report is organised as follows:

- Section 2 provides a brief introduction to the concept of comparative benchmarking, reviews the practical challenges that arise when undertaking benchmarking analysis for regulatory purposes, and offers a first, high level assessment of AER's/EI's benchmarking analysis.
- Section 3 provides a detailed assessment of the international benchmarking undertaken by the AER/EI and identifies a number of shortcomings with that analysis.
- Section 4 offers an analysis of the Australian benchmarking RIN data used by the AER/EI in the benchmarking exercise.

- Section 5 provides a discussion of the apparent weaknesses in the benchmarking RIN data collected by AER and used by EI, including a discussion of the wide range of issues that may have confounded EI's analysis.
- Section 6 provides an assessment of how the AER has made use of EI's efficiency analysis in its draft decision.
- Section 7 provides a set of recommendations to the AER that would, in our view, improve significantly the quality of future benchmarking exercises.

2 Challenges of benchmarking and deficiencies in the AER's approach

2.1 What is benchmarking?

Benchmarking is the process of evaluating the performance of an entity by comparison to some externally determined standard, or by reference to performance of a peer or set of peers. This definition is broad and could encompass a wide range of different approaches, used for a similarly wide range of purposes.

In the context of economic regulation, a review of practice around the world tells us that benchmarking has always had an important role in price review proceedings, particularly in jurisdictions where incentive regulation is the prevailing paradigm. Benchmarking provides an approach through which the mismatch in information between regulator and regulated company can, at least in part, be overcome. It can form an essential part of a wider set of incentive arrangements, putting companies on notice that their performance will be assessed against that of other companies, with the prospect of inefficiency being identified and excess costs disallowed.

There is a broad spectrum of what could constitute 'benchmarking' for regulatory purposes. Benchmarking could involve comparing a network's performance against its own historical performance and/or against the contemporaneous or historical performance of suitable peers. The simplest forms of benchmarking use very basic performance metrics such as normalised outputs and normalised inputs. These so-called 'Partial Productivity Indicators' (PPIs) do not account for multiple factors that may simultaneously influence a network's performance (hence the nomenclature 'partial') and may therefore fail to measure well 'inefficiency' as they fail to control for important differences in operating environment. Nor do they allow for variation in measured performance that is due purely to random statistical noise.

The most sophisticated benchmarking approaches are statistical techniques which, if applied properly, can account better for multiple drivers of performance and statistical noise. Whilst these more sophisticated statistical techniques may seem attractive these techniques are limited by factors such as:

- the availability of reliable data (without which any measure of relative efficiency may be rendered meaningless);
- the ability to identify the most important factors that explain differences in performance (over time and/or between networks), other than managerial inefficiency;
- the ability to quantify and measure those factors in a systematic and consistent way; and
- the ability to capture genuinely 'good' performance, so as to encourage and reward the appropriate conduct on the part of the firm and not to create perverse incentives.

In practice, these challenges are very real, and it is critical that the limitations imposed by data and measurement issues are recognised explicitly to avoid overstating the validity and precision of measured inefficiencies.

Given the wide range of benchmarking techniques available, in our view regulators should not restrict themselves to a narrow set of techniques to the exclusion of others, but should consider a wide range of cross checks and sense checks to develop a holistic view of relative efficiency.

2.2 Intrinsic challenges of benchmarking

No two network businesses are exactly the same, implying that some observed differences in costs might be justified by these differences. Ideally, the benchmarking methodology employed should seek to take appropriate account of such factors, allowing any differences in performance as measured by that technique to be ascribed to differences in relative efficiency. In practice, this can be difficult to achieve.

Differences in perceived performance can arise from a number of potential sources including underlying differences in:

- input costs (e.g. labour rates, local taxes);
- operating environment (e.g. climate, topography, soil properties, vegetation, and the urban/rural nature of certain areas);
- past (legacy) configuration decisions and planning constraints; and
- current managerial and operating efficiency.

Some of these factors are straightforward to correct for, such as local taxes. Others are far more challenging (e.g. some elements of operating environment and the effects of past/present differences in technical/planning standards). Importantly, in respect of determining efficiency discounts in regulatory proceedings (i.e. disallowing past and/or future costs owing to their supposed inefficiency) it is only excess cost owing to the last type of underlying difference – managerial performance – that should be taken into account. Differences in performance due to the other reasons mentioned above should not be used to justify the imposition of cost reductions.

2.2.1 The enhanced challenge of international benchmarking

Further complications arise when attempting to benchmark operators in different countries. There could be material differences in a number of additional areas to those identified above, including:

- legislative framework (e.g. employment, environmental, planning, tax, procurement and health and safety law etc);
- regulatory arrangements (e.g. data collection processes, incentive frameworks, scope of licensed activities, boundary/interface with other businesses etc);
- cost of capital and other financing arrangements (which may affect planning and design decisions);

- differences in design standards, types of equipment and assets used, and the costs of those types of assets (e.g. including differences in transport costs); and
- exchange rates.

There are also likely to be more prodigious differences in operating environment when taking data from very different countries. Differences that can sometimes be safely assumed away within region (e.g. assuming that climate may be sufficiently similar to require no adjustment) may become material in the context of a sample drawn from many countries.

Designing a benchmarking methodology that accounts adequately for all of these factors is extremely challenging – and in our view is unlikely to be possible without significant effort.

2.2.2 The AER's benchmarking

In its first attempt at applying economic benchmarking to assess the efficiency of NSPs' costs, the AER has employed data from non-Australian jurisdictions. To do international benchmarking well is an extremely complex task. The main difficulties involved are:

- ensuring the consistency and comparability of data in different jurisdictions that may have different regulatory reporting requirements and conventions; and
- taking proper account of factors within and between jurisdictions that are unrelated to the underlying efficiency of the networks (e.g. operating environment, climate, geography, regulatory and legal obligations), but that could distort the measurement of relative efficiency if not controlled for.

The AER itself has previously acknowledged the challenges involved in international benchmarking, and in its November 2013 Expenditure Forecast Assessment Guideline, which described international benchmarking as a long-term aspiration:[9]

> We consider international collaboration of economic benchmarking to be an appropriate goal in the long term and our economic benchmarking should not be limited to a comparison of Australian NSPs. In our view, **potential problems with availability of consistent and reliable international data and other analytical issues, may make implementation of an international benchmarking exercise difficult in the short term.** [Emphasis added]

We agree with this assessment, indeed we might have expanded this to add that international benchmarking may be difficult even in the medium to long term. However, a mere 12 months later the AER has relied on international benchmarking, apparently without regard to the reservations that it expressed in its own Guideline. By way of

9 AER, Explanatory Statement Expenditure Forecast Assessment Guideline, November 2013, p.140.

comparison we note that, as far as we are aware, no economic regulator in Europe uses international benchmarking to assess the relative efficiency of distribution networks.[10]

In our view, given these major complexities and inevitable data limitations that arise when attempting international benchmarking, and the AER's lack of experience with benchmarking, the AER's attempt at international benchmarking at this time was over-ambitious and premature. This lack of regard for the challenges that would be faced in attempting international benchmarking has manifested itself in a number of ways, including:

- a lack of proper due diligence of the data from different jurisdictions;
- the very compressed timeframes within which it has attempted to conduct this analysis, which appears to have exacerbated the challenges involved by allowing insufficient time to interrogate the robustness of the data;
- inadequate consultation with the industry about the role of international benchmarking in setting the price control, and inadequate opportunity for stakeholders to comment on the appropriateness of the data that the AER intended to use;
- the application of only very crude or no controls for cross-jurisdictional differences (of which there appear to be many); and
- a lack of appreciation of how materially the international data appear to be influencing the benchmarking results.

Furthermore, the Australian data that the AER has available to it for benchmarking purposes appears to be largely untested and has not been submitted to an appropriate level of scrutiny and adjustment to correct for potential differences in reporting approaches. The potential for there to be such differences in where certain costs/activities are reported gives rise to additional concerns in respect of the comparability of the Australian data and the validity of EI's work.

It is striking to us that as part of its first attempt at benchmarking the AER has attempted to apply approaches that are among the most sophisticated of benchmarking techniques. These techniques tend to be used (if they are used at all) by regulators with significantly more experience in benchmarking (and therefore more time to compile

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10 Frontier Economics (Europe) is participating in a pan-European effort underway to develop a consistent dataset that may be used to benchmark transmission networks, involving the companies and their regulators from a number of Member States in collaboration. This effort has been deemed necessary as most European countries have only a single transmission operator (some countries have three to four), and as a result no meaningful benchmarking can be undertaken on only within country samples by any European regulator. However, as far as we understand many of the participating regulators are not choosing to apply the emerging results of the study in their regulation, or are adopting a very cautious approach to applying the results. To the best of our knowledge, similar efforts have not been made by any regulatory body in relation to distribution networks, except in the case of Northern Ireland Electricity, where it has been compared to the 14 distribution companies operating in Great Britain. In this case, Frontier advised NIE on how to achieve consistency in cost reporting data through mapping its reported costs onto a Great Britain reporting structure basis, a process that took approximately six months of dedicated effort to obtain first results, and a number of iterations after this to correct remaining inaccuracies.

good data) and in jurisdictions with considerably more homogeneity between networks (allowing the regulator to place greater faith in a model with few cost drivers owing to an underlying assumption that circumstances across the sample can be presumed to be similar). As we go on to explain, such an assumption cannot be justified in respect of the Australian sample.

In the presence of these features, we might have anticipated a cautious interpretation of the results of EI's analysis. But on the contrary, AER/EI instead make a strong assumption in respect of the possible sources of unexplained variation of cost in EI's model.

A perennial question in panel data measurement of relative efficiency is the extent to which it is possible to capture satisfactorily *three* different aspects of the unexplained variation in a regression model. These are

- *idiosyncratic error* arising from errors of measurement, sampling and specification (of the variables and model)
- *latent heterogeneity* in the sample arising from the possibility that the sample is drawn from several different parent populations; and
- *residual inefficiency* arising from the differences in managerial performance that the regulator is attempting to measure.

Most of the existing frontier efficiency models in the literature are able to separate two of these factors, e.g. idiosyncratic error and inefficiency or idiosyncratic error and latent heterogeneity, but few are able to address all three factors.

Stochastic frontier analysis (one of the key technique used by EI) generally is able to distinguish idiosyncratic error and inefficiency by decomposing the residual variation into two clearly distinct statistical representations – one that is symmetrical and therefore can be used to represent idiosyncratic variation and one that is asymmetrical and therefore can be conceptualised as (and is commonly referred to as) inefficiency on the grounds that DNSPs that are very inefficient are less likely to occur than ones that are only slightly inefficient and DNSPs that are negatively inefficient cannot occur at all. However, most of the current generation of stochastic frontier analysis models do not address the issue of whether the part of the error composition which is ascribed to inefficiency could also reflect latent heterogeneity.

This gives rise to a significant risk of mismeasurement, which arises in two ways:

- if the method used to overcome this latent heterogeneity is inadequate to the task. If these issues are important, then the apparent inefficiency in the sample may be due to latent and un-modelled heterogeneity; and
- if the larger sample in which the Australian data is embedded is so widely different that it is likely to arise from different parent populations.

Assessing the extent of these risks in the present case has been the main focus of our work. There are important regulatory consequences here. Since the EI report recommends massive cuts in the operating expenditures of some of the DNSPs it is more than usually important that these policy changes are securely based on robust models. If the models are fragile and highly sensitive to small changes in specification then it is highly risky to implement cost reductions of the scale recommended by EI on some of the Australian DNSPs.

As we set out in the following sections, we find strong evidence to suggest that both of these risks are manifested here, leading us to conclude that the AER/EI analysis and its estimates of inefficiency for the Australian DNSPs are unsafe.

Under these circumstances, it would have been most sensible for the AER to focus more effort on identifying the best ways to deal with the large and obvious heterogeneity between Australian DNSPs, and collecting reliable and consistent data, than attempting to apply the most sophisticated benchmarking techniques.

By first getting the basics right (and once all stakeholders have confidence in the robustness of the data and the AER's ability to deal adequately with heterogeneity) the AER would be in a strong position, in time, to develop the use of the more complex techniques. Until such time, it would be desirable if the AER were to focus on simpler, more pragmatic techniques than it has done during this reset.

3 Shortcomings with the AER's international benchmarking

In order to conduct benchmarking the AER/EI have supplemented the Australian data with data on regulated distribution networks in New Zealand and Ontario. However, while it would appear from its report that EI has an impressive knowledge of the relevant benchmarking techniques, it has not investigated exhaustively the full set of available options. It has also failed to apply suitable due diligence to the data, raising significantly the risk that its benchmarking results are distorted by lack of consistency between the Australian and overseas data, intrinsic and unresolved heterogeneity between Australian and overseas networks, as well as errors in the overseas data.

We have investigated thoroughly the reasonableness of including these international data. We raise important concerns in respect of the inclusion of data from Ontario and New Zealand, which we report below.

In the following subsections we present:

- the results of our own econometric investigation into the EI models and dataset;
- a range of descriptive analyses which suggest that the DNSPs in Ontario and New Zealand have markedly different business models and cost structures to those in Australia;
- evidence that potentially important differences in reporting protocols and definitions between the two overseas jurisdictions and Australia have not been investigated adequately;
- an overview of apparent errors in the data reported by networks in Ontario and New Zealand; and
- lastly, a comparison of EI's model with the model developed by the Ontario Energy Board.

Given the length and importance of this section, we begin with a summary of our findings.

3.1 Summary

Our review has found that the overseas data play a central role in determining the EI model. EI acknowledges in its report that its models cannot be made operational in the absence of the international data in the sample:[11]

> "After a careful analysis of the economic benchmarking RIN data we concluded that there was insufficient variation in the data set to allow us to reliably estimate even a simple version of an opex cost function model (e.g. a Cobb–Douglas LSE model with three output variables and two operating environment variables)…

[11] Economic Insights, Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs, 17 November 2014, pp.28-29.

Hence, in this case, there is little additional data variation supplied by moving from a cross–sectional data set of 13 observations to a panel data set of 104 observations. As a consequence we are essentially trying to use a data set with 13 observations to estimate a complex econometric model. The 'implicit' degrees of freedom are near zero or even negative in some cases, producing model estimates that are relatively unstable and unreliable.

We thus concluded that to obtain robust and reliable results from an econometric opex cost function analysis we needed to look to add additional cross sectional observations which meant drawing on overseas data, provided largely comparable DNSP data were available…"

Whilst EI recognise clearly the need for comparability in the DNSP data between jurisdictions, it is not apparent that it has performed the necessary checks for sufficient comparability. In the very limited time available to develop our report, we have investigated certain aspects of the comparability of the networks in Ontario and New Zealand with those in Australia and find many important differences. There are major differences in respect of scale, population density, network characteristics, weather, and terrain between Australia, Ontario and New Zealand. Owing to these differences, it is apparent that the companies in (in particular) Ontario and New Zealand have developed entirely different business models and design philosophies to serve their regions from those developed by DNSPs in Australia. In fact, we find explicit statistical evidence to suggest that it is inappropriate to pool the data from these three countries as EI has done, owing to significant differences in underlying differences between the relationship between costs and cost drivers.

By way of practical illustration of the extent of differences, the frontier firm in EI's analysis using the 'medium' sample, Hydro One Brampton Networks Inc. is, without exception, smaller in scale than all the networks in the Australian sample, and significantly smaller than Essential Energy, Ausgrid and Endeavour Energy. It is also one of the smallest networks in the Ontario sample, and has the largest proportion of underground circuit (over 70%) in EI's full sample of 87 companies. The Australian DNSPs have 19 times more circuit length than the frontier firm in EI's medium sample, the majority of which is overground circuit, and a significant proportion of which is associated with sub-transmission assets (for Essential, Ausgrid and Endeavour Energy in particular).

There has been an insufficient investigation into potentially important differences in the basis of preparation of cost and cost driver data reported across the three jurisdictions in the sample, in particular between Australia and Ontario.

Based on our rapid review, we have also found what appear to be clear errors in the Ontarian data in particular, calling into question its quality, and giving rise to the risk that unreliable data may be distorting the benchmarking results.

Given the simple model with the few cost drivers that EI has used to control for these differences in circumstance between Australia, New Zealand and Ontario in its SFA analysis, we have reviewed the reasonableness of EI's conclusion that the entirety of the residual variation found, after accounting for idiosyncratic error, may be ascribed to inefficiency. In contrast to EI, given the material differences in cost structure we have found, plus the failure to ensure data consistency across and within countries in the sample, we consider it at least as likely that much of the remaining variation is in fact due genuine operational differences between the networks unrelated to differences in relative managerial efficiency. Objective differences between businesses of this kind, owing purely to operating circumstances rather than managerial efficiency, are referred to in the benchmarking literature as 'latent heterogeneity'. This view is supported by our investigation of the "true" fixed and random effects models first developed by Greene,[12] and in respect of the Australian DNSPs also by some simple Data Envelopment Analysis (DEA), as set out in Section 4.3.

Finally, we find that the efficiency rankings of Ontarian networks implied by EI's analysis and by recent benchmarking work conducted by the OEB (which presumably has a better understanding of the most important circumstances influencing Ontarian networks' costs than does EI) are entirely inconsistent.[13] For instance, EI's preferred model identifies Hydro One Brampton Networks Inc. as not only the most efficient network in Ontario, but the most efficient DNSP across all three jurisdictions. However, the OEB's benchmarking analysis identifies Hydro One Brampton Networks Inc. as the 25th most efficient network amongst 73 in Ontario. This is a very material discrepancy that in our view further calls into question the robustness of EI's model and reasonableness of its mechanistic application to the Australian companies.

Similarly large differences in rankings occur with several other DNSPs from Ontario. Whilst the OEB's analysis identified a very large spread in the efficiency scores of the Ontarian networks, the OEB imposed only very modest (and much more realistic) cost adjustments for even those networks identified as least efficient. The OEB's approach to applying the results of its benchmarking analysis when regulating networks in Ontario is much less mechanistic, and much more measured, than the approach taken by the AER to networks in Australia. The OEB's "stretch factors" in Ontario range from 0% per year for the most efficient networks to a maximum of 0.6% per annum for the least efficiency networks.

Taken together, we consider there are very many weaknesses with the international benchmarking work undertaken by EI, which casts serious doubt over the way in which the AER has used the efficiency estimates derived by EI to propose very large cost reductions to some Australian networks as part of the present reset process.

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12 Greene, W. (2005), Reconsidering heterogeneity in panel data estimators of the stochastic frontier model, Journal of Econometrics 126(2), 269-303.

13 Whilst a detailed regulatory information disclosure scheme has operated in New Zealand for a number of years, the New Zealand Commerce Commission has not, to date, undertaken any statistical benchmarking work using these data. Indeed, the Commerce Commission is prohibited by law from using the results of use comparative benchmarking on efficiency in order to set starting prices, rates of change, quality standards, or incentives to improve quality of supply under the Default Price-Quality Path regime that applies to Electricity Distribution Businesses (EDBs) in New Zealand. As such, we are unable to compare EI's findings of relative efficiency with those of the regulator in New Zealand.

3.2 Our investigation of the EI models and data

The EI report undertakes a thorough frontier benchmarking study involving several different types of model including multi-factor total productivity analysis, stochastic frontier analysis and panel data analysis corrected for autocorrelation and heteroscedasticity. EI finds a very wide range of efficiency scores for Australian DNSPs and recommends deep cuts in operating expenditures for several of these DNSPs. However, while the range of models used by EI is impressive it is not exhaustive.

In this subsection we describe our investigation of the EI models and data, including an assessment of some alternative SFA models, and the significant shortcomings that this has revealed.

We demonstrate that when alternative and more general SFA models are applied to the EI data, they provide evidence to suggest that EI's assumption – that all unexplained residual variation should be ascribed to differences in managerial efficiency – is not justified, i.e. there is evidence to suggest that latent heterogeneity is the dominant cause of residual variation in cost amongst the Australian DNSPs. This already casts significant doubt on EI's results.

We also show that the Australian firms comprise only 19% of EI's full sample, on the basis of which we might expect the Ontarian and New Zealand networks to drive materially EI's results for the full sample. However, statistical testing indicates that there are significant differences between the values of key parameters in the model for Australia and the corresponding values for New Zealand and Ontario, indicating that the datasets are not poolable across countries. This suggests that it was inappropriate to have conducted work on this three country sample and suggests that the results should not be used to inform the present price review process.

3.2.1 Verifying EI's results

In order to check the modelling approach used by EI, we have been able to access both the full dataset used by EI, which is broken down into different sample sizes, and the computer codes that EI used to transform and update the original raw data. Our modelling approach was this: We adopt the specific model used by EI to generate tables 5.2-5.5 (pp.33-7) in EI's report, the Cobb-Douglas form of the operating cost function. The EI report used for its key results the sample referred to as the 'medium' dataset, and to ensure comparability, that is the dataset that we have used as well. EI's preferred model is the Cobb-Douglas cost frontier in which the logarithm of operating cost is regressed against the logarithms of customer numbers, circuit length, ratcheted maximum demand, share of underground cabling and a time trend, together with two binary (0,1) dummy variables representing the New Zealand and the Ontario observations (in an attempt to capture latent heterogeneity at the country level).

The first task was to set a control by trying to replicate exactly the EI results in tables 5.2-5.5 and this we were able to do immediately. Therefore we know that we are working with the same sample and data definitions that appear in EI's report. For this initial task we used the econometric software used by EI, i.e. Stata. Our main results are summarised in Table 2 below.

Table 2: Replication of EI's preferred SFA model

	EI's preferred SFA model
Log (customer numbers)	0.667***
Log (Circuit length)	0.106***
Log (Ratcheted maximum demand)	0.214***
Log (share of underground cables)	-0.131***
Time trend	0.018***
Constant	-26.526***
Country dummies	
New Zealand	0.050
Ontario	0.157**
Variance parameters:	
Mu	0.385***
SigmaU-squared	0.039
SigmaV-squared	0.010
LLF	372.620
N	544

*Source: Frontier analysis; *** significant at 1% ** significant at 5% *significant at 10%*

The results from Table 1 above can be interpreted as follows:

- **Slope parameters:** the coefficients on the cost drivers in EI's log-log function can be interpreted as elasticities, i.e. they show the percentage impact on opex of a 1% change in the driver. For example, the estimated coefficient of 0.667 on customer numbers implies that a 1% increase in customer numbers would lead to a 0.667% increase in opex.
- **Time trend:** EI's coefficient of 0.018 on the time trend indicates an increase in opex of 1.8% per year (everything else remaining the same) during the time period modelled. EI suggests that this implies technical regress over the modelled period. However, this increase in opex over time may also (or alternatively) be due to a range of factors outside management's control that affect costs industry wide, such as increases in regulatory obligations over time (which may be a significant driver of costs for the Australia DNSPs), or input prices, neither of which are controlled for in EI's modelling.
- **Country dummies:** EI does not provide an explanation for how its country dummy variables can be interpreted. The coefficients on the country dummy variables indicate the difference in the opex cost frontier in New Zealand and Ontario compared to Australia that is not explained by the explanatory variables in the model.

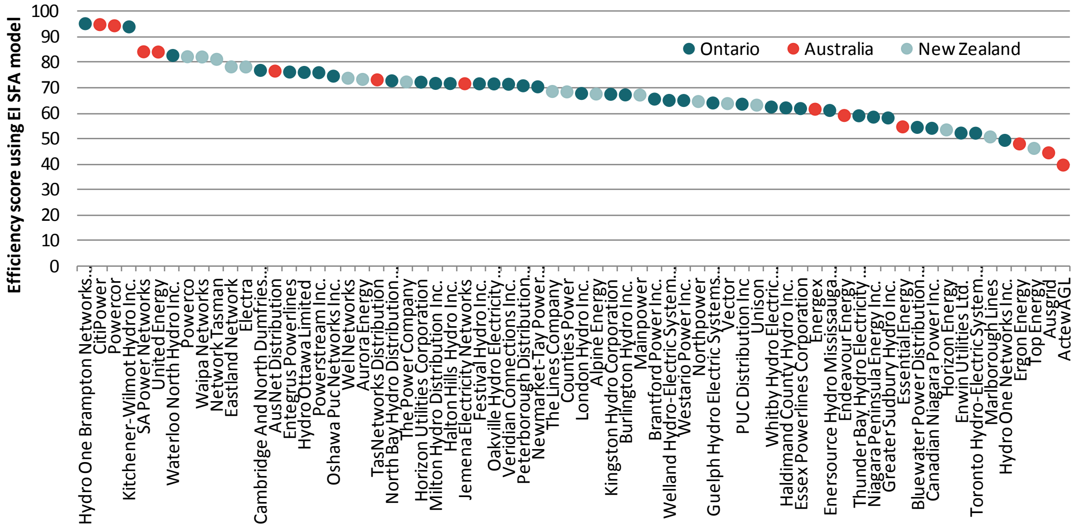
The coefficients of 0.050 and 0.157 on the New Zealand and Ontario country dummies, respectively, suggest that the cost frontier for New Zealand is 5% higher than Australia, and for Ontario is 16% higher than in Australia (everything else remaining the same). In other words, for an Australian DNSP to be fully efficient, it has to have about 14% lower opex than a utility in Ontario, and 5% lower opex than a utility in New Zealand with the same characteristics.[14] EI does not justify why these more generous frontiers for Ontario and New Zealand are reasonable.

- **Constant:** The intercept or constant from this model is the expected value of the logarithm of opex when all explanatory variables are set to zero.
- **Variance parameters:**
  - Mu is the estimate of the mean of the truncated normal distribution used to model the inefficiencies.
  - SigmaU-squared is an estimate of the variance of the assumed asymmetric distribution that is used to model the inefficiency component of the overall residual in the model.
  - SigmaV-squared is an estimate of the variance of the assumed symmetric distribution that is used to model the idiosyncratic component of the overall random error, i.e. measurement, sampling and specification error.
- **LLF (value of the log-likelihood function)**. The log-likelihood function (LLF) is the expression that is maximised using an iterative procedure to obtain the solution to the estimation model. Unlike the criterion of minimising the residual sum of squares in the standard regression model, the maximum likelihood approach used in stochastic frontier analysis works as follows: Assume that the underlying models of the probability distributions of the components of the residual are true, then find the numerical values of the parameters (regression coefficients, Mu, SigmaU-squared and SigmaV-squared) that maximise the joint probability of observing the sample in question. The LLF is a measure of this probability, hence equations with higher LLF values can be said to have values for the parameters that are more likely to describe the sample than those of other equations, i.e. higher LLF values are more desirable.
- **Number of observations**: EI's modelling is based on a total of 544 observations including 68 DNSPs over 8 years of time.

EI presented in its report only efficiency scores for the Australian DNSPs and did not report scores for the overseas networks. Using the same methodology applied by EI, we were able to derive scores for all the networks in EI's medium sample, including those from Ontario and New Zealand. Figure 3 below plots the efficiency scores for all of the networks in EI's medium sample.

14 If Ontario's frontier cost function is about 16% higher than Australia's, Australia's cost frontier will be about 14% lower than Ontario's. The cost frontiers for Australia and New Zealand differ by about 5% in both directions.

Figure 3: Efficiency scores implied by EI's analysis for all networks in the medium sample



Source: Frontier Economics

Figure 3 reveals a wide spread in performance across the entire sample, including within each of the three countries concerned. Since they are not presented in its report EI does not comment on the reasonableness of its efficiency estimates for the New Zealand and Ontario companies. We do so, in respect of Ontario, in Section 3.6.

3.2.2 Alternative specifications for heterogeneity and inefficiency

In addition to replicating EI's main model, we considered a wider range of SFA models which differ in the manner in which latent heterogeneity between DNSPs, the idiosyncratic error component, and the inefficiency error component are modelled.

Variations in operating expenditures between DNSPs and over time can be modelled as:

- Explained variation
  - cost variations that can be explained by differences in the right hand side variables in the model: customer numbers, circuit length, ratcheted maximum demand, share of underground cables and, year of observation.
- Residual variation
  - Idiosyncratic error (symmetrically distributed random variable, v)
  - Latent heterogeneity
  - Residual inefficiency (asymmetrically distributed random variable, u)

The problem area is the latent heterogeneity component. Each DNSP faces a unique operating environment and not all aspects of that environment are captured by the explanatory variables in the model. Hence there are unique (unmeasured) characteristics influencing each DNSP's costs which lead to latent heterogeneity in the cost function. There are various ways of modelling this latent heterogeneity component. The range of model specifications considered by EI, some additional specifications assessed by

Frontier, and a summary of the findings on inefficiencies, is presented in Table 3. The models differ mainly in the way the residual variation is modelled and interpreted.

The individual components of the residual variation are difficult to estimate statistically. Current procedures that bypass the difficulties include:

- **Ignore** both idiosyncratic error (*v*) and latent heterogeneity and assume all residual variation is inefficiency, e.g. as in MTFP (see EI report) and Data Envelopment Analysis (DEA, see Section 4.3 of this Frontier report below) approaches;
- Measure idiosyncratic error (*v: symmetric distribution*) and latent heterogeneity (using dummy variables) **but interpret the latent heterogeneity as inefficiency**: LSE (as in the EI report) approach; and
- Measure idiosyncratic error (*v: symmetric distribution*) and inefficiency (*u: asymmetric distribution*) and **assume the explained variation captures all the heterogeneity**: SFA Pitt-Lee approach with single country dummy variables (NZ, Ont) (EI's preferred model).

EI recognises that there is <u>some</u> latent heterogeneity in the sample by including country dummy variables for New Zealand and Ontario in its preferred SFA model. The coefficients on the dummy variables represent a shift in the frontier cost function for the New Zealand and Ontario businesses compared to the frontier cost functions against which the Australian businesses are assessed. In EI's preferred model, the frontier cost function for the Ontarian businesses enables an Ontarian business to have approximately 16% higher costs than an equivalent Australian DNSP (in terms of customer numbers, circuit length, ratcheted maximum demand and underground circuit) and still have the same efficiency score. A New Zealand business can have approximately 5% higher costs than an equivalent Australian business yet have the same score. These higher cost allowances for the Ontarian and New Zealand businesses are due to unspecified differences in the operating environments in the different countries, i.e. latent heterogeneity between countries.

However, cross-country differences are not the only sources of such latent heterogeneity. As pointed out above, each DNSP's costs are influenced by factors not captured by the explanatory variables in the model, which also results in latent heterogeneity within each country in the sample. Two model specifications that allow for latent heterogeneity at the DNSP level are the 'true' Fixed Effects (FE) and Random Effects (RE) SFA models. We have estimated these variants of EI's model using the **sfpanel** command in Stata to estimate the true RE SFA model, with some cross-checking carried out using the widely-used econometric software package LIMDEP.[15]

[15] All stochastic frontier analysis estimates are the result of iterative solutions of sets of non-linear equations involving derivatives of a joint probability density function which do not have analytical solutions expressible in tractable algebraic formulas. In some cases, these iterative procedures do not produce a solution, and some experimentation may be necessary to achieve convergence of the iterative procedure to a valid solution.

Table 3: Comparison of EI's and Frontier Economics' specifications and findings using the EI medium dataset

Explained variation in operating costs is due to:	**Customer numbers, ratcheted maximum demand, circuit length, share of underground cabling, year of observation**					
Residual variation is due to:	**Model: MTFP (EI)**	**Model: LSE (EI)**	**Model: Pitt-Lee time invariant inefficiency, (EI) & Frontier Economics**	**Model: Battese-Coelli time varying inefficiency, Frontier Economics**	**Model: True Fixed Effects, Frontier Economics**	**Model: True Random Effects, Frontier Economics**
1. Idiosyncratic error	Not modelled explicitly	Modelled by symmetric probability density function	Modelled by symmetric probability density function	Modelled by symmetric probability density function	Modelled by symmetric probability density function	Modelled by symmetric probability density function
2. Latent heterogeneity	Not modelled explicitly	Modelled explicitly but enforced interpretation as inefficiency only	Not modelled explicitly at DNSP level, but 2 country dummy variables	Not modelled explicitly at DNSP level, but 2 country dummy variables	Modelled explicitly at DNSP level	Modelled explicitly at DNSP level
3. Inefficiency	Assumed source of all residual variation	Not modelled explicitly	Modelled by asymmetric probability density function	Modelled by asymmetric probability density function	Modelled by asymmetric probability density function	Modelled by asymmetric probability density function
Summary Efficiency Findings	Wide dispersion	Wide dispersion	Wide dispersion	Does not converge	Minimal efficiency dispersion, but widely dispersed heterogeneity	Minimal efficiency dispersion but widely dispersed heterogeneity

Source: Frontier Economics

Shortcomings with the AER's international benchmarking

We report the main estimation results in Table 4 with the implied inefficiencies for the Australian DNSPs presented in Table 5. In both tables, the corresponding results for EI's preferred SFA model are presented for comparison.

Table 4. Estimation results for true FE and RE models compared with EI's SFA model

	EI's preferred SFA model	True FE SFA model	True RE SFA model
Log (customer numbers)	0.667***	0.506***	0.527***
Log (circuit length)	0.106***	-0.081	0.110***
Log(ratcheted maximum demand)	0.214***	0.212**	0.342***
Log(share of underground cables)	-0.131***	0.031	-0.130***
Time trend	0.018***	0.017***	0.018***
Constant	-26.526***		-25.498***
Country dummies			
New Zealand	0.050		
Ontario	0.157**		
Variance parameters			
mu	0.385***		
sigma_u	0.197	0.042	0.043
sigma_v	0.099	0.08	0.089
LLF	372.62	533.195	373.676
N	544	544	544

*Source: Frontier; *** significant at 1% ** significant at 5% *significant at 10%*

Notes:

1. *For the true effects models, we selected the **sfpanel** default distribution, the exponential, to model the inefficiencies. For the true RE model, selecting the truncated normal for the inefficiency distribution produced almost identical results. For the true FE model, the truncated normal option did not converge.*
2. *For the true RE model, we have excluded the country dummies since these are likely to be correlated with the inefficiency term, leading to inconsistent estimates. However, the qualitative findings from the model that includes these dummies are quite similar*
3. *We note that for the true FE model the coefficients on circuit length and share of underground cables do not have the expected sign. However, both these coefficients are not significant, even at the 10% level. This is likely due to the fact that these variables are fairly constant over time; hence their impact is picked up by the fixed effects*

Table 5. True FE and RE efficiency scores compared to EI's preferred model (%)

DNSP	EI's preferred SFA model Battese Coelli efficiencies %	True FE model Battese Coelli efficiencies (average) %	True FE model Battese Coelli efficiencies (last year) %	True RE model Battese Coelli efficiencies (average) %	True RE model Battese Coelli efficiencies (last year) %	True RE model Jondrow et al efficiencies (average) %	True RE model Jondrow et al efficiencies (last year) %
ActewAGL	39.9	95.9	93.2	98.8	99.0	92.7	95.0
Ausgrid	44.7	95.8	97.9	98.6	98.2	95.1	92.5
CitiPower	95.0	95.7	93.6	78.6	86.8	96.5	97.7
Endeavour Energy	59.3	96.0	97.8	97.3	95.8	96.9	95.0
Energex	61.8	96.2	93.6	97.2	98.0	97.0	97.9
Ergon Energy	48.2	96.1	97.8	98.4	98.1	96.3	95.1
Essential Energy	54.9	95.8	95.2	97.9	98.4	95.9	97.3
Jemena	71.8	96.1	96.1	95.2	96.1	96.9	97.3
Powercor	94.6	96.1	94.1	82.7	90.5	96.8	97.8
SA Power	84.4	95.5	91.3	87.5	95.2	96.9	98.2
AusNet	76.8	96.1	93.9	94.0	96.7	96.9	97.9
TasNetworks	73.3	96.0	97.6	93.6	90.8	96.9	96.0
United Energy	84.3	96.1	97.0	89.7	88.0	97.0	96.7
Summary statistics across all countries and all years							
Mean	68.3	95.9		95.6		96.4	
Standard deviation	12.0	2.2		4.3		2.5	
Min	39.9	69.9		68.6		55.4	
Max	95.4	98.8		99.1		98.4	

Source: Frontier

Notes:

1. *For the true effects models, we report both the average efficiency score for each Australian DNSP across the sample time period, and the efficiency score in the last year of the sample. In EI's model the efficiency scores are assumed to be constant over time*
2. *Two measures of technical efficiency are commonly used in SFA modelling, the Battese Coelli measure and the Jondrow et al measure.[16] For EI's model and the true FE model these are almost*

[16] Battese, G. and T. Coelli. (1988). "Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data", *Journal of Econometrics* 38, 387-399.

identical (<0.05% difference for EI's model, and <0.26% for the true FE model). For the true RE model the two measures differ more widely and we report both measures

3. *The mean, standard deviation, minimum value and maximum value of the efficiency scores are calculated across the DNSPs in all countries and over all years*

Table 5 above shows that by allowing explicitly for latent heterogeneity in the residual variation, the inefficiencies found in EI's modelling reduce significantly. Across both true effects models, and both measures of efficiency, all Australian DNSPs have an average efficiency score across the period of at least 78.6%, and in the last year of the sample (2013) all Australian scores are 86.8% or better.

The standard deviation of efficiency scores across the businesses in all three countries and all years is reduced from 12.0% for EI's model to 4.3% or less for the true effects models.

Put simply, specifying a model that captures latent heterogeneity, not just across countries, but also within countries, reduces the measured inefficiency of the Australian DNSPs to negligible levels.

This analysis reveals a key weakness within EI's analysis. EI has only considered SFA models that account for idiosyncratic error and 'inefficiency', and these more limited models find a wide spread in inefficiency. EI has not, however, considered the 'true effects' SFA models that allow a richer decomposition of 'inefficiency', into latent heterogeneity and inefficiency. Had they done so, they would have found that these models find little inefficiency, but instead ascribe most of the unexplained variation to latent heterogeneity.

By presenting this analysis we do not claim that we have solved the problem of modelling the efficiency of the Australian DNSPs, and that AER should abandon benchmarking work and assume all the firms are efficient. It is clear that benchmarking the Australian companies is a challenging task and many of the criticisms we go on to level at the EI data and approach in the remainder of this report may be just as readily deployed to criticise the 'true effects' SFA models we have explored. Nevertheless, it has turned out to be possible to completely overturn the EI efficiency score results for the Australian DNSPs by minor modifications to EI's preferred SFA model. This should be cause for significant concern in its own right, notwithstanding the wider critique we go on to present.

What we have pointed out is that the treatment of latent heterogeneity in the sample by EI is quite arbitrary. This is perhaps best exemplified by the identical use of dummy variables in EI's LSE model to measure, on the one hand, latent heterogeneity in the case of country dummies, but, on the other hand, pure inefficiency in the case of Australian businesses' dummies. These dummy variables are interpreted as genuine heterogeneity for some sample points but enforced as inefficiency for others. The key issue is that the EI's analysis either

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Jondrow, J. et al (1982), "On the estimation of technical inefficiency in the stochastic frontier production model", *Journal of Econometrics* 19, 233-238 assumes latent heterogeneity cannot be a real problem once the country dummy variables are used, or it enforces the interpretation of inefficiency on factors designed to model heterogeneity. As soon as this strong assumption is dropped, the apparent inefficiency differences disappear. The problem of accurately measuring relative performance remains – it has not been solved by Frontier-Economics – but equally, if not more strongly, it has not been solved by EI either.

If the regulatory recommendation was to impose minor operating cost reductions – say of the order of 2 to 3 percent – this might not be too serious. But EI's recommendation is for cost savings on a massive scale, based on modelling which it has been relatively easy to call into question. This seems to be a very high risk policy strategy.

3.2.3 Poolability of data across countries

Under the EI method, the Australian data sample is embedded within a much larger sample comprising data from New Zealand and Ontario in order to generate a sufficiently large variation in the data to enable robust estimation of measured inefficiency from which the within-Australia variation in efficiency can be inferred. As shown in Table 6 below, the Australian DNSPs account for only 19% of the preferred sample. The New Zealand DNSPs account for 26%, and the Ontarian DNSPs account for 54%, more than half of the sample.

Table 6: Number of companies in EI's sample

	Australia	New Zealand	Ontario
Number of companies	13	18	37
Proportion of EI's sample	19.1%	26.5%	54.4%

Source: EI dataset

In Table 7 we present the estimation results for EI's model specification when estimated using each of the three separate country sub-samples. It can be seen that the results for EI's pooled model are more similar to the results for Ontario alone, than to the results for Australia or New Zealand.

It is also worth noting that for the Australian data, circuit length and ratcheted maximum demand are statistically not significant. Moreover, the coefficient on ratcheted maximum demand has the wrong sign. These poor results for the Australian sample are most likely due to the small sample size, hence we can appreciate EI's desire to expand the sample to obtain more robust estimates, as absent the international data EI's models cannot be made operational.

However, an important criterion that should be satisfied when pooling data from different sources is that the data sources are indeed poolable. Poolability requires that there are no statistically significant differences between values of the main parameters in the model across the sub-samples. We tested for the poolability of the data from the three countries by re-estimating EI's preferred model with the addition of variables that could pick up any differences between the countries in the values of the elasticities on the four main drivers of costs (customer numbers, circuit length, ratcheted maximum demand and share of underground cables) as well as the time trends. We did this by using Australia as a reference country, and 'interacting' each of the five variables of interest with the two country dummy variables for New Zealand and Ontario. The coefficients on these so-called 'interaction' terms are estimates of the differences between the parameter values for New Zealand (respectively, Ontario) and the corresponding parameter value for Australia.

Table 7: Estimation results for EI's SFA model for each sub-sample

	EI's combined sample preferred model	Australia	New Zealand	Ontario
Log(customer numbers)	0.667***	1.146***	0.566***	0.732***
Log(circuit length)	0.106***	0.130	0.201*	0.041
Log(ratcheted maximum demand)	0.214***	-0.242	0.206*	0.234**
Log(share of underground cables)	-0.131***	-0.021	-0.088	-0.211***
Time trend	0.018***	0.034***	0.023***	0.010***
Constant	-26.526***	-56.742***	-37.564***	-10.049**
Country dummies				
New Zealand	0.050			
Ontario	0.157**			
Variance parameters				
mu	0.385***	-0.278	-0.043	0.391***
sigma_u	0.197	0.563	0.269	0.133
sigma_v	0.099	0.088	0.108	0.091
LLF	372.62	78.56	92.63	235.69
N	544	104	144	296

*Source: Frontier; *** significant at 1% ** significant at 5% *significant at 10%*

We calculated two versions of this test: (a) by allowing the estimates of the deviations in relevant coefficients compared to Australia to be different for Ontario and New Zealand, and (b) by assuming that the deviations in the relevant coefficients compared to Australia are the same for both Ontario and New Zealand. In both cases we tested the hypothesis that these deviations can be assumed to be zero, in which case the pooling of the data for the three countries is justified.

The results of both versions of this poolability test overwhelmingly reject this hypothesis. For version (a) we obtained a chi-squared (10 degrees of freedom) value of 46.3, with a corresponding p-value of less than 0.0000001. For version (b) the chi-squared value (with 5 degrees of freedom) was 31.8; with again a p-value of less than 0.0000001. Hence, pooling of the data from the different countries cannot be justified from a statistical point of view. Imposing common coefficients across countries in this case results in biased and inconsistent estimates of the coefficients relevant to each individual country.

These statistical tests provide strong evidence that the weights associated with the different cost drivers are significantly different between the countries. In other words, at least some of the costs imposed on an Australian DNSP as a result of an extra customer, an extra km of circuit, an extra MW of demand or a change in the share of underground cabling, are significantly different in the other two countries. This could be due to a wide range of factors such as differences in labour costs, differences in the costs materials (perhaps affected by exchange rates), differences in regulatory costs, or simply underlying differences in costs to serve owing to a wealth of differences in operating conditions.

In Sections 3.3 and 3.4 below we demonstrate a range of factors that explain why DNSPs in Ontario and New Zealand are markedly different.

3.3 Comparability issues between Ontario, New Zealand and Australia

In this section, we present a range of descriptive analysis (using the latest year of data, in most instances) which clearly demonstrates that the DNSPs in Ontario and New Zealand have markedly different business models and cost structures to those in Australia. The analysis presented in this section, and the conclusions we draw from it, support and provide an explanation for the results of statistical tests of poolability presented above.

3.3.1 Differences in scale

The 13 DNSPs in Australia are significantly larger than the 37 companies from Ontario and the 18 companies from New Zealand that EI has used, within its 'medium sample' as comparators in its benchmarking analysis. This is demonstrated clearly in Table 8 below.

- The Australian DNSPs are, on average, four times larger than the companies in Ontario when compared using energy delivered and demand, six times larger when compared using customer numbers, and eleven times larger when compared using circuit length.
- The Australian DNSPs are, on average, eight times larger than the DNSPs in New Zealand when compared against all these measures of scale.

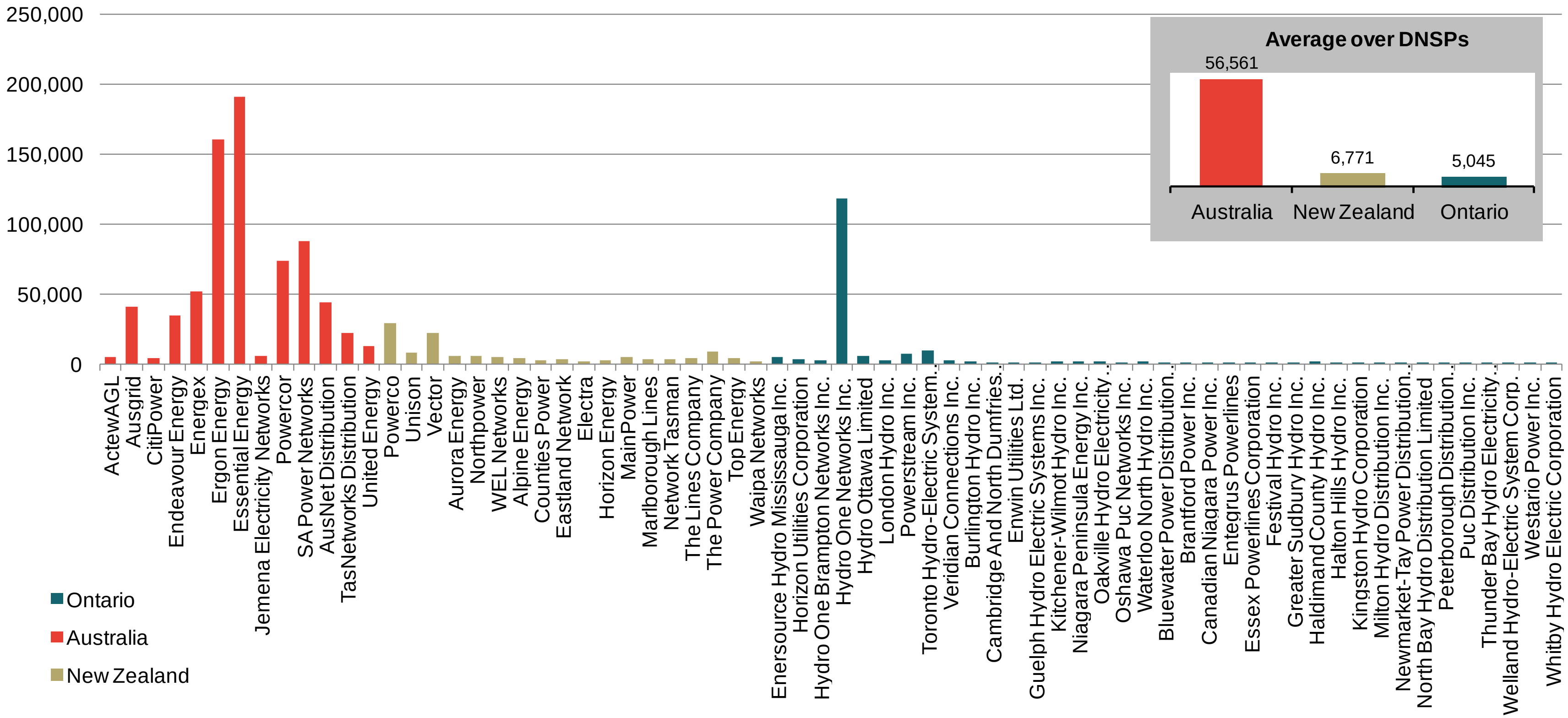
Table 8: Comparison of average scale of Australian and Ontarian networks

	Australia	Ontario	New Zealand	Australian value as a multiple of Ontarian value	Australian value as a multiple of New Zealand value
Energy (GWh)	11,038	3,073	1,441	4	8
Maximum Demand (MW)	2,346	603	287	4	8
Ratcheted Maximum Demand (MW)	2,516	651	313	4	8
Customer Numbers	731,308	124,270	96,577	6	8
Circuit Length (kms)	56,561	5,045	6,771	11	8

Source: EI dataset

Figure 4 below shows that only one out of the 37 Canadian DNSP (Hydro One Networks Inc) is similar to the Australian DNSPs when compared using a measure of circuit length. Similarly, the DNSPs in New Zealand have significantly smaller circuits than the Australian DNSPs, with the exception of two companies (Powerco and Vector) which are comparable in size to the smallest DNSPs in Australia. Ergon Energy and Essential Energy are two clear outliers in the sample when the companies are compared using a measure of circuit length. Both these DNSPs have circuits that are twice as long as any other Australian DNSP.

Figure 4. Circuit length (kms), 2013



Source: Source: EI dataset, AER RIN data

Figure 5, Figure 6, and Figure 7 below shows that Ausgrid is the largest DNSP in the sample when compared using measures of customer numbers, energy delivered and ratcheted maximum demand. Ausgrid's geographic coverage is unique as it covers a dense urban area (Sydney CBD) as well as more regional areas. Endeavour Energy and Energex are amongst the largest networks in the combined samples.

As in Figure 4 above, Figure 5, Figure 6, and Figure 7 show that Hydro One Networks Inc is one of the only companies in the Ontario sample that is comparable in size to the larger Australian DNSPs when compared using measures of customer numbers, energy delivered and ratcheted maximum demand. The other large company in the Ontario dataset is Toronto Hydro-Electric, which serves an urban area. The remaining companies in the Ontario dataset are clearly significantly smaller in scale when compared with the Australian DNSPs.

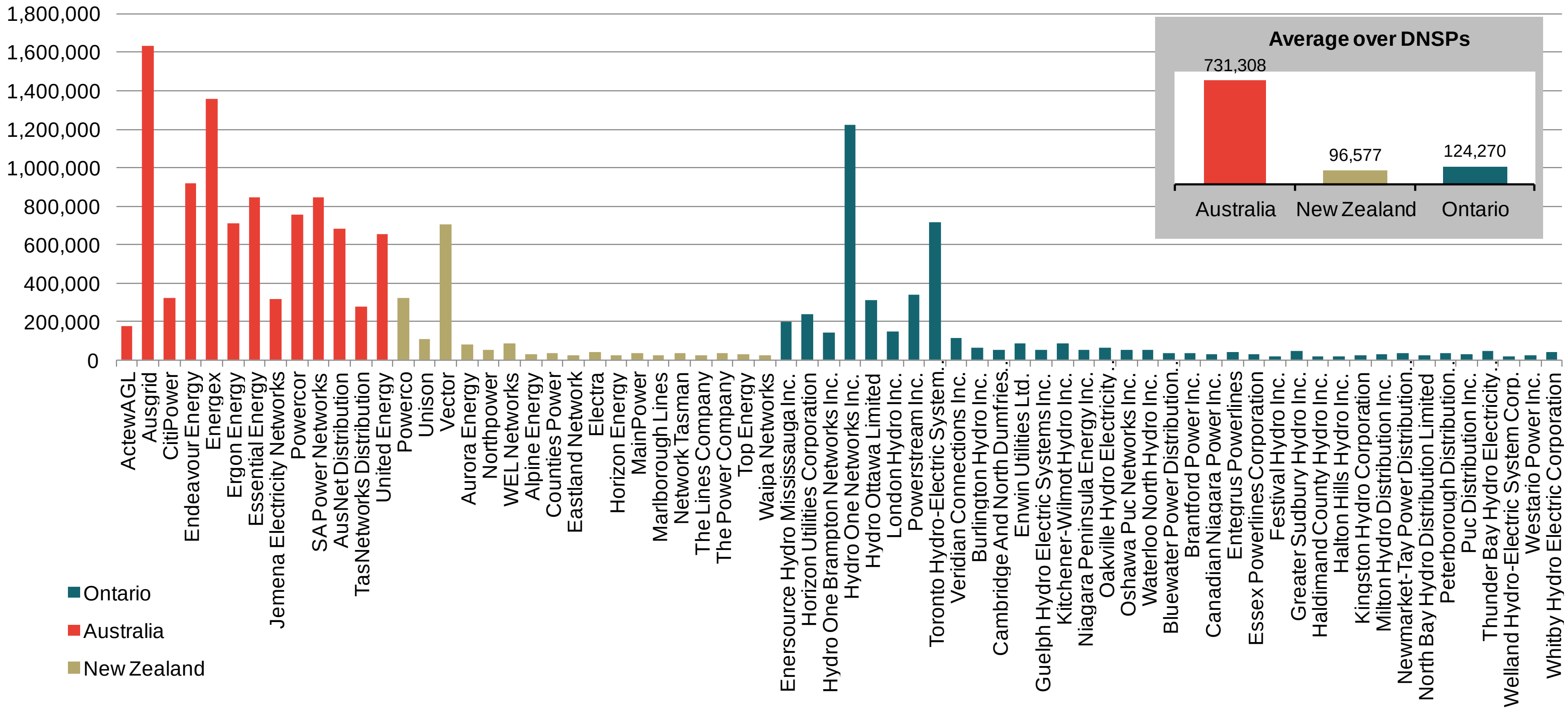
Similarly, as in Figure 4 above, Figure 5, Figure 6, and Figure 7 show that the DNSPs in New Zealand are materially smaller than the Australian DNSPs when compared using measures of customer numbers, energy delivered and ratcheted maximum demand. Only two DNSPs in New Zealand (Powerco and Vector) are comparable in size to the smaller DNSPs in Australia.

As shown in Figure 3 the network identified by EI's analysis as the most efficient one is an Ontarian firm, Hydro One Brampton Networks Inc. The analysis in Figure 4 to Figure 7 demonstrates clearly that Hydro One Brampton Networks is smaller than most, if not all, the DNSPs in Australia, including CitiPower (the most efficient Australian DNSP, as identified in EI's analysis).

From this we conclude that the use of an international sample has added very few companies of sufficiently similar scale to the larger Australian firms. This is particularly true in respect of circuit length, where only one of the firms in the international sample operates a network with circuit length comparable to the larger Australian firms. Only one (non-Australian) company in the international sample appears to serve a large, relatively rural area, casting doubt over whether we can expect the EI model(s) to capture at all well the unique costs of serving such a region (i.e. needing to have "many" assets to serve "few", widely dispersed customers).

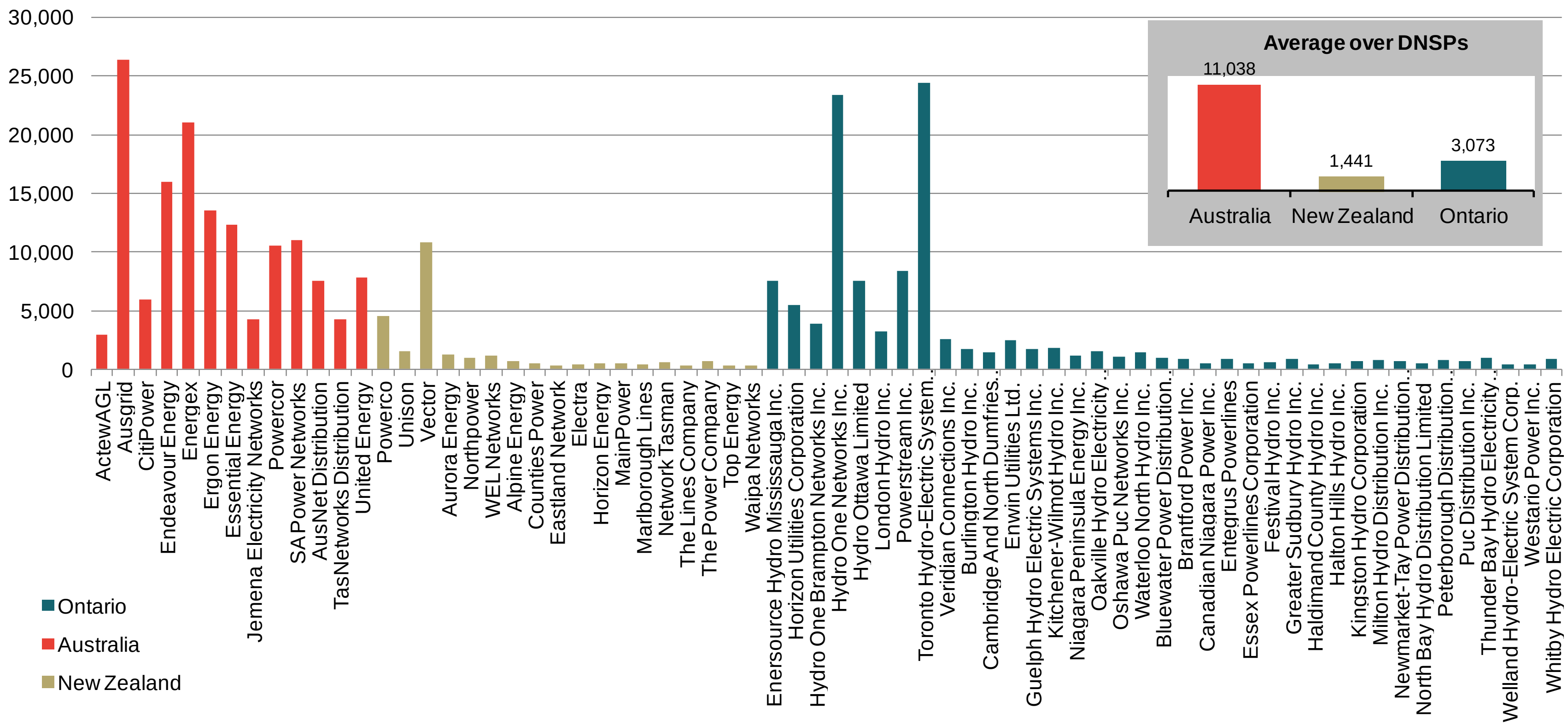
The small number of large companies in the sample may also call into question the validity of the finding that there are scale efficiencies at all scales of operation. The sample is dominated by small firms, where scale efficiencies can most readily be expected to be found, so we would expect this finding to emerge in the sample on average. However, this tells us nothing about whether there may be diseconomies of scale at the extreme size of some of the Australian firms, which could be an important consideration when interpreting the generally low efficiency scores of large companies under the EI model.

Figure 5: Customer numbers, 2013



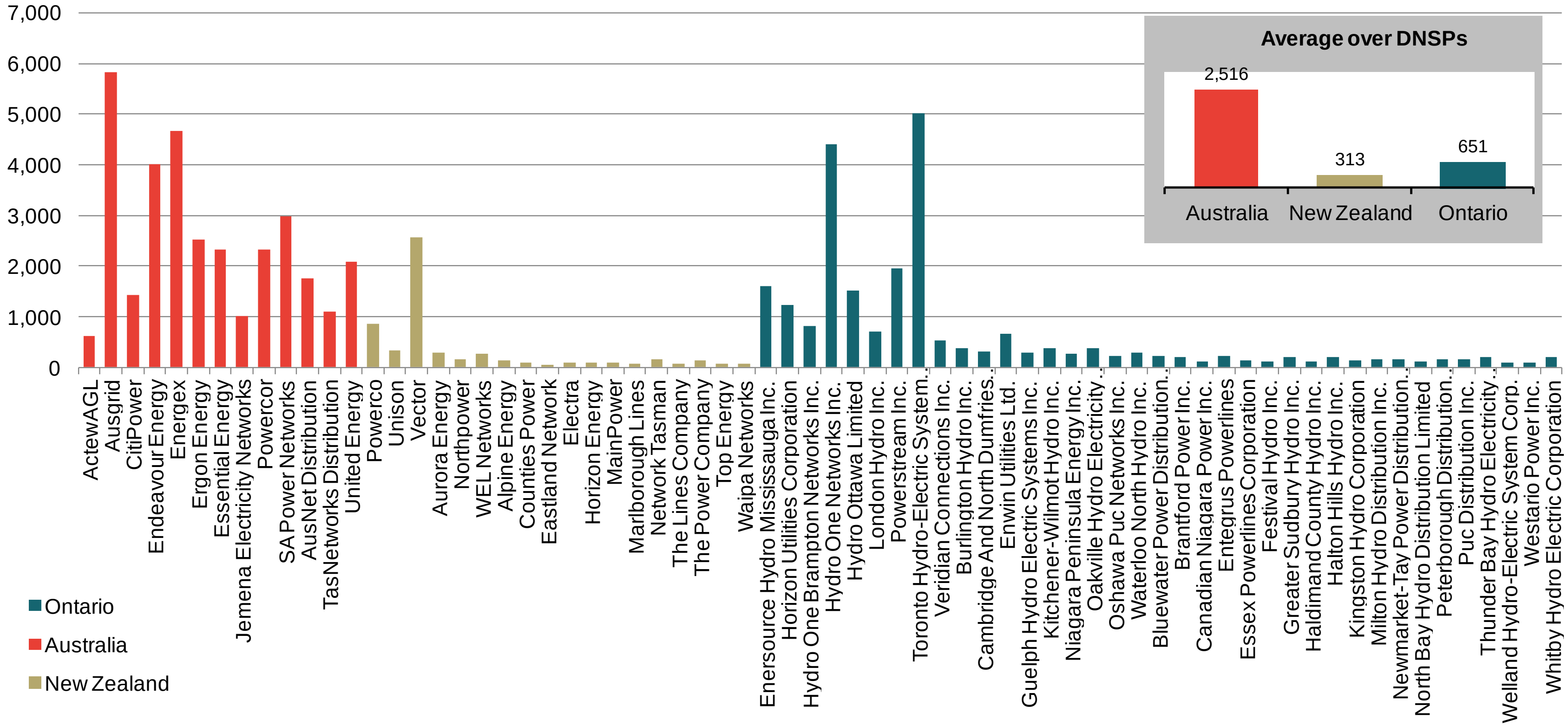
Source: EI dataset, AER RIN data

Figure 6: Energy delivered (GWh), 2013



Source: EI dataset, AER RIN data

Figure 7: Ratcheted maximum demand (MW), 2013



Source: EI dataset, AER RIN data

3.3.2 Differences in climate/geography

Differences in climate and geography are particularly notable between Australia and Ontario. Figure 8 and Figure 9 illustrate the average maximum daily temperature and average minimum daily temperature respectively of the Australian capital cities of the regions analysed in the AER's benchmarking exercise and 12 selected Ontario cities.[17] They illustrate that the summer temperatures in the Australian cities and Ontario cities are relatively similar, however, the winter temperatures are significantly lower in Ontario. The temperature is lower on average in Ontario.

Figure 10 illustrates the average monthly snowfall in the 12 selected Ontario cities and the Australian cities. There is no recorded snowfall in the Australian cities[18], however there is between 23cm to 83cm of snow in the Ontario cities on average in the winter months.

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17 All of Ontario's 187 weather stations were considered for this analysis. Only 12 are presented in this section in order to simplify the information presented in the charts. These 12 cities were selected on the basis of population size and geographic location; we have selected the most populous cities as well as cities that provide a representation of the geographic dispersion on climate across Ontario. Including the climatic information from the excluded cities does not change the high level observations of the analysis.

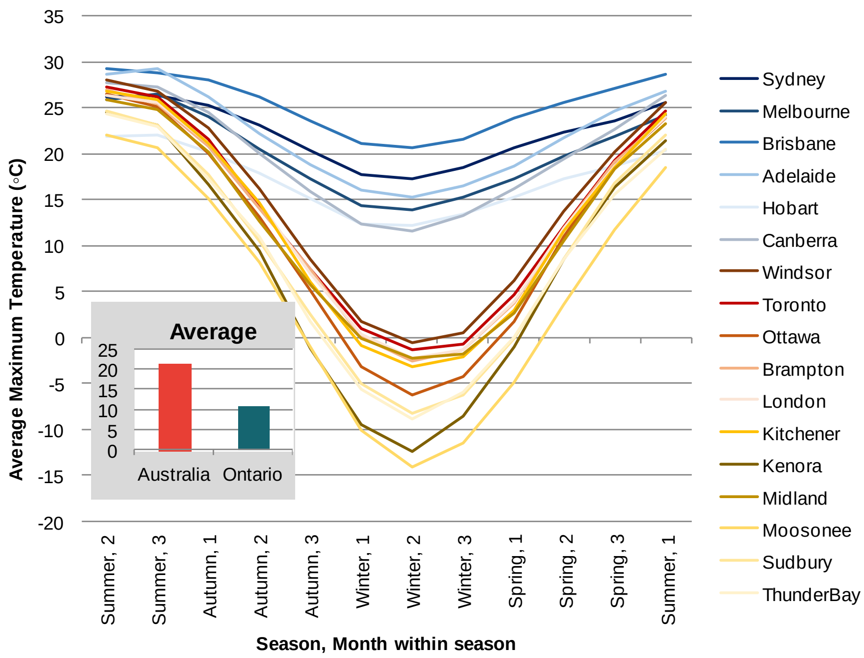
Averages for the Australian data are for the period 1971 to 2000 except for Adelaide, which covers the period 1977 to 2000. Averages for the Ontario data are for the periods ranging from 1932 to 2013. The range used in the average calculation is based on the availability of data. In calculating the averages, we have excluded missing, incomplete and unrecorded observations.

Climate data for the Ontario cities has been sourced from the Environment Canada website: http://climate.weather.gc.ca/advanceSearch/searchHistoricData_e.html, viewed 19/12/2014. Climate data for the Australian cities has been sourced from the Australian Bureau of Statistics website: http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Australia's%20climate~143, viewed 19/12/2014.

The x-axis of each chart identifies the season as well as the position of the month within that season. For example, "Summer, 1" refers to the first month of summer which is December in Australia and June in Ontario, "Summer, 2" refers to the second month of summer which is January in Australia and July in Ontario

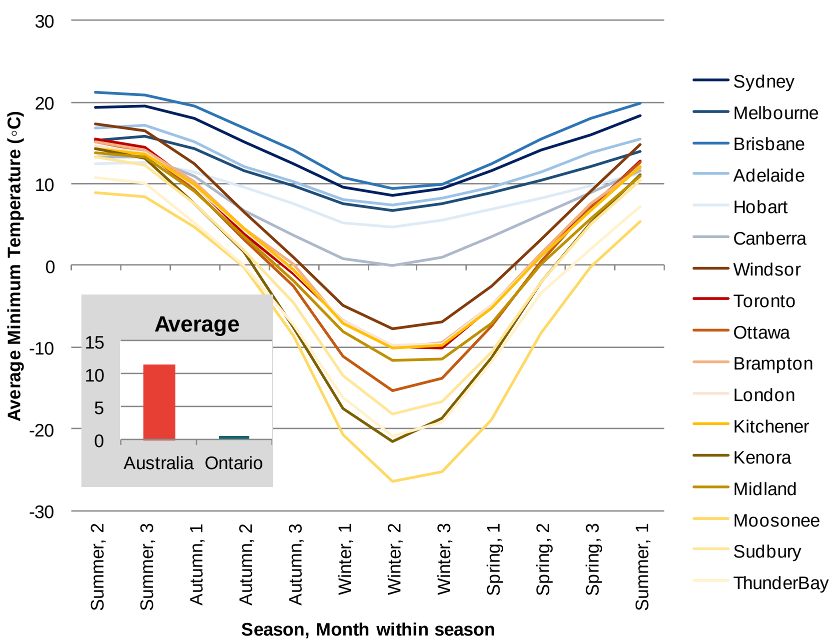
18 Snow depth data is not available from the Bureau of Meteorology. Snow fall at sea level and low elevations is extremely rare in Australia.

Figure 8: Average maximum daily temperature



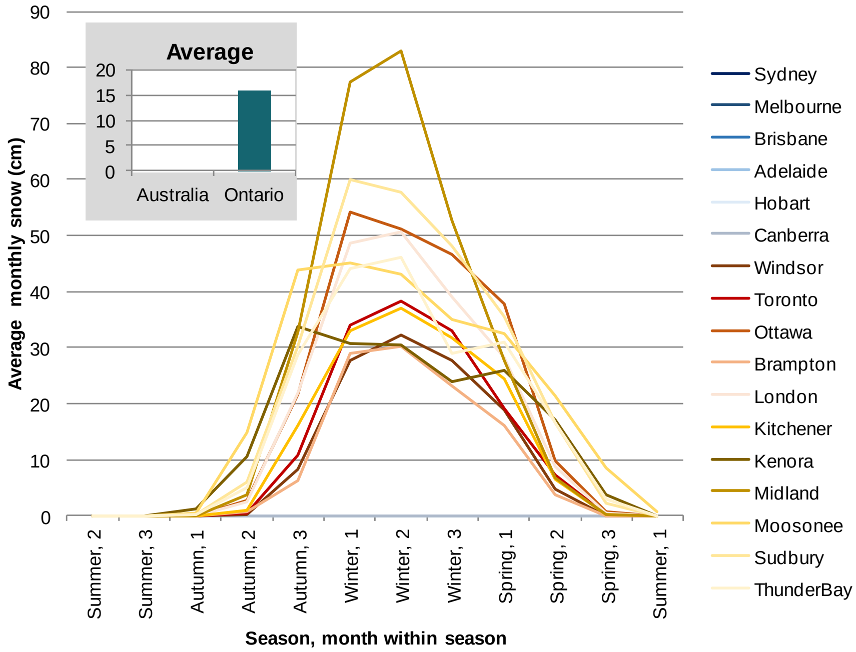
Source: Australian Bureau of Statistics, Environment Canada; Australian weather data spans the years 1971 to 2013 (except for Adelaide, for which data were only available from 1977 onwards), and Canadian weather data spans the years 1932 to 2013 (with varying data availability in different regions of Canada).

Figure 9: Average minimum daily temperature



Source: Australian Bureau of Statistics, Environment Canada; Australian weather data spans the years 1971 to 2013 (except for Adelaide, for which data were only available from 1977 onwards), and Canadian weather data spans the years 1932 to 2013 (with varying data availability in different regions of Canada).

Figure 10: Average monthly snow



Source: Australian Bureau of Statistics, Environment Canada; Australian weather data spans the years 1971 to 2013 (except for Adelaide, for which data were only available from 1977 onwards), and Canadian weather data spans the years 1932 to 2013 (with varying data availability in different regions of Canada).

We would anticipate that network operators in Ontario will have had to develop very different types of network in order to address the challenges of Canada's harsh winters. There is no a priori reason to suppose therefore, that the different design philosophies adopted across countries within the sample will have led to common relationships between cost and cost drivers. (Indeed, as discussed in Section 3.2.3, we find statistical evidence that this is not the case.) The most obvious difference will have been to underground significantly more network in order to ensure harsh winter weather does not damage power lines, a topic we consider in the following subsection.

3.3.3 Differences in spatial characteristics

The DNSPs in Australia have significantly different network characteristics from those in both Ontario and New Zealand.

Figure 11 below demonstrates that companies in Ontario have a significantly larger proportion of underground cables when compared with the DNSPs in Australia and New Zealand. On average, 22.3% of total circuit length in Ontario, and 26.5% of total circuit length in New Zealand, is underground; this compares to just 13.3% of undergrounding in Australia, on average.[19] Ontario's harsh climate makes economic very high levels of undergrounding. This could potentially imply that most of these companies' costs are in capex (i.e. incurred during the initial build), not opex (as fault, inspection and maintenance costs are reduced significantly when lines are undergrounded).

We note that within the sample of 68 DNSPs used by EI in its econometric analysis, the percentage of network underground ranges between circa 2.5% and circa 73% (over all years for which data are available). Such a large scale difference in operational circumstances suggests that very different types of network have been built across the sample, and these might have very different prevailing levels of cost, and splits of cost between opex and capex. This calls into question whether it is reasonable to presume that the inclusion of a simple underground percentage variable is sufficient to capture costs structure differences across such a wide range of network designs.

Figure 12 demonstrates that some DNSPs in Australia have a large high voltage network. In contrast, we understand from Networks NSW that the data for Ontario excludes all costs associated with assets over 50kV, and all but two networks in New Zealand (Vector and Countries Power) report negligible amounts of circuit length over 66kV, creating significant comparability issues with the DNSPs in Australia. In short, it would appear that a number of companies in Australia are undertaking an additional sub-transmission task that is not being undertaken by most of the international peer companies. This uncontrolled for cost incurred by some Australian companies would likely be picked up and interpreted as inefficiency in the EI model. Furthermore, there are likely to be significant comparability issues even between the Australian DNSPs, as only five of these (including Essential, Ausgrid and Endeavour, in particular) have large volumes of high voltage assets, while others have none.

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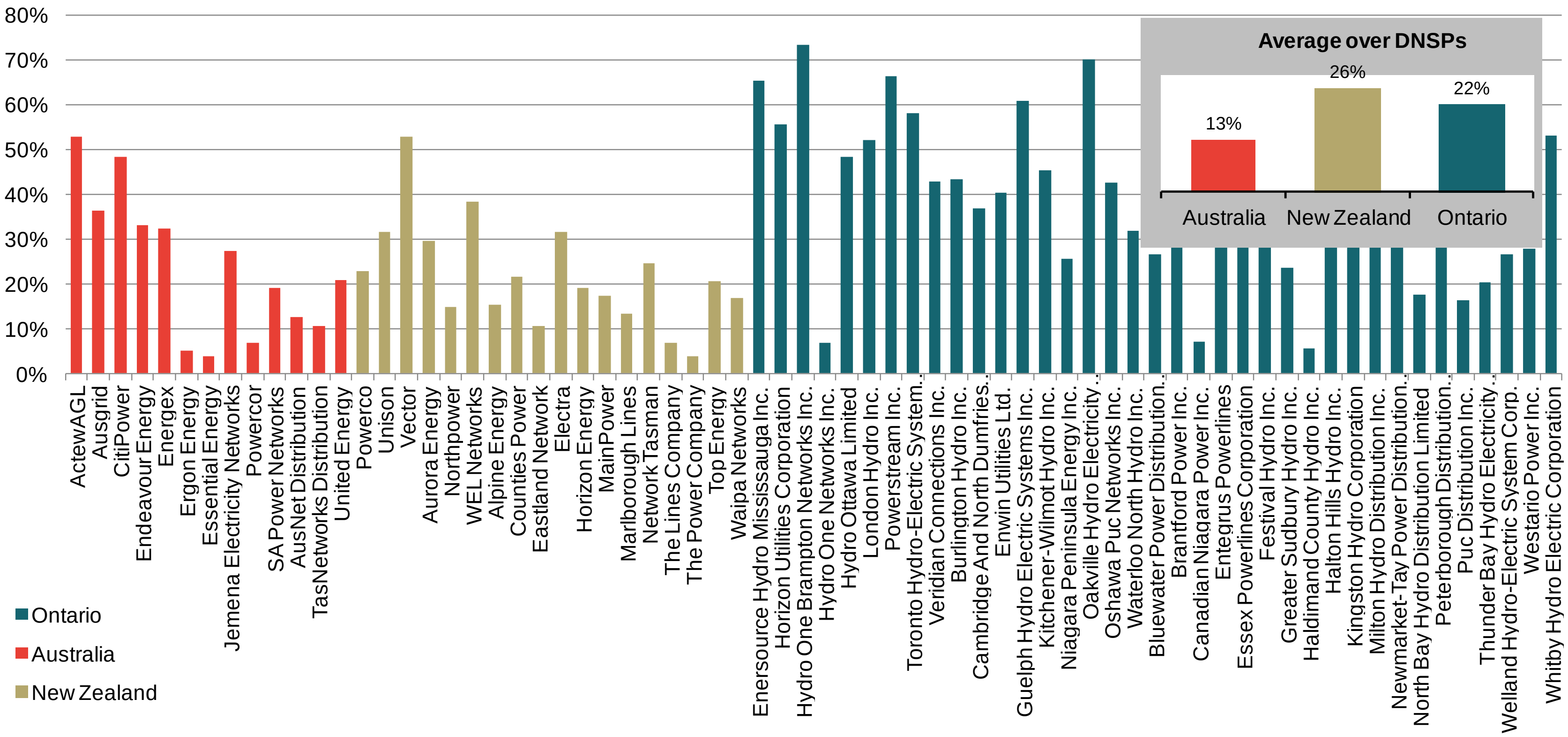
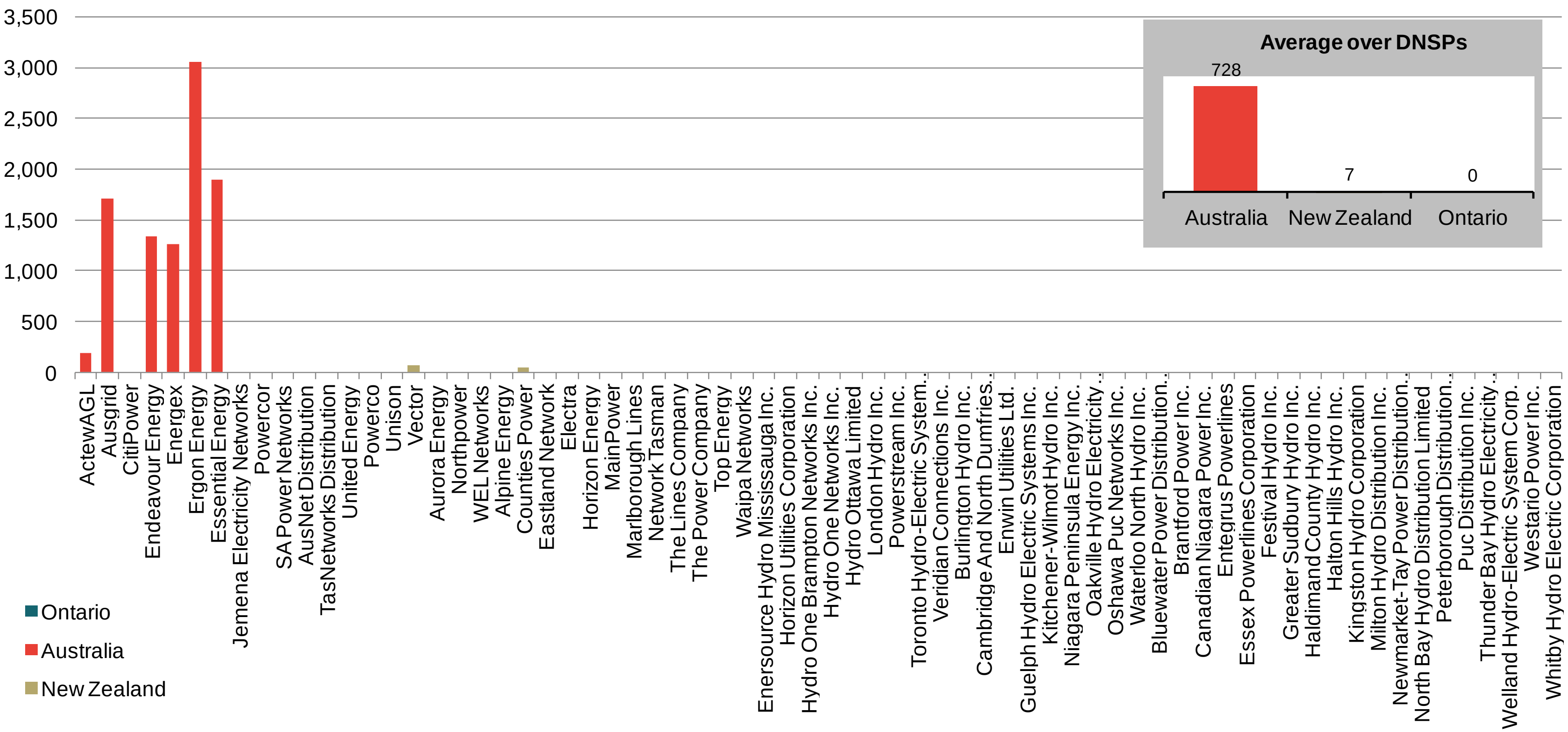
19 The average underground circuit length for the jurisdiction is calculated by summing up underground circuit length in that jurisdiction across DNSPs, and total circuit length in the jurisdiction across all DNSPs, and taking the ratio of the two values. (We have followed an analogous approach to calculate the ratios presented below in section 3.3.4 below.) We did not derive the average proportion of undergrounding by simply averaging the share of undergrounding over all DNSPs because such an approach would give disproportionately large weight to small networks, and disproportionately high weight to large networks.

Figure 11: Share of underground circuits, 2013



Source: EI dataset, AER RIN

Figure 12: Length over 66kV (kms), 2013



Source: EI dataset, AER RIN data

The analysis in this section demonstrates that cost structures in New Zealand and Ontario are materially different. This would imply that the relationship between opex and the relevant cost drivers is also different across the counties in the sample, helping to explain the poolability results presented above.

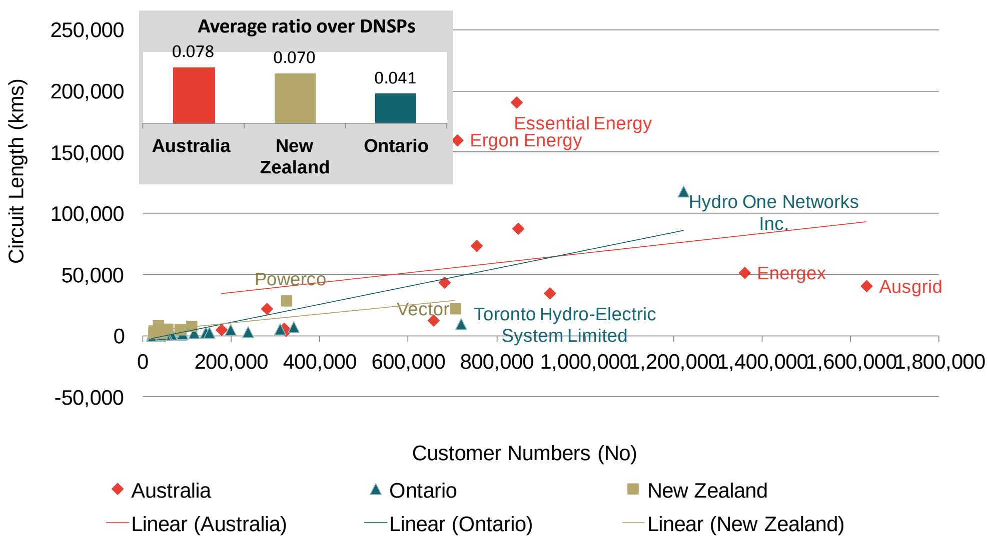
3.3.4 Differences in output mix

Figure 13 below shows that, on average, Australian networks have around 90% more circuit length per customer than the Ontarian networks, and approximately 12% more circuit length per customer than the New Zealand networks.

Furthermore, the two largest companies within each of the three countries are clear outliners when the DNSPs are compared using a measure of circuit length per customer: Ergon Energy and Essential Energy in Australia; Hydro One Networks Inc. and Toronto Hydro-Electric System Ltd. in Canada; and Powerco and Vector in New Zealand.

Finally, the relationship between circuit length and customers is less clear in Australia then in Ontario and New Zealand, owing to the significantly larger size of networks in Australia, and the major differences in respect of population density and terrain of the areas served by Australian networks.

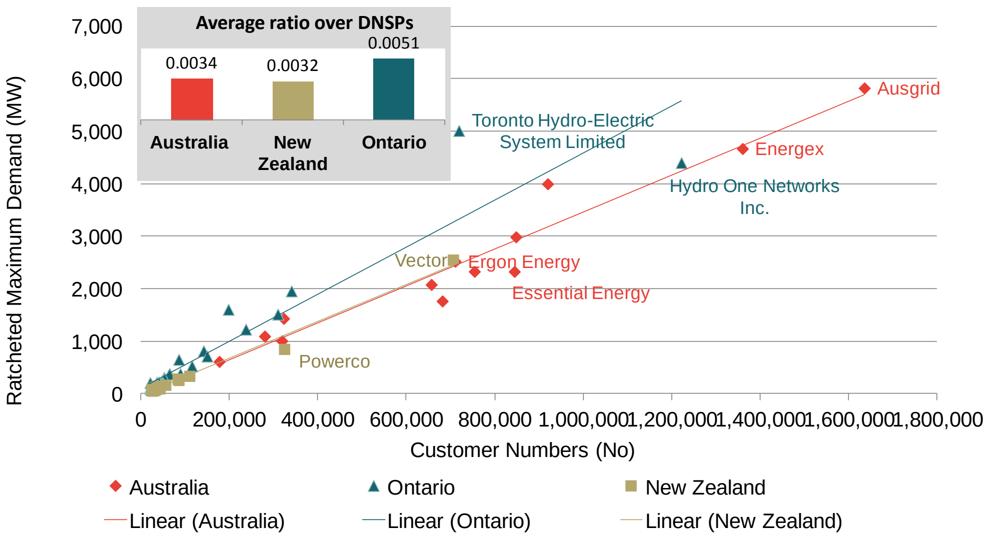
Figure 13: Circuit length per customer, 2013



Source: EI dataset, AER RIN data

As Figure 14 below, average ratcheted maximum demand per customer is around 49% greater in Ontario than in Australia, and is approximately 6% lower in New Zealand than in Australia. Once again, the two largest networks in Ontario and New Zealand are clear outliers within each of the respective countries. In Australia, Ausgrid is the largest networks in terms of ratcheted maximum demand per customer, owing to its unique coverage of both the Sydney CBD region and a large urban area in New South Wales.

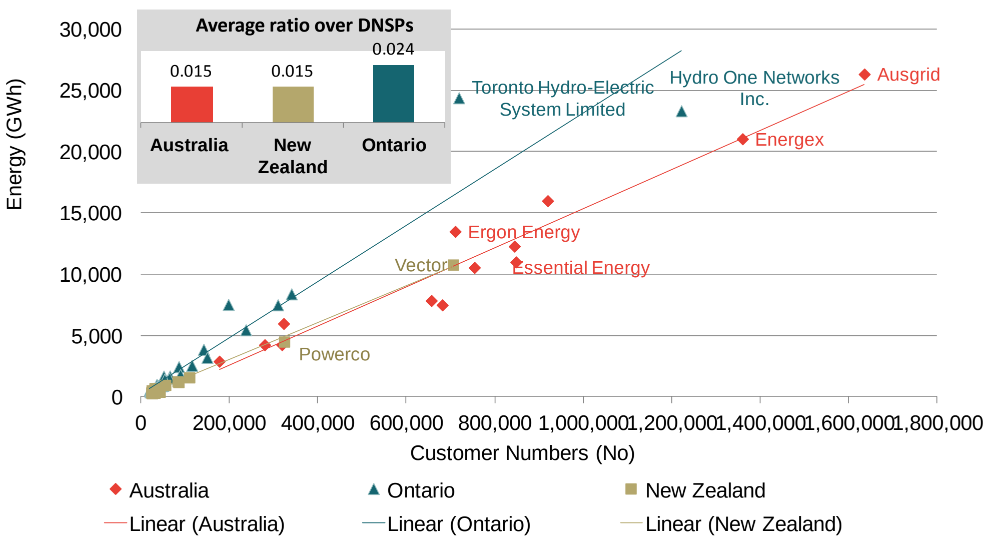
Figure 14: Ratcheted maximum demand per customer, 2013



Source: EI dataset, AER RIN data

And energy use per customer is around 60% higher in Ontario than in Australia and New Zealand, as shown in Figure 15 below. Furthermore, as in Figure 14 some networks are unique in their circumstances.

Figure 15: Energy delivered per customer, 2013



Source: EI dataset, AER RIN data

3.3.5 Differences in relationship between opex and cost drivers

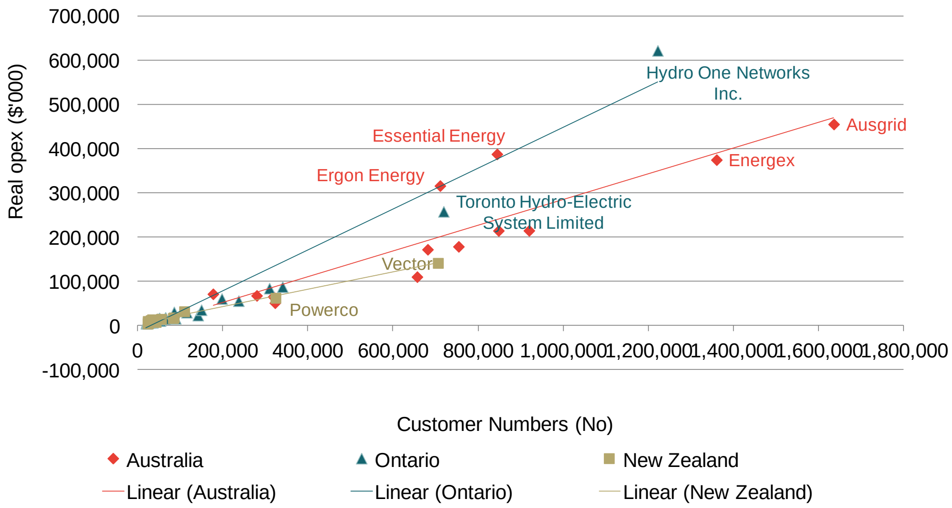
Material differences in network size and characteristics would imply that cost structures in Ontario and in New Zealand are greatly from those in Australia. Figure 16 to Figure 19 compare the relationship between opex and key output variables across countries, showing respectively:

- real opex per customer;
- real opex vs. ratcheted maximum demand;
- real opex vs. energy delivered; and
- real opex vs. circuit length

The analysis in this section demonstrates that the relationship between opex and the relevant cost drivers is markedly different across countries, and as a consequence these differences cannot be captured using simple country dummy variables.

Figure 16 below shows that the relationship between opex and customer numbers is substantially different across countries. Furthermore, there are clear outliers in the relationship between opex and customers in all three countries. Essential Energy and Ergon Energy are clear outliers in the Australian sample, owing to the significantly larger area served by both of these networks, relative to any other network in the sample.

Figure 16: Real opex per customer, 2013



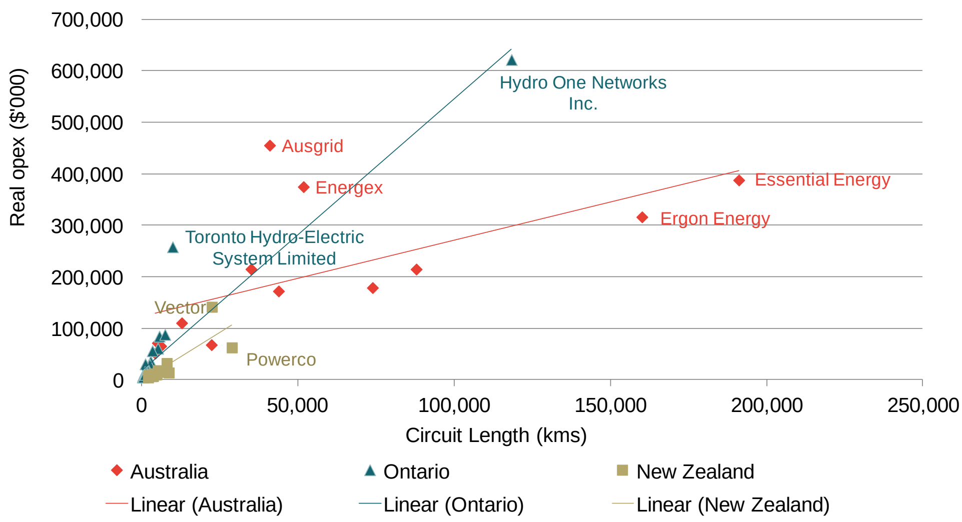
Source: EI dataset, AER RIN data

As is evident in all of the analysis in Sections 3.3.1 and 3.3.3, there are two networks in both Ontario (Hydro One Networks Inc and Toronto Hydro-

Electric System Inc) and New Zealand (Vector and Powerco) that are significantly larger than the remaining networks in these countries. Figure 16 shows that these networks are also clear outliers in the relationship between opex and customer numbers.

Figure 17 below shows that the relationship between opex and circuit length is substantially different across the three jurisdictions. This is likely to be due to the differences in network characteristics and circumstance across jurisdictions discussed above, which make meaningful cross-country comparisons very challenging. The relationship between opex and circuit length in New Zealand and Ontario is clearly defined by the outliner networks within each of the countries. Furthermore, owing to the vast heterogeneity in network characteristics in Australia, there is a very weak relationship between opex and circuit length within the country.

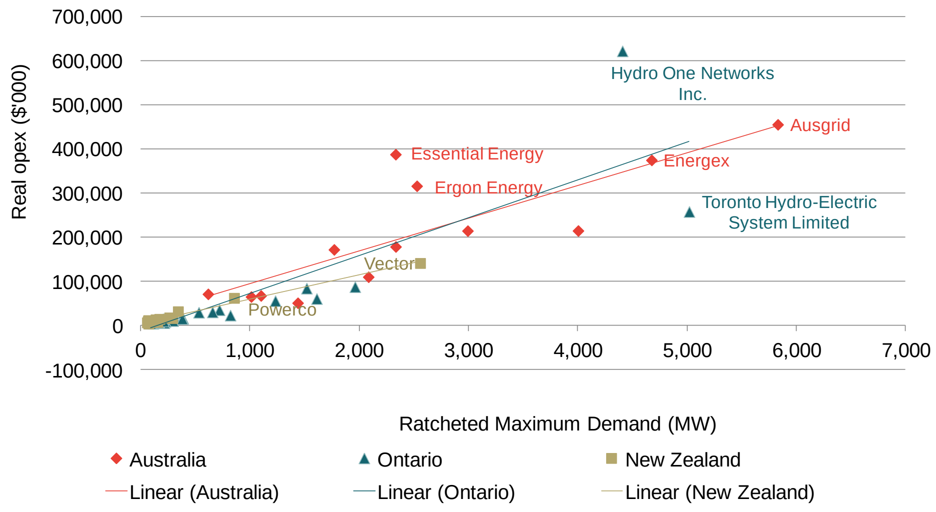
Figure 17: Real opex vs. circuit length, 2013



Source: EI dataset, AER RIN data

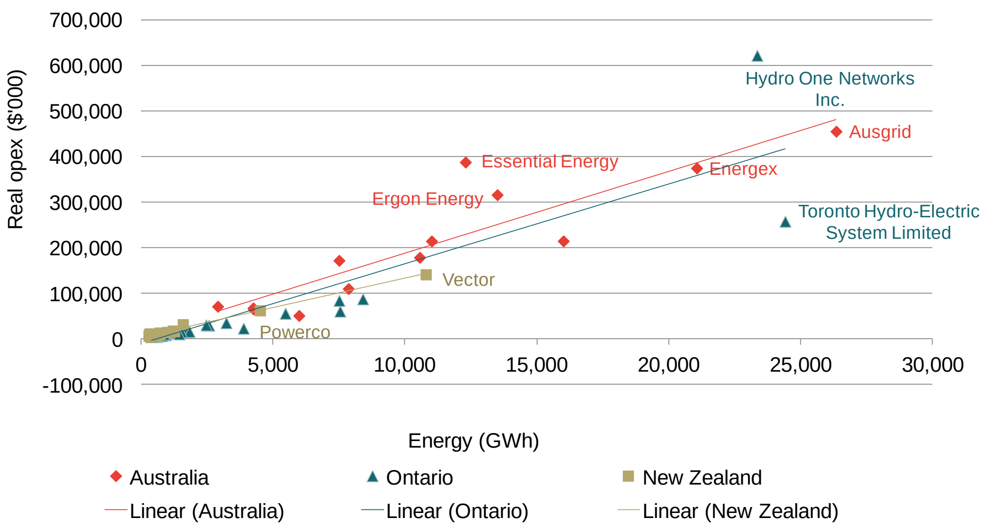
Figure 18 and Figure 19 below show that while the relationship between opex and ratcheted maximum demand and opex and energy is on the face of it more comparable across countries, there are clear outlier networks particularly in Australia (Ergon Energy and Essential Energy) and Ontario (Hydro One Networks Inc and Toronto Hydro-Electric System Inc) which may have unique network characteristics that require further investigation. We know from the analysis in Section 3.3.1, for example, that these outlier networks also have the largest circuits in the sample. We also know from Section 3.3.3 above that Ergon, Essential Energy and Hydro One have the lowest proportion of underground circuit amongst the 73 networks in the full sample, and Ergon and Essential Energy have the highest length of circuit over 66kV in the full sample.

Figure 18: Real opex vs. ratcheted maximum demand, 2013



Source: EI dataset, AER RIN data

Figure 19: Real opex vs. energy delivered, 2013



Source: EI dataset, AER RIN data

3.4 Inconsistencies between the data from overseas and Australia have not been investigated adequately

When attempting international benchmarking the very first step should be to check whether the definition and basis of preparation of the networks' data in different jurisdictions are similar. Failure to control for such differences, before combining data from different jurisdictions, would give rise to distorted measures of relative inefficiency.

Unless a careful due diligence process of this kind is undertaken, the measures of the networks' relative efficiencies may be distorted by uncontrolled factors. Undertaking such checking is typically a very involved and entirely necessary process.

It does not appear that EI has undertaken any of these necessary checks; EI presents no discussion in its report about detailed consistency checks. However, it does acknowledge that:[20]

> "**We cannot be certain that we have exactly the same opex coverage across the three countries** so we have included country dummy variables for New Zealand and Ontario to pick up differences in opex coverage (as well as systematic differences in operating environment factors such as the impact of harsher winter conditions in Ontario)." [Emphasis added]

Simply including country dummy variables is an inadequate way of controlling for specific differences between networks and between countries. The dummy variable simply shifts the intercept term, without affecting the slope coefficients, which as demonstrated in the previous subsections is an insufficient method of controlling for differences. It may also fail to take account of important within country heterogeneity that may bias results.

3.4.1 Differences in regulatory reporting rules in Ontario, New Zealand and Australia

Consistency of data definitions between jurisdictions

It is not clear to us that EI has checked if data reported in different jurisdictions are consistent with one another. A first step towards investigating this would be to examine the definitions of different variables in the reporting guidance published by the regulators in the three jurisdictions. Table 9 below compares the definitions of EI's key dependent variable (opex) and explanatory variables (customer numbers, circuit length, ratcheted maximum demand and share of underground cable length), as they are found in the regulatory reporting guidelines in Australia, New Zealand and Ontario.

The definitions of opex found in the Australia benchmarking RIN guidelines are very broad. By contrast, the opex reporting categories for Ontarian networks are detailed, narrow and extensive. The definition of opex that has historically been

20 Economic Insights, Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs, 17 November 2014, p.31.

used by the OEB to benchmark networks in Ontario – operation expenditure, maintenance and administration expenditure (OM&A) – encompasses 75 distinct categories within which networks may report costs (see Annexe 1 for full list). Within the Australian benchmarking RIN templates, the opex reporting categories are far fewer in number (i.e. six in total) and so are necessarily very broad.[21] This may suggest that there is more room for interpretation by the Australian networks when classifying costs into different categories, and more scope for inconsistent reporting between Australian DNSPs.

There appear to be a number of costs reported by Australian networks as part of opex that are not reported as part of operating expenditure, maintenance and administration (OM&A) by networks in Ontario (and vice versa). There are several cost categories reported by Australian networks that are difficult to map precisely to the standardised cost codes within which networks in Ontario report. Examples of these inconsistencies are provided in Annexe 1.

Inconsistent reporting makes checking for comparability with the Ontarian data a much more difficult task, and it is not clear to us that EI has undertaken any appropriate level of checking. In particular, it is not clear that there is a consistent boundary between opex and capex between Australia and Ontario, a matter that we return to in Section 5.

As in Australia, opex, as reported by EDBs in New Zealand, has six categories of costs. However, unlike the RIN guidelines, the New Zealand ID guidelines produced by the Commerce Commission offers very clear instructions on how costs should be classified within these six categories.

21 The opex categories are: Opex for network services; Opex for metering; Opex for connection services; Opex for public lighting; Opex for amounts payable for easement levy or similar direct charges on DNSP; and Opex for transmission connection point planning

Table 9: Comparison of key variable definitions in Australia, New Zealand and Ontario

Variable	Australian Regulatory Information Notices (RINs)	New Zealand Information Disclosures (IDs)	Ontarian Reporting & Record Keeping Requirements (RRRs)
Opex	"The costs of operating and maintaining the network (excluding all capital costs and capital construction costs)." (p.46) [a]	Total opex is the sum of Network opex and Non-network opex. "Network opex…means the sum of operational expenditure relating to service interruptions and emergencies, vegetation management, routine and corrective maintenance and inspection, and asset replacement and renewal". (p.172) "Non-network opex…means the sum of operational expenditure relating to system operations and network support, and business support" (p.173) [b]	In its benchmarking work, the OEB uses as its measure of opex the sum of operations expenditure, maintenance expenditure, and administration costs (OM&A). A full list of cost categories captured in the measure of OM&A used in the benchmarking analysis is presented in Annexe 1 of this report.
Customer numbers	"Distribution Customers are defined as the number of active National Meter Identifiers (NMIs) for all customers except for unmetered customers. Each NMI is counted as a separate customer. Only NMIs for active customers must be counted. Hence NMIs for deactivated accounts are not to be included. For unmetered customers, the Customer Numbers are the sum of connections (excluding public lighting connections) in DNSP's network that don't have a NMI and the energy usage for billing purposes is calculated using an assumed load profile (examples include bus shelters, security lighting and traffic signals where not metered). Public lighting connections are not to be counted as when calculating the number of unmetered customers." (p.48) [a]	"Number of connections (ICPs)… means the number of points of connection, as represented by unique ICP identifiers having a status of active or inactive recorded on the registry in accordance with the Electricity industry Participation Code 2010" (p.173) [b]	Under RRRs, Ontarian networks are required to submit the number of "customer accounts/connections on SSS" [Standard Supply Service]. However, this variable is not defined explicitly.
Circuit length	"Circuit length is calculated from the Route length (measured in kilometres) of lines in service (the total length of feeders including all spurs), where each SWER line, single-phase line, and three-phase line counts as one line. A double circuit line counts as two lines. The length does not take into account vertical components such as sag." (p.32) [a]	"Circuit length…includes all lines and cables with the exception of services, street lighting, and private lines (and, when a pole or tower carries multiple circuits, the length of each of the circuits is to be calculated individually)." (p.163) [b]	"For the purpose of reporting statistics for the Distribution system, utilities will provide the total length of primary voltage circuit by designated voltage category. For those utilities who are able to provide it, circuit length for low voltage (<=1,000 Volts) secondary or service wire connections may also be reported. Each circuit segment on the Distribution system may be designated as "single-phase", "two-phase" or "three-phase". The total circuit km will be calculated as the sum of the one, two and three phase circuit. The total circuit km will be calculated as follows: Total Circuit km = Single-Phase Circuit km + Two-Phase Circuit km + Three-Phase Circuit km". (p.62, also Canadian Electricity Association, Definition of Circuit Length, 22 March 2007) [c]
Ratcheted maximum	Based on the Coincident Raw System Annual Maximum Demand at the transmission connection point. "This is the actual, unadjusted (i.e. not weather normalised) summation of actual raw demands for the	"Maximum coincident system demand…means the aggregate peak demand for the EDB's network, being the coincident maximum sum of GXP [grid exit point] demand and embedded generation output at HV	Ratcheted maximum demand not clearly defined in the RRR filing guide. EI refers to PEG's used of ratcheted maximum demand in its May 2013 study.[d] That study refers to 'System capacity peak demand'

demand	requested asset level (either the zone substation or transmission connection point) at the time when this summation is greatest. The Maximum Demand does not include Embedded Generation." [a]	and above, measured in MW" (p.171) [b]	(p.46). System capacity peak demand is not defined in the OEB's RRR filing guide. However, 'Maximum Monthly Peak Load' is defined as "…the noncoincident peak reported both inclusive and exclusive of embedded generation" (p.59) [c]
Share of underground cable length	"DNSP must report against the capacity variables for its whole network. In this context the network includes overhead power lines and towers, underground cables and pilot cables that transfer electricity from the regional bulk supply points supplying areas of consumption to individual zone substations, to distribution substations and to customers. Network also includes distribution feeders and the low voltage distribution system but excludes the final connection from the mains to the customer and also wires or cables for public lighting, communication, protection or control and for connection to unmetered loads." "In relation to Table 6.1.1 'Overhead network length of circuit at each voltage' and Table 6.1.2 'Underground network circuit length at each voltage', circuit length is calculated from the Route length (measured in kilometres) of lines in service (the total length of feeders including all spurs), where each SWER line, single-phase line, and three-phase line counts as one line. A double circuit line counts as two lines. The length does not take into account vertical components such as sag." (p.32) [a]	"Underground…means the total length of all circuits that are installed as underground cables, expressed in km" (p.180) [b]	Underground circuit kilometres of line not defined precisely in the RRRs. The RRR filing guide refers to the Canadian Electricity Association website for circuit km definition. See Circuit length comments. "total overhead and underground circuit kilometers of line should be equal to the total of all phases (3 phase, 2 phase, and single phase). Submarine cables are reported in the underground cables category." (p.62) [c]

Source: [a] AER, Economic benchmarking RIN for distribution network service providers Instructions and Definitions, November 2013; [b] New Zealand Commerce Commission, Electricity Distribution Information Disclosure Determination 2012 Electricity Distribution Information Disclosure Determination under Part 4 of the Commerce Act 1986, 1 October 2012; OEB, [c] RRR Filing Guide, For electricity distributors' reporting and record keeping requirements, April 2014; [d] PEG, Empirical research in support of incentive rate setting in Ontario, May 2013

Table 10: Six categories of opex reported by EDBs in New Zealand

Category of cost	Guidance on cost classification
Service interruptions and emergencies	In relation to expenditure, means operational expenditure where the primary driver is an unplanned instantaneous event or incident that impairs the normal operation of network assets. This relates to reactive work (either temporary or permanent) undertaken in the immediate or short term in response to an unplanned event. Includes back-up assistance required to restore supply, repair leaks or make safe. It also includes operational support such as mobile generation used during the outage or emergency response. It also includes any necessary response to events arising in the transmission system. It does not include expenditure on activities performed proactively to mitigate the impact such an event would have should it occur. Planned follow-up activities resulting from an event which were unable to be permanently repaired in the short term are to be included under routine and corrective maintenance and inspection
Vegetation management	in relation to expenditure, means operational expenditure where the primary driver is the need to physically fell, remove or trim vegetation (including root management) that is in the proximity of overhead lines or cables. It includes expenditure arising from the following activities- (a) inspection of affected lines and cables where the inspection is substantially or wholly directed to vegetation management (e.g., as part of a vegetation management contract). Includes pre-trim inspections as well as well as inspections of vegetation cut for the primary purpose of ensuring the work has been undertaken in an appropriate manner; (b) liaison with landowners including the issue of trim/cut notices, and follow up calls on notices; (c) the felling or trimming of vegetation to meet externally imposed requirements or internal policy, including operational support such as any mobile generation used during the activity. The following activities and related costs are excluded from this category- (a) general inspection costs of assets subject to vegetation where this is not substantially directed to vegetation management (include in routine and corrective maintenance and inspection); (b) costs of assessing and reviewing the vegetation management policy (include in network support); (c) data collection relating to vegetation (include in network support); (d) the cost of managing a vegetation management contract, except as stated above (include in network support); (e) emergency work (include in service interruptions and emergencies)
Routine and corrective maintenance and inspection	in relation to expenditure, means operational expenditure where the primary driver is the activities specified in planned or programmed inspection, testing and maintenance work schedules and includes- (a) fault rectification work that is undertaken at a time or date subsequent to any initial fault response and restoration activities (b) routine inspection (c) functional and intrusive testing of assets, plant and equipment including critical spares and equipment (d) helicopter, vehicle and foot patrols, including negotiation of landowner access (e) asset surveys (f) environmental response (g) painting of network assets (h) outdoor and indoor maintenance of substations, including weed and vegetation clearance, lawn mowing and fencing (i) maintenance of access tracks, including associated security structures and weed and vegetation clearance (j) customer-driven maintenance (k) notices issued
Asset replacement and renewal	means- (a) in relation to capital expenditure, expenditure on assets (b) In relation to operational expenditure, operational expenditure where the primary driver is the need to maintain network asset integrity so as to maintain current security and/or quality of supply standards and includes expenditure to replace or renew assets incurred as a result of- the progressive physical deterioration of the condition of network assets or their immediate surrounds; the obsolescence of network assets; preventative replacement programmes, consistent with asset life-cycle management policies; or the need to ensure the ongoing physical security of the network assets

System operations and network support	in relation to expenditure, means operational expenditure where the primary driver is the management of the network and includes expenditure relating to control centre and office-based system operations, including- (a) asset management planning including preparation of the AMP, load forecasting, network modelling (b) network and engineering design (excluding design costs capitalised for capital projects) (c) network policy development (including the development of environmental, technical and engineering policies) (d) standards and manuals for network management (e) network record keeping and asset management databases including GIS (f) outage recording (g) connection and customer records/customer management databases (including distributed generators) (h) customer queries and call centres (not associated with direct billing) (i) operational training for network management and field staff (j) operational vehicles and transport (k) IT & telecoms for network management (including IT support for asset management systems) (l) day to day customer management including responding to queries on new connections, disconnections and reconnections, distributed generators (m) engineering and technical consulting (n) network planning and system studies (o) logistics (procurement) and stores (p) network asset site expenses and leases
Business support	in relation to expenditure, means operational expenditure associated with the following corporate activities- (a) HR and training (other than operational training) (b) finance and regulation including compliance activities, valuations and auditing (c) CEO and director costs (d) legal services (e) consulting services (excluding engineering/technical consulting) (f) property management (g) corporate communications (h) corporate IT (i) industry liaison and participation (j) commercial activities including pricing, billing, revenue collection and marketing (k) liaison with Transpower, customers and electricity retailers

Source: Electricity Distribution Information Disclosure Determination 2012 Electricity Distribution Information Disclosure Determination under Part 4 of the Commerce Act 1986, 1 October 2012

In New Zealand, the measure of customer numbers is a connection point concept. However, Australia and Ontario, the measure of customer numbers may represent the number of accounts or the number of connections. It is unclear whether this in fact leads to an important difference in what is recorded as "number of customers" in the EI sample. However, in some circumstances, the number of connection points may not be a good measure of customer numbers.[22] In our view comparability should have been confirmed before proceeding with the study, but it is not clear that EI has done so.

22 For instance, in high-rise buildings, there may be a small number of connection points but a large number of customers. However, in some circumstances, the distributor serving the building may be responsible for wiring the building, in which case the number of connection points recorded by the

Ratcheted maximum demand is typically derived from a measure of maximum system demand. Maximum system demand may be measured on a coincident basis (i.e. peak demand arising from a range of source/customers) or non-coincident basis. The New Zealand and Australian reporting guidelines allow for reporting of coincident and non-coincident maximum demand.[23] However, in Ontario only non-coincident peak demand is mentioned in the reporting guidelines; it is unclear if coincident peak demand is reported by the Ontarian networks. This may lead to a systematic difference in the demand levels reported across the three counties in the sample, in particular a company in Ontario may report higher demand than a similar company in Australia.

Further, in Australia, maximum demand "does not include embedded generation"; in New Zealand embedded generation is included in maximum demand; and in Ontario maximum demand may be reported inclusive or exclusive of embedded generation.

There may be similar questions over the consistency and veracity of reported circuit length and proportion of underground. Our experience of information gathering in Great Britain suggests that it has taken companies many years to have accurate GIS representations of their network and pending the development of these systems many were only able to provide estimates of network length and undergrounding. Again, it is not clear that comparability and robustness has been checked in this respect.

Consistency of data definitions over time

The definitions reported in Table 9 are based on the most recent regulatory reporting guidelines available in each of the three jurisdictions. However, reporting guidelines and, as a result, definitions, change over time as well. For instance, in New Zealand the Commerce Commission first issued Electricity Information Disclosure Requirements in March 2004. These largely replicated the information disclosure provisions promulgated in regulations by the Ministry

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distributor in that situation may match more closely the number of customers. As such, the appropriateness of connection points as a proxy for customer numbers will vary be the specific circumstances.

23 The New Zealand guidelines allow for the reporting of **Non-coincident sum of maximum demands** – the sum of the anytime maximum demands (that is, the diversified demands) of a group of assets or Connection Points which may be determined by adding directly measured system metered demands and Connection Point metered demands at different times. The Australian guidelines also have a provision for **Non–Coincident Raw System Annual Maximum Demand** – the actual unadjusted (i.e. not weather normalised) summation of actual raw annual Maximum Demands for the requested asset level (either the zone substation or transmission connection points) irrespective of when they occur within the year. This Maximum Demand is not to be adjusted for Embedded Generation. This creates further doubt about whether ratcheted maximum demand for New Zealand and Australian networks has been derived using coincident or non-coincident maximum demand; EI provides no clarification on this point.

of Economic Development the 1990s. The Commission viewed its 2004 disclosure requirements as interim measures and in late 2004 began consulting with stakeholders on expanding and improving the disclosure rules. After nearly four years of development, the Commission released revised Information Disclosure requirements in October 2008.[24] Four years later, in October 2012, the Commission released further revised disclosure requirements.

With each revision, the definitions of certain variables changed (e.g. by increasing the granularity of required reporting, or by making the definition of certain variables consistent with definitions used elsewhere within the regulatory framework). For instance:

- When the Commission released its 2008 disclosure requirements, it replaced a very large number of opex disclosure line items that were previously required, in the 2004 requirements, with just seven categories of expenditure:[25]
  - Routine and preventative expenditure;
  - Refurbishment and renewal;
  - Fault and emergency management;
  - System management and operations;
  - Management, administration and overheads;
  - Pass-through costs; and
  - Other operational expenditure
- When the Commission released its 2012 disclosure requirements (i.e. the prevailing requirements), defined six categories of opex:[26]
  - Service interruptions and emergencies
  - Vegetation management
  - Routine and corrective maintenance and inspection
  - Asset replacement and renewal
  - System operations and network support; and
  - Business support

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24 For a brief description of how the regulatory disclosure requirements in New Zealand evolved up to October 2008 see: New Zealand Commerce Commission, Information Disclosure Regime Companion Paper to the Revised Information Disclosure Requirements, 31 October 2008.

25 New Zealand Commerce Commission, Information Disclosure Regime Companion Paper to the Revised Information Disclosure Requirements, 31 October 2008, p.106.

26 New Zealand Commerce Commission, Electricity Distribution Information Disclosure Determination 2012 Electricity Distribution Information Disclosure Determination under Part 4 of the Commerce Act 1986, 1 October 2012

Furthermore, when changing the subcategories of cost to be reported within opex, it is also unclear whether the boundary between opex and capex may have changed.

In other words, the New Zealand data that EI has used in its benchmarking analysis covers a period (2006 to 2013) during which there were three different sets of definitions of opex. It is not clear that EI has done any checks to assess the consistency of the definitions of the New Zealand data over time. Just as data consistency between networks is critical in a sound benchmarking exercise, consistency in the data over time is also necessary to ensure that the statistical techniques employed by EI produce robust and sensible results.

3.4.2 Vegetation management

As Figure 20 shows, Australian DNSPs' reporting of vegetation management costs is very inconsistent. Some networks report no expenditure on vegetation management (perhaps because the local authority is responsible for vegetation management or perhaps because expenditure on vegetation management is reported within a broader category of costs rather than being reported separately), whilst others report very high spend. For several networks, this is a very material cost category and some of this may be driven by increased efforts by DNSPs to reduce bushfire risk in their service areas, following the 2009 Black Saturday bushfires and the findings released subsequently by the Victorian Bushfire Royal Commission (VBRC).[27]

As vegetation management appears to be (in proportional terms) a large cost category for several Australian networks, EI should have checked if these costs are similarly important for Ontarian and New Zealand networks (which are jurisdictions that have not suffered from bushfire events as severe as has been experienced in Australia). If these costs are less material for networks in Ontario and New Zealand that may suggest that there are important cross-country differences that should be controlled for (notwithstanding potential within Australia for differences in vegetation management activity), or alternatively that vegetation management costs should have been excluded from this benchmark and assessed separately. However, Ontarian networks do not appear to report these costs separately, which makes it very difficult to undertake the required checks.

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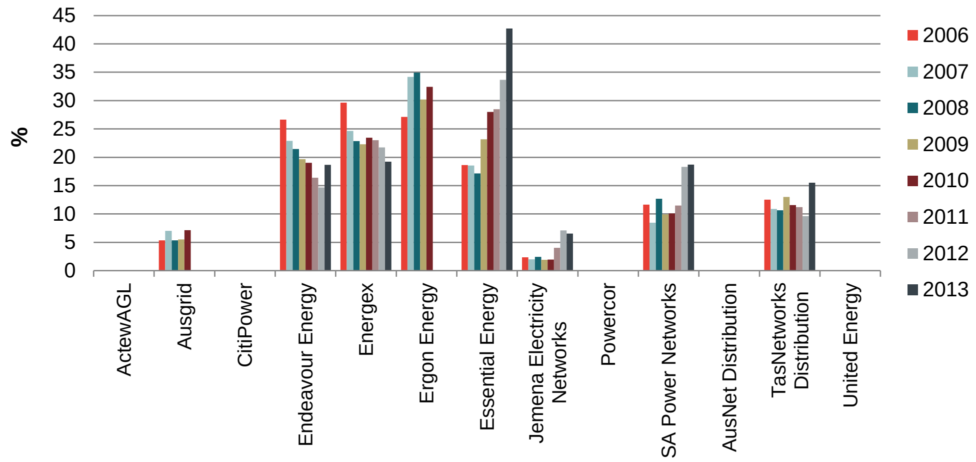
27 The VBRC inquiry highlighted the need for all DNSPs to ensure diligence with appropriate risk mitigation activities in high risk bushfire areas. We understand from Networks NSW that following the inquiry, Victorian DNSPs applied to the AER for a number of 'pass-throughs' related to recovery of costs of implementing the VBRC recommendations.

Figure 20: Expenditure on vegetation management as a proportion of opex – Australian DNSPs



Source: AER RIN data

As noted in the previous section, it is only recently (under the 2012 information disclosure rules) that New Zealand networks have had the opportunity to report vegetation management costs separately. However, the present disclosure rules state that, as a transitional measure "vegetation management is not required to be separately disclosed" for the 2013 disclosure year. Hence, in the dataset used by EI there are no data on vegetation management costs reported by New Zealand networks.[28]

As we will go on to discuss in respect of the Australian DNSPs, differences in vegetation management activity arising from differences in vegetation growth rates, statutory requirements in respect of clearance thresholds and the extent to which vegetation is present within service region and adjacent to network assets may explain substantial differences in cost to serve between ostensibly similar networks. It is a matter of important concern that such potential differences have not been investigated.

3.4.3 Capitalisation rates

The boundaries between opex and capex can often be a matter of fine judgement, even in the presence of apparently definitive rules.

For instance, some projects undertaken on the network may contain a mix of maintenance work (typically classified as opex) and replacement work (typically

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28 Electricity Distribution Information Disclosure Determination 2012 Electricity Distribution Information Disclosure Determination under Part 4 of the Commerce Act 1986, 1 October 2012, pp.59-61.

classified as capex). Management systems and/or responsible individuals will need to make judgements in respect of how total project costs are reported, and practice may vary in the absence of very prescriptive guidelines. Similarly, regulatory reporting requirements, and company reporting practice, may differ in respect of the extent to which project design and management is "opex" or "capex". For example, how many visits to site are required before the project designer and work manager is considered an integral part of the cost of delivering a capex project, rather than being recorded as a head office/back office cost?

In addition to potential differences in reporting of a given activity, networks can often substitute between opex and capex activities at the planning stage, as depending on the prevailing regulatory treatment it may be more rewarding for them to incur opex rather than capex, or vice versa. For example, there may have been incentives for firms in Australia to treat marginal expenditure as opex rather than capex because under regulatory frameworks such as the AER's, as opex is recovered as it is incurred, whereas capex is recovered more slowly over time. It was only with the recent introduction of the AER's Better Regulation reform package that the AER moved to balance the incentives for spending between opex and capex.[29] In contrast, as we discuss below, it appears that in Ontario the past benchmarking of only opex may have encouraged the companies to avoid opex and prefer to incur capex.

Moreover, experience from Great Britain suggests that different companies may choose to adopt very different approaches to designing and operating their networks, that can lead to a different mix between opex and capex. Some DNOs in GB adopt an investment-heavy approach with an associated focus on keeping operating expenditures low, whilst other DNOs seek out innovative ways to avoid incurring capex by looking for opex-based solutions until it is necessary to make the investment. One of the main benefits of smarter grids is that it provides the information and the means through which investment can be deferred or avoided altogether.

Analysis of opex alone then may be confounded by a range of factors that could lead to differences in reported opex and capex levels and which may lead to biased estimates of efficiency, including differences in:

- Reporting policies or practices;
- Regulatory arrangements; and
- Company Business model.

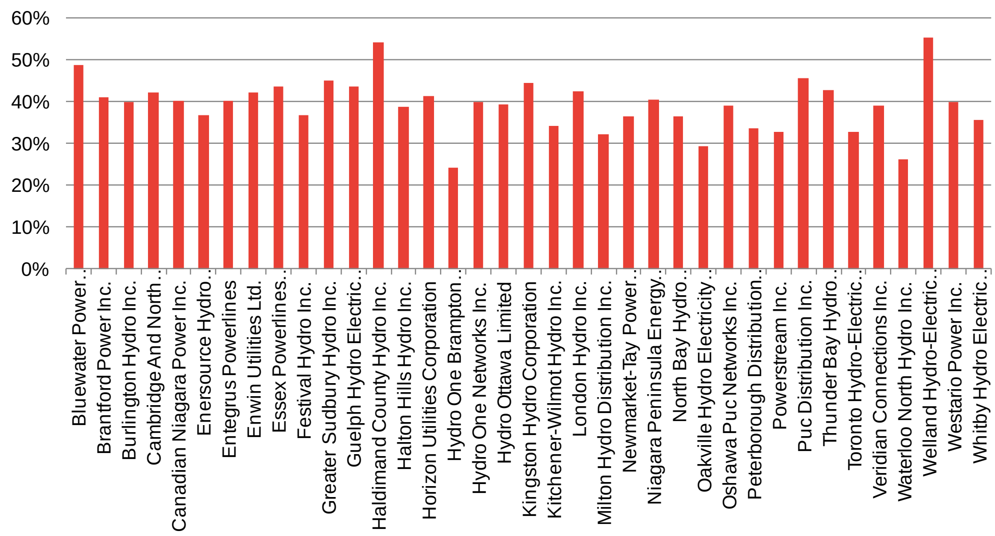
These complex interactions and trade-offs are not acknowledged at all in the analysis conducted by EI. Regulators overseas, such as Ofgem, have recognised

29 AER, Overview of the Better Regulation reform package, April 2014.

the possibility of such trade-offs and modified their benchmarking and wider regulatory arrangements accordingly.

Whilst a full investigation has not been possible in the time available, it is possible to get an indication of differences in capitalisation policies between networks by comparing the ratio of opex to total costs. Figure 21 below plots opex as a ratio of total cost for the networks in Ontario. The chart indicates that there is a reasonable degree of variation in this ratio between networks. It is unclear what may be driving these differences, but we would consider it necessary to investigate further to confirm comparability.

Figure 21: Opex to total expenditure ratios for the Ontarian networks



Source: EI dataset

In Ontario, efficiency analysis based on benchmarking of costs has been carried out since 2008. It is only very recently that this benchmarking analysis has been conducted using a total expenditure approach; benchmarking was initially implemented on 'operation, maintenance, and administrative' (OM&A) expenditures.[30] When the Ontarian regulator was first developing its benchmarking methodology in 2007/2008, some industry stakeholders (e.g. consumer representatives) argued that a "…benchmarking study that focuses only on OM&A can create perverse incentives to cut operating costs, which can

30 See OEB, Report of the Board Renewed Regulatory Framework for Electricity Distributors: A Performance-Based Approach, 18 October 2012; PEG, Productivity and benchmarking research in support of incentive rate setting in Ontario: Final report to the Ontario Energy Board, November 2013; and PEG, Empirical Research in Support of Incentive Rate-Setting: 2013 Benchmarking Update, July 2014.

be achieved through excessive capitalization or at the expense of reliability".[31] More recently, commentators such as Cronin and Motluk (2011) have argued that the Ontarian regulator's focus on opex benchmarking "…can be expected to have incented LDCs to curtail O&M expenditures so as to improve their benchmarking score".[32]

The different regulatory treatments in Australia and in Ontario, historically, may have given networks in the two jurisdictions very different sets of incentives, in terms of whether allocation of spending towards opex or capex. EI ought to have investigated this issue and made appropriate adjustments for differences in capitalisation policies before combining the Canadian data with the Australian data[33]. It is not clear that EI did so.

3.5 Apparent errors in the data reported by networks in Ontario and in New Zealand

An examination of the data reported by the networks in Ontario has revealed several large inconsistencies for key variables reported by the same network over time. Below we provide a range of examples based on our review of data for the 37 Ontarian DNSPs included in the EI sample.

- 9 instances in which reported operating expenditure, in consecutive years, rose or fell by 30% or more. In the case of one network (Greater Sudbury Hydro Inc.) opex:
  - rose by 69% between 2006 and 2007;
  - fell by 33% between 2007 and 2008;
  - fell again by 33% between 2009 and 2010; and
  - rose by 61% between 2010 and 2011.
- 3 instances in which reported energy supplied increased from one year to the next by 97% or more. The largest increase of this kind was for Enwin

31 OEB, Report of the Board on 3rd Generation Incentive Regulation for Ontario's Electricity Distributors, 14 July 2008, p.18.

32 Cronin, F. J., Motluk, S. (2011), 'Ten years after restructuring: Degraded distribution reliability and regulatory failure in Ontario', Utilities Policy 19, pp. 235-243.

33 In New Zealand, the Commerce Commission is prohibited by law from undertaking comparative benchmarking of electricity networks for the purposes of setting prices or quality standards under the default price-quality path regime. Specifically, Section 53P(10) of the Commerce Act 1986 states that: "The Commission may not, for the purposes of this section, use comparative benchmarking on efficiency in order to set starting prices, rates of change, quality standards, or incentives to improve quality of supply." Hence, the considerations discussed above, in relation to the Ontarian networks, do not apply in New Zealand.

Utilities Ltd., which reported a 187% increase in energy supplied between 2006 and 2007.

- 3 instances in which reported maximum demand changed between consecutive years by 30% or more. One network, Halton Hills Hydro Inc., reported a 94% increase in maximum demand between 2012 and 2011. Another network, Wheland Hydro Electric System Corp., reported maximum demand in 2012 of 0.089 MW (whilst continuing to report non-zero values for other categories in that same year). Between 2005 and 2011, the values for maximum demand reported by this network have ranged from approximately 86 MW to approximately 104 MW. Hence, the value reported for 2012 is likely to be an error.
- 1 instance (by Halton Hills Hydro Inc.) in which reported ratcheted maximum demand rose by 75% between 2011 and 2012.
- 6 instances in which reported circuit length changed between consecutive years by 32% or more. One network, Niagara Penninsula Energy Inc., reported a 52% increase in circuit length between 2007 and 2008, followed by a 34% reduction in circuit length between 2008 and 2009. Another network, reported a 32% reduction in circuit length between 2010 and 2011, followed by a 54% increase in circuit length between 2011 and 2012.

While there are fewer obvious inconsistencies in the data from New Zealand, the following two are notable. In examining data between 2005 and 2012 (for 18 New Zealand DNSPs) we found the following.

- There are 2 instances in which reported operating expenditure, in consecutive years, rose by 50% or more.
    - In the case of Alpine Energy, opex rose by 59% between 2006 and 2007; and
    - In the case of Horizon Enegy, opex rose by 58% between 2007 and 2008;
- In the case of Counties Power, length over 66kV increased by 146% between 2006 and 2007.

A number of these year-on-year changes seem implausibly large and may be evidence of reporting errors, or significant changes in the definition/basis of reporting. Data errors can result in distorted parameter estimates and measures of efficiency. It is not clear that EI investigated the possibility of errors, or made any attempt to address any errors found. By contrast, when Pacific Economics Group (PEG) conducted benchmarking analysis on behalf of the Ontario Energy Board (OEB), using the same Ontarian data, it identified certain of these anomalies, and took account of these in the analysis. For instance, PEG noted "anomalous trends in circuit km data for some distributors". On account of these apparent anomalies, in the econometric model used to estimate relative efficiency, PEG used **average** circuit length over the period 2002-2012, rather than circuit length in any particular year.[34]

3.6 Comparison of EI model with Benchmarking undertaken by the Ontario Energy Board

Given the critical role that Ontarian data plays in determining the EI results, it is helpful to assess the extent to which EI may have modelled Ontario well. This can be achieved by comparing EI's analysis and efficiency results with that of Ontario's own regulator.

The OEB undertakes benchmarking analysis using the data employed by EI in its efficiency analysis. The OEB's latest efficiency analysis was undertaken by PEG, and was published in July 2014.[35] PEG assessed the efficiency of the 73 networks in Ontario using a total cost econometric model.[36] As far as we can tell, the modelling technique used was ordinary least squares rather than SFA. The econometric model fitted a statistical relationship between distributors' total costs and five business condition variables:

- The number of customers served;
- kWh deliveries;
- system peak capacity;
- the average km of distribution over the sample period; and
- the percent of customers added in the last 10 years.

The OEB used the results from PEG's econometric modelling to set 'stretch factors' for each of the 73 distribution networks. The stretch factor is the efficiency gains part of each network's X-factor. It reflects the potential for incremental productivity gains by a given distribution network under incentive regulation, which in turn depends on an individual distributor's level of cost efficiency. The stretch factor can vary from company to company. In this respect, the stretch factor is similar to the base catch up factor applied by the AER, except that the OEB's stretch factor represents an expected **annual** efficiency improvement, whereas the AER's catch up factor represents a **single (i.e. upfront) adjustment to a base year level of expenditure**. The OEB's

34 PEG, Productivity and benchmarking research in support of incentive rate setting in Ontario: Final report to the Ontario Energy Board, November 2013, p.59.

35 PEG, Empirical Research in Support of Incentive Rate-Setting: 2013 Benchmarking Update, July 2014.

36 Total costs included operating, maintenance and administration (OM&A) costs and capital costs. Capital costs were comprised a measure of deprecation on the asset base and a return on capital.

stretch factor ranged from 0% p.a. (applied to the firms judged most efficient) to 0.6% p.a. (applied to the firms judged least efficient).

When comparing the OEB's and the AER's/EI's benchmarking analysis, there are two notable observations to be made:

- Firstly, OEB does **not** translate, in a mechanistic way, the efficiency scores derived from econometric modelling into cost reductions for individual networks. Rather, the OEB groups networks into five bands, based on the networks' efficiency scores, and then applies the same moderate stretch factor to all networks within a given band. This approach recognises, to some extent, the uncertainty that surrounds the estimated efficiency score for any individual network.
- Secondly, the efficiency scores derived by the OEB/PEG and the AER/EI for the same distributors are very inconsistent. It is reasonable to presume that the OEB has a much better grasp of the relevant drivers of the costs of networks in Ontario than does the AER/EI. The disparity in the efficiency rankings of the Ontarian networks, as between the OEB and the AER, casts strong doubt over the AER's results in relation to the Ontarian networks. Given that one Ontarian firm, Hydro One Brampton Networks Inc., sets the efficiency frontier in the AER's analysis for the networks in all three jurisdictions, and given the important influence of Ontario in determining the parameters of the EI model, there would seem to be considerable doubt over the reliability of the AER's benchmarking analysis.

3.6.1 Translation of efficiency scores to stretch factors by the OEB

Unlike the AER, the OEB does not translate, in a mechanistic way, the gap between those networks identified to as most efficient and all remaining networks into immediate cost reductions.

The OEB calculates the efficiency scores for any given network by taking the percentage difference between (a) the firm's actual costs and (b) the fitted (i.e. predicted) costs implied by its econometric model. A network with actual costs in excess of predicted costs would receive a positive efficiency score (and vice versa). Having done this, the OEB determines the stretch factor for each network by grouping networks into cohorts, according to the estimated efficiency scores:[37]

> "As discussed in the Board Report, distributors that averaged 25% or more below cost received the lowest stretch factor of 0%. Those that averaged

37 PEG, Empirical Research in Support of Incentive Rate-Setting: 2013 Benchmarking Update, July 2014, pp.10-14.

> between 10% and 25% below cost received a stretch factor of 0.15%. Those within 10% of predicted cost received a stretch factor of 0.30%. Those distributors that had cost in excess of 10% to 25% of that predicted received a stretch factor of 0.45%. The few distributors that had cost in excess of 25% were assigned the highest stretch factor of 0.60%."

Whilst the OEB now groups networks into five distinct cohorts, when the OEB first introduced econometric benchmarking to determine stretch factors, it grouped networks into three cohorts on grounds of simplicity.[38] As the OEB gained more experience with benchmarking, the number of distinct cohorts used to determine stretch factors was expanded to five.

Figure 22 plots the OEB's estimated efficiency score for each network ('Benchmarking performance'), the required cost reduction for each network implied by its efficiency score (in order to match the most efficient network), and the stretch factors determined by the OEB for each network.

The stretch factor assigned to each network (left-hand axis) is plotted using the light blue bars. The estimated efficiency scores and implied cost reductions for each network (plotted on the right-hand axis) are denoted by the dark blue and red dots, respectively.

According to the OEB's/PEG's analysis, the most efficient network in Ontario is Hydro Hawkesbury Inc., which received an efficiency score of -55.5%, which implies that its actual costs were over 55% lower than its predicted costs. Being the most efficient firm in the sample, Hydro Hawkesbury Inc. needn't make any cost reductions. By comparison, the firm judged least efficient, Algoma Power Inc., received an efficiency score of 68.5%, which implies that its actual costs were over 68% greater than its predicted costs.

The chart shows that, as would be expected, as the estimated efficiency score (denoted by the dark blue dots) rises, the cost reduction required to catch up to the most efficient network (denoted by the red dots) falls. Based on the efficiency scores, the least efficient network would need to reduce its costs by nearly 80% to catch up to the most efficient network. This is a very large spread. Yet, the annual efficiency saving expected by the OEB for the least efficient network, embodied by its stretch factor, is only 0.6%.[39]

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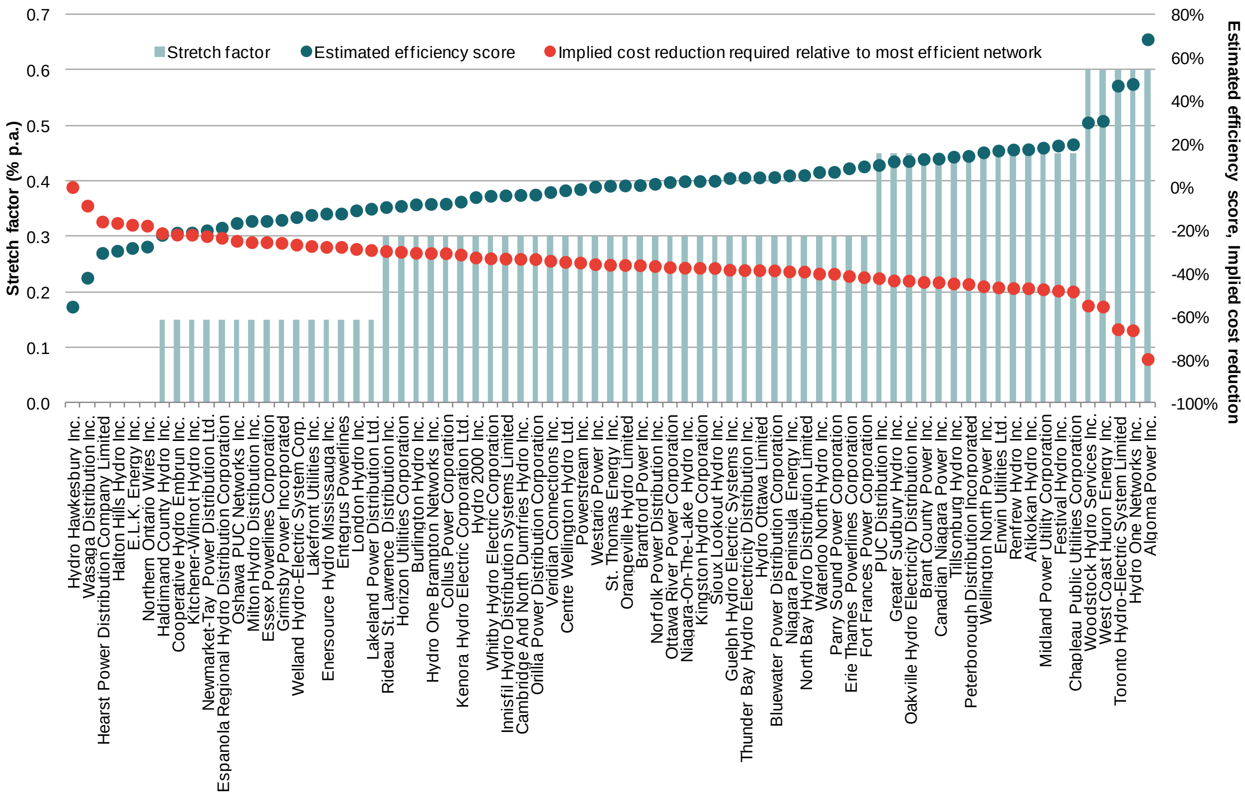
38 OEB, Report of the Board on 3rd Generation Incentive Regulation for Ontario's Electricity Distributors, 14 July 2008, p.17.

39 The OEB has applied a stretch factor of 0.6% to the cohort identified as least efficient since it first began applying benchmarking to determine stretch factors. See OEB, Supplemental Report of the Board on 3rd Generation Incentive Regulation for Ontario's Electricity Distributors, 17 September 2008, p.22.

Figure 22: OEB's estimates of efficiency, cost reductions implied by efficiency scores, and stretch factors determined



Source: PEG, Empirical Research in Support of Incentive Rate-Setting: 2013 Benchmarking Update, July 2014; Frontier analysis

Shortcomings with the AER's international benchmarking

A striking feature of Figure 22 is that there is typically significant heterogeneity in the efficiency scores of networks within each stretch factor cohort. By applying the same stretch factor for a group of networks within a band of efficiency scores recognises this heterogeneity and effectively takes account of the uncertainty involved in estimating the degree of inefficiency with limited data and imperfect modelling techniques, explicitly recognising that a considerable proportion of any estimated "inefficiency" may actually be explained by latent heterogeneity.

When the OEB first developed its methodology for econometric benchmarking and the setting of stretch factors, many stakeholders argued that, given data limitations and the possibility of modelling errors, there was a significant risk that networks might be misclassified within the wrong cohort (i.e. be mistakenly identified as more efficient, or less efficient, than they truly are). Whilst the OEB considered that the risks had been exaggerated by some submitters, it did accept that its analysis could be subject to error, and that it would likely reduce the risk of misclassification as it gained more experience with benchmarking, and improved the quality of the data, over time:[40]

> "The Board recognizes that the risk of misclassification cannot be ruled out. The Board intends to undertake further work on the model and will consult with stakeholders to identify whether it can improve the grouping approach and further reduce the potential for misclassification in the two OM&A benchmarking evaluations. It is also expected that the Board's knowledge of and facility with benchmarking will improve over the course of the 3rd Generation IR, and that any anomalies will be addressed in due course."

The OEB went on to note that the stretch factors applied should:

- be sufficient to motivate networks to become more efficient over time;
- however, not be punitive; and
- be set cautiously initially, given the OEB's relatively little experience with benchmarking.

Specifically, the OEB stated that:[41]

> "The Board also believes that it is important that the stretch factors be sufficient to influence distributor behaviour over the course of the plan. While the Board accepts that this is not the time to adopt large stretch factors, it does believe that they must be of such magnitude that they are

40 OEB, Supplemental Report of the Board on 3rd Generation Incentive Regulation for Ontario's Electricity Distributors, 17 September 2008, pp.20-21.

41 OEB, Supplemental Report of the Board on 3rd Generation Incentive Regulation for Ontario's Electricity Distributors, 17 September 2008, p.21.

likely to motivate distributors to change or maintain their status, as the case might be."

…

"With respect to Group III (the poorest performers), the Board believes that the stretch factor value should not be so demanding as to be considered punitive. In the Board's view, the stretch factor approach ought to serve as an incentive for incremental productivity improvement and not as a punitive measure."

3.6.2 Inconsistency in the efficiency rankings derived by the OEB/PEG and the AER/EI

Our analysis indicates that the AER's/EI's analysis ranks the efficiency of the Ontarian networks very differently than does the OEB's/PEG's analysis. There are 73 Ontarian networks in total, but the AER/EI employed only 37 of these in their final analysis[42]. When we compare the efficiency rankings of these 37 networks in the AER's/EI's and the OEB's/PEG's analysis, we find very little consistency between the two.

For instance, as the second and third columns in Table 11 show:

- The most efficient Ontarian network according to the AER's/EI's analysis (Hydro One Brampton Networks Inc.) ranks 25th most efficient (amongst all 73 Ontarian networks) in the OEB's/PEG's analysis.[43]
- The 2nd most efficient Ontarian network according to the AER's/EI's analysis (Kitchener-Wilmot Hydro Inc.) ranks 9th most efficient in the OEB's/PEG's analysis.
- The 3rd most efficient Ontarian network according to the AER's/EI's analysis (Waterloo North Hydro Inc.) ranks 51st most efficient in the OEB's/PEG's analysis.

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42 excluding the smallest networks with less than 20,000 customers in an attempt to ensure comparability with the Australian networks.

43 On the OEB's/PEG's analysis, Hydro One Brampton Networks Inc. would rank 14th most efficient if all the Ontarian networks excluded by the AER/EI were dropped.

Table 11: Efficiency rankings implied by the AER's/EI's and OEB's/PEG's models

Network	Efficiency ranking – EI model	Efficiency ranking – OEB model (full sample)	Efficiency ranking – OEB model (medium sample only)
Hydro One Brampton Networks Inc.	1	25	14
Kitchener-Wilmot Hydro Inc.	2	9	3
Waterloo North Hydro Inc.	3	51	28
Cambridge And North Dumfries Hydro Inc.	4	31	16
Entegrus Powerlines	5	19	10
Hydro Ottawa Limited	6	47	24
Powerstream Inc.	7	35	18
Oshawa PUC Networks Inc.	8	12	5
North Bay Hydro Distribution Limited	9	50	27
Horizon Utilities Corporation	10	23	12
Milton Hydro Distribution Inc.	11	13	6
Halton Hills Hydro Inc.	12	4	1
Festival Hydro Inc.	13	67	35
Oakville Hydro Electricity Distribution Inc.	14	57	31
Veridian Connections Inc.	15	33	17
Peterborough Distribution Incorporated	16	61	33
Newmarket-Tay Power Distribution Ltd.	17	10	4
London Hydro Inc.	18	20	11
Kingston Hydro Corporation	19	43	21
Burlington Hydro Inc.	20	24	13
Brantford Power Inc.	21	39	20
Welland Hydro-Electric System Corp.	22	16	8
Westario Power Inc.	23	36	19

Guelph Hydro Electric Systems Inc.	24	45	22
PUC Distribution Inc.	25	55	29
Whitby Hydro Electric Corporation	26	29	15
Haldimand County Hydro Inc.	27	7	2
Essex Powerlines Corporation	28	14	7
Enersource Hydro Mississauga Inc.	29	18	9
Thunder Bay Hydro Electricity Distribution Inc.	30	46	23
Niagara Peninsula Energy Inc.	31	49	26
Greater Sudbury Hydro Inc.	32	56	30
Bluewater Power Distribution Corporation	33	48	25
Canadian Niagara Power Inc.	34	59	32
Enwin Utilities Ltd.	35	63	34
Toronto Hydro-Electric System Limited	36	71	36
Hydro One Networks Inc.	37	72	37

Source: Frontier analysis

The consistency of rankings between EI's analysis and the OEB's analysis is not improved much even if we eliminate from the OEB's full sample all networks not used by EI in its medium sample, then rank the remaining 37 networks according to the efficiency scores derived by the OEB (in other words, if we do a direct comparison of the OEB's and EI's ranks for only those networks in the medium sample). These ranks are reported in the fourth column in.

As these figures indicate:

- The most efficient Ontarian network according to the AER's/EI's analysis (Hydro One Brampton Networks Inc.) ranks 14th most efficient (amongst 37 Ontarian networks in the medium sample) in the OEB's/PEG's analysis. Hydro One Brampton Networks Inc. is denoted in Figure 23 by the blue dot.
- The 3rd most efficient Ontarian network according to the AER's/EI's analysis (Waterloo North Hydro Inc.) ranks 28th most efficient (out of 37 networks) in the OEB's/PEG's analysis.
- The 27th most efficient Ontarian network, according to the AER's/EI's analysis (Haldimand County Hydro Inc.) ranks 2nd most efficient (out of 37 networks) in the OEB's/PEG's analysis.

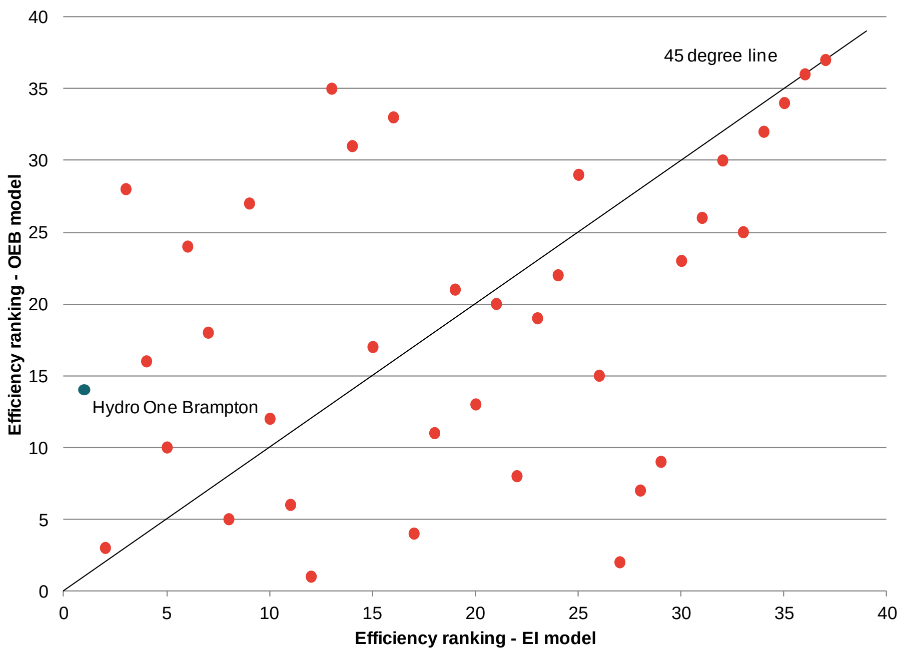
Shortcomings with the AER's international benchmarking

These are very material discrepancies.

Figure 23 plots the efficiency rankings implied by the AER's/EI's model against the rankings implied by the OEB's/PEG's model (derived from columns 2 and 4 in above). The more consistent the rankings derived, the closer the points in the Figure would sit along a straight line. Had the results from the two benchmarking studies been identical, all of the points would have sat along the 45-degree line plotted. In fact, we find very little consistency between the AER's/EI's and the OEB's/PEG's rankings.[44]

The discrepancies are concerning because Hydro One Brampton Networks Inc. is identified by the AER/EI not only as the most efficient Ontarian network, but the most efficient network across all networks in all three jurisdictions. It is reasonable to presume that the OEB has a much better grasp of the specific circumstances of the networks it regulates in Ontario, and the drivers of those networks' costs, than does the AER. Hence, analysis by the AER and its adviser that presents a network of average efficiency (by the OEB's assessment) as the most efficient network in three jurisdictions should be viewed with scepticism.

Figure 23: Comparison of efficiency rankings implied by the AER's/EI's and OEB's/PEG's models



Source: Frontier analysis

[44] We find a correlation coefficient between rankings derived by EI and those derived by the OEB of just 0.38, which suggests that the rankings are fairly weakly correlated.

4 Analysis of Australian data

In Section 3 we reviewed the full, three country dataset, used by AER/EI. We have identified important limitations in what can be done using that data, owing primarily to the lack of comparability of reported costs and the manifest differences between business models and cost structure of Australian companies and those operating in Ontario and New Zealand, which cannot be adequately controlled for using the cost driver set presently available. These limitations render the international benchmarking unreliable for the purposes of setting price controls.

In this section therefore, we present an analysis of only the Australian data. The primary focus of our analysis is to investigate whether there is credible evidence to suggest that any of the Australian DNSPs may be as vastly inefficient as is posited by EI. Consequently, we first undertake some initial assessment of the data and then formalise that assessment by illustrating, through DEA, that many of the companies in the sample have very distinct characteristics that present significant challenges in the estimation of efficiency that the EI work has not overcome.

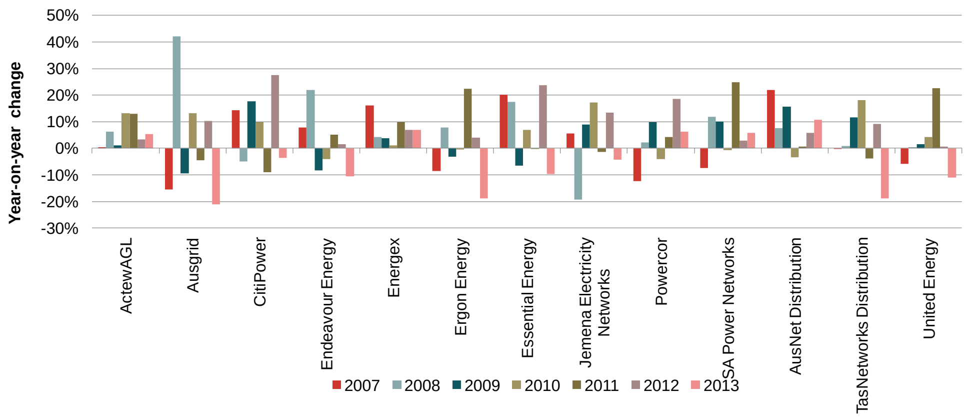
4.1 Initial assessment of opex

First it is necessary to consider the merits of using the full panel of data between 2006 and 2013 in a regulatory context.

As can be seen in Figure 24, there appears to be very substantial differences in real opex from year to year for a number of the Australian companies, both upwards and downwards. Based on the limited information we have available to us on each of the companies, it is not possible for us to provide a commentary on why cost may be varying so materially over time for many members of the panel. But what is clear is that the simple cost drivers used in the EI model also cannot explain this variation. Each of these high level cost drivers is typically very slow moving, evolving incrementally over time. Such cost drivers cannot possibly explain the jumps up and down in incurred cost seen over the period.

It seems difficult to conceive that there has been no external driver for this variation, i.e. that all of this variation should properly be considered as either "noise" or changes in managerial efficiency. The scale of variation is simply too great. We conclude that either there must have been, over this period, other important drivers of cost beyond those included in the EI model, or that the cost data has been prepared on an inconsistent basis (due to the back-casting of data which we discuss in more detail in section 5). Since the timing, scale and direction of changes varies amongst companies, it seems reasonable to conclude that any uncontrolled for cost drivers may have affected different companies in markedly different ways.

Figure 24: Year-on-year change in real opex



Source: AER/EI dataset

This very high level assessment of opex already seems to imply that the efficiency estimates derived from the EI panel data modelling will not be definitive.

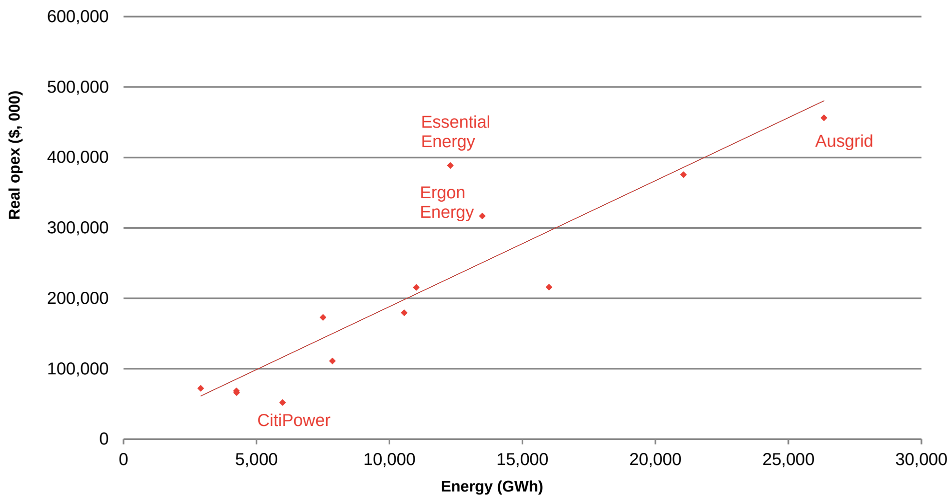
- It seems clear that the set of cost drivers used by EI is insufficient to explain observed cost variation.
- Given the unexplained variation in cost, it seems unsafe to use a technique that produces an average measure of efficiency/inefficiency over the entire period. Such a measure may well be heavily influenced by either past inefficiency that has already been addressed, or by past costs incurred to deliver activities that are now no longer undertaken at all or undertaken in the same volume.
- However, if it may be unsafe to employ a panel technique and a cross sectional analysis may be preferred, it is similarly not clear which year of data may be most representative of the forthcoming regulatory period across the industry, and hence which year should be preferred for cross sectional analysis.

Notwithstanding this last observation, in order to conduct and present at least an initial analysis of the Australian DNSPs, we present an analysis of 2013 on the basis that at least this is the latest year for which evidence is available, albeit that there may be concerns over the extent to which real opex performance for this year may be assessed adequately using the simple set of cost drivers contained in the EI dataset.

4.2 Analysis of simple metrics for 2013

In order to begin to understand better the data and the position of each company in the sample, we begin by presenting some very simple scatter plots of real opex against high level cost drivers, in particular energy delivered, ratcheted maximum demand and customers.

Figure 25: Real opex vs. energy delivered, Australian DNSPs, 2013



Source: AER/EI dataset

Table 12: Real opex vs. energy delivered, Australian DNSPs, 2013

	PPI value	Rank	Efficiency score relative to median	Efficiency score relative to UQ
ActewAGL	24.81	12	**143%**	**160%**
Ausgrid	17.31	7	**100%**	**112%**
CitiPower	8.68	1	**50%**	**56%**
Endeavour Energy	13.47	2	**78%**	**87%**
Energex	17.83	8	**103%**	**115%**
Ergon Energy	23.47	11	**136%**	**151%**
Essential Energy	31.60	13	**183%**	**204%**
Jemena Electricity Networks	15.51	4	**90%**	**100%**
Powercor	16.99	6	**98%**	**110%**
SA Power Networks	19.56	9	**113%**	**126%**
AusNet Distribution	23.03	10	**133%**	**148%**
TasNetworks Distribution	16.11	5	**93%**	**104%**
United Energy	14.11	3	**81%**	**91%**
Median	**17.31**			
Upper quartile (UQ)	**15.51**			

Source: AER/EI dataset, Frontier analysis

Figure 25 and Table 12 above report real opex by energy delivered. While we can clearly observe an increasing relationship between real opex and energy, it is clear that there a number of companies well below the sample average level, and a number well above. CitiPower stand out as a clear outlier with very much lower cost per energy than is typical, while Essential and to a lesser degree Ergon stand out as clear outliers with much higher cost per energy than is typical. Both companies immediately stand out as worthy of detailed investigation, in order to understand their circumstances, as it is extremely unlikely that such a spread could arise from differences in managerial performance alone.

CitiPower is a unique company in the Australian sample, being relatively small in scale as measured by the EI cost driver set and having a (comparatively) very small service area, (157 km^2) orders of magnitude smaller than some other DNSPs, serving as it does the CBD of Melbourne. Assessment of "performance" on a metric such as cost per energy will inevitably reveal that CitiPower is a strong performer, as its operating environment allows it to serve many customers, and distribute significant volumes of power, using comparatively few assets owing to the densely packed customer base it serves. In contrast Essential and Ergon operate very large service areas (775,520 km^2 and 1,698,100 km^2, respectively) serving customers in highly rural areas. Essential Energy serves an area significantly greater than the land area of France, while Ergon Energy serves an area significantly greater than the land area of France, the UK and Spain combined.

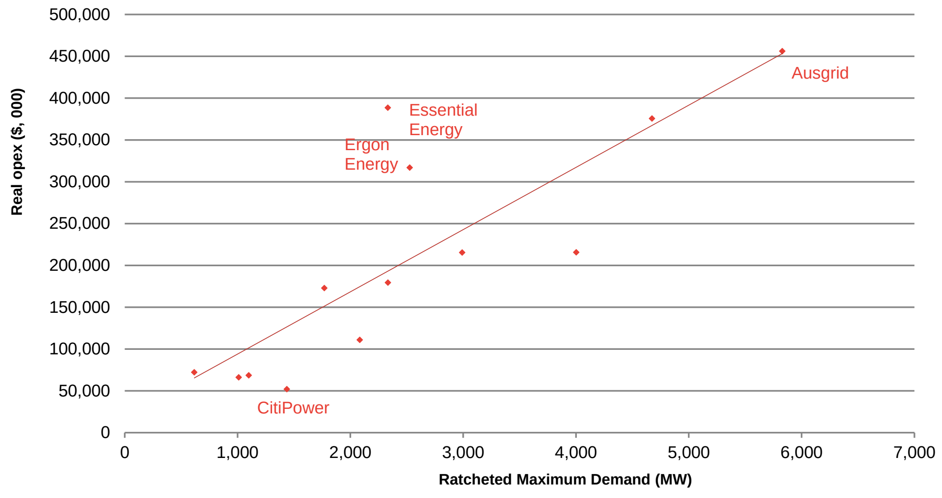
These facts alone ought give the AER pause to consider whether it is sensible to treat networks of such scale the same as networks that serve much smaller geographies. Yet, the AER appears to have given no particular consideration to the unique circumstances faced by these networks.

In practice, in order to supply energy to their customer bases, Essential and Ergon will have had to install and maintain very extensive networks, potentially running over substantially harder to access and cross terrain, and will necessarily incur significantly more cost than is typical in the Australian sample in doing so.

We observe at this stage that CitiPower is identified as the most efficient Australian DNSP in EI's analysis, whereas Essential and Ergon are among the least efficient, which suggests to us that EI's analysis may be failing to capture the obvious heterogeneity of circumstance present in the Australian data, with this heterogeneity instead being captured and reported as inefficiency.

We draw similar conclusions from the simple analysis of real opex per unit of ratcheted maximum demand and real opex per customer below. In both cases CitiPower is identified as an outlier with low cost per unit, with Essential and also Ergon identified as outliers with high cost per unit.

Figure 26: Real opex vs. ratcheted maximum demand, Australian DNSPs, 2013



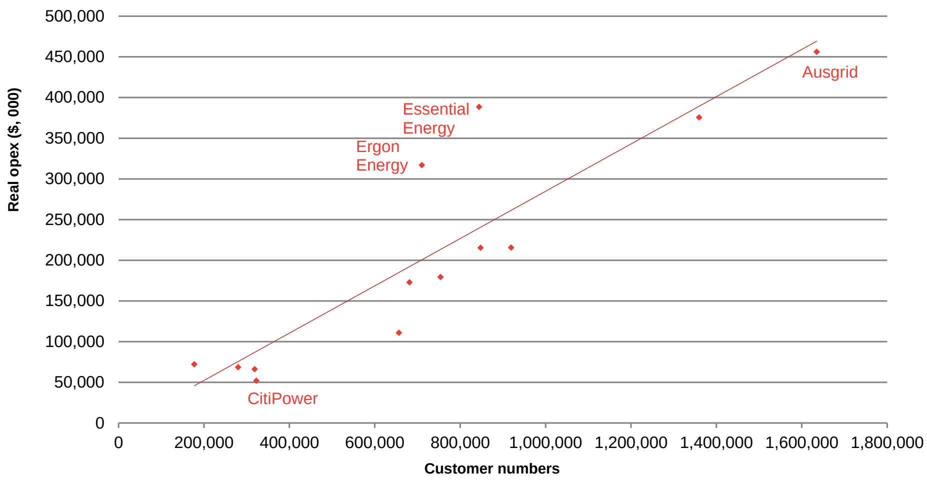
Source: AER/EI dataset

Table 13: Real opex vs. ratcheted maximum demand, Australian DNSPs, 2013

	PPI value	Rank	Efficiency score relative to median	Efficiency score relative to UQ
ActewAGL	116.81	11	**152%**	**188%**
Ausgrid	78.23	8	**102%**	**126%**
CitiPower	36.10	1	**47%**	**58%**
Endeavour Energy	53.84	3	**70%**	**87%**
Energex	80.32	9	**105%**	**129%**
Ergon Energy	125.37	12	**163%**	**202%**
Essential Energy	166.53	13	**217%**	**268%**
Jemena Electricity Networks	65.27	5	**85%**	**105%**
Powercor	76.86	7	**100%**	**124%**
SA Power Networks	71.96	6	**94%**	**116%**
AusNet Distribution	97.63	10	**127%**	**157%**
TasNetworks Distribution	62.19	4	**81%**	**100%**
United Energy	53.20	2	**69%**	**86%**
Median	**76.86**			
Upper quartile (UQ)	**62.19**			

Source: AER/EI dataset, Frontier analysis

Figure 27: Real opex vs. number of customers, Australian DNSPs, 2013



Source: AER/EI dataset

Table 14: Real opex vs. number of customers, Australian DNSPs, 2013

	PPI value	Rank	Efficiency score relative to median	Efficiency score relative to UQ
ActewAGL	0.41	11	**160%**	**173%**
Ausgrid	0.28	10	**110%**	**119%**
CitiPower	0.16	1	**63%**	**69%**
Endeavour Energy	0.23	4	**92%**	**100%**
Energex	0.28	9	**109%**	**118%**
Ergon Energy	0.45	12	**176%**	**190%**
Essential Energy	0.46	13	**181%**	**196%**
Jemena Electricity Networks	0.21	3	**82%**	**88%**
Powercor	0.24	5	**94%**	**101%**
SA Power Networks	0.25	8	**100%**	**108%**
AusNet Distribution	0.25	7	**100%**	**108%**
TasNetworks Distribution	0.24	6	**96%**	**104%**
United Energy	0.17	2	**67%**	**72%**
Median	**0.25**			
Upper quartile (UQ)	**0.23**			

Source: AER/EI dataset, Frontier analysis

4.3 Data Envelopment Analysis

We have attempted to formalise the simple analysis set out above using the well-known non-parametric technique, Data Envelopment Analysis (DEA). Conceptually, this deterministic technique can be understood to be an extension of the simple ratio analysis described above to circumstances with potentially multiple inputs and multiple outputs.

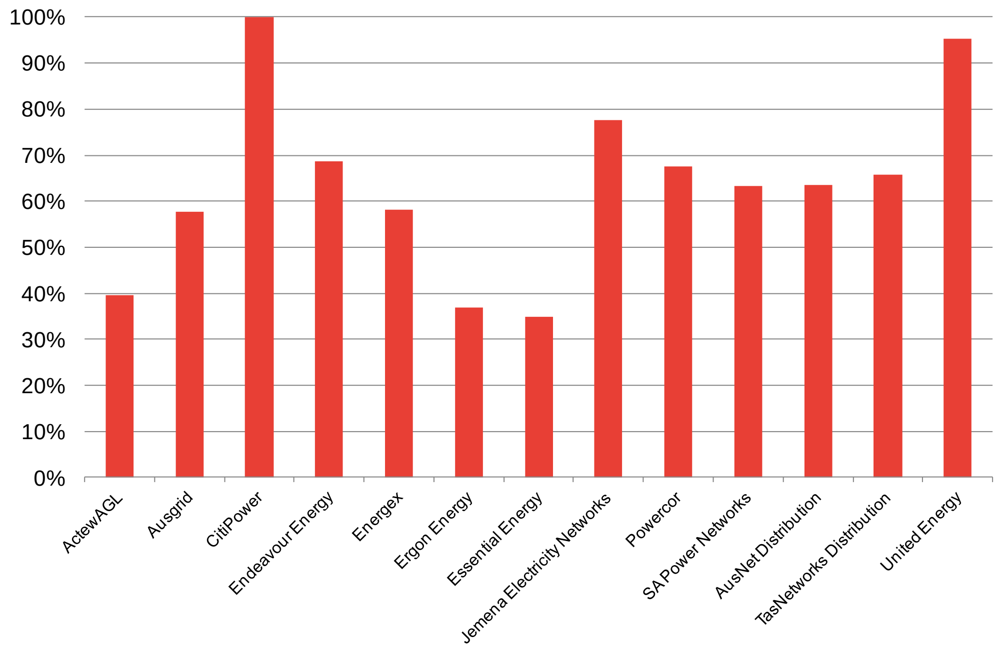
We note that the AER's Expenditure Forecast Assessment Guideline indicated that the AER intended to apply three main techniques when undertaking economic benchmarking: Multilateral Total Factor Productivity analysis; econometrics analysis (such as SFA); and DEA. In the Draft Decision the AER has presented results from the first two techniques, but did not present any DEA results. In the Draft Decision (Attachment 7, p.7-55), the AER simply dismisses the use of DEA outright stating that SFA is a "superior technique to DEA". We find this surprising because:

- The Expenditure Forecast Assessment Guideline did not intimate that DEA would not be applied if it became feasible to apply SFA.
- The AER appeals to a conceptual argument by EI about the relative strengths and weaknesses of SFA and DEA (i.e. it did not appeal to new empirical evidence that became available after the publishing of the Guideline to justify its view). These conceptual arguments should have been available to AER at the time it developed the Guideline, yet it did not set out then that it believed SFA to be a superior technique.
- The AER may reasonably come to a view that DEA has weaknesses, and even that it may be less preferable than other techniques. But, having signalled in the Guideline that it intended to apply DEA, it seems odd that the AER did not even present any DEA results before dismissing the technique in favour of another technique, which, as we have shown suffers from its own significant limitations.

We recognise the need to be aware that DEA scores can require careful interpretation, since an outlier with extremely low cost may give rise to very low measured efficiency scores for many companies in the sample. However, in order to get a sense of the heterogeneity in the sample, it is precisely this feature of DEA which is attractive. Therefore, we still regard DEA as a helpful tool to facilitate inquiry, as by varying model specification, including assumptions over scale, it allows one to build up a picture of each company, such as which variables may be influencing the measured position of which companies. This can aid the regulator in understanding which companies are similar in their output mix, and consequently which companies it should consider close peers to one another.

As a starting point, we begin by considering a model with one input (real opex) and three outputs (energy delivered, ratcheted maximum demand and customers), for only 2013, using an assumption of constant returns to scale. This simple "service" model focuses on the outputs that customers really value (a connection to the grid, regular supply of units through that connection and an ability to continue to be served during peak periods), but completely ignores differences in each company's circumstances and the relative degree of challenge of their service task owing to their service region. The results from this very simple model are presented below in Figure 28.

Figure 28: DEA results with energy delivered, ratcheted maximum demand and customers as key outputs



Source: AER/EI dataset, Frontier analysis

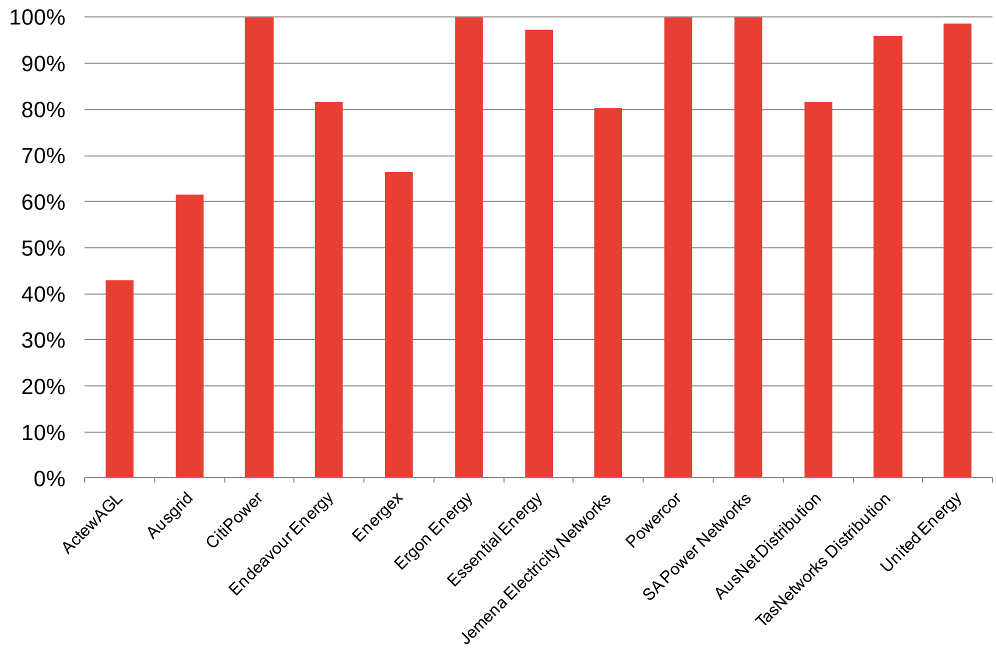
This simple model locates just one DNSP, CitiPower, on the efficient frontier, which is to be expected given the results of the simple one dimensional ratio analysis presented above. All other firms are found to be off the efficient frontier, and all bar one are off the frontier by a considerable distance.

In our view CitiPower should, however, be regarded as unique amongst the Australian DNSPs. This view is supported by running the Andersen-Petersen algorithm to measure super-efficiency. We find an Andersen-Petersen score of 1.55, implying that CitiPower could increase its costs by 55% and still remain (just) on the efficient frontier. The twin facts of the very large spread in efficiency scores, combined with the fact that the presence of CitiPower in the sample makes all other DNSPs in the sample look highly inefficient leads us to conclude that it is inconceivable that the efficiency results in this model (which bear a reasonable resemblance to the econometric results derived by EI) are due to differences in managerial efficiency alone. It must be explained by other factors, such as its relatively advantageous service region characteristics, that are not controlled for in this model.

We next extend the model by adding an additional output, circuit length. This variable may go some way to controlling for differences in population density between the Australian DNSPs, but it is likely to be inadequate for a range of reasons, not least owing to differences in multi-circuiting practice across the regions. It is our understanding, from discussions with Networks NSW, that DNSPs operating in urban areas will in many cases install multiple circuits along each route to allow sufficient network capacity to be provided to an area. Additionally, high voltage and low voltage circuits may use common routes (if practical) as this is more cost effective than running completely separate circuits. Given that in urban areas each route serves many customers and is unlikely to be lengthy, the increase in cost from multi-circuiting is not so great when compared to the benefits that result as to make this uneconomic. In contrast, in highly rural areas, almost all routes will be populated with single circuit networks. Owing to this, circuit length may fail to reflect population density, and its effects on costs, as well as the (still limited) route length variable would.

Nevertheless, the results for this one input, four output model using the CRS frontier are presented in Figure 29 below.

Figure 29: DEA results with energy delivered, ratcheted maximum demand, customers and circuit length as key outputs

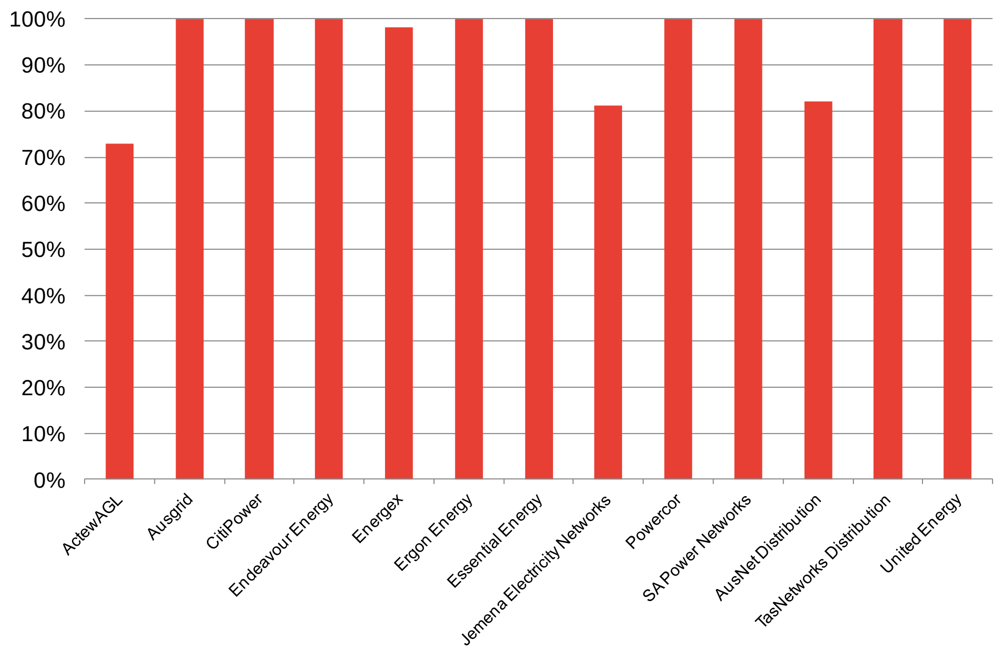


Source: AER/EI dataset, Frontier analysis

This model locates four DNSPs (CitPower, Ergon Energy, Powercor and SA Power Networks) on the efficient frontier, and also generates efficiency scores of 96% or more for three others (Essential Energy, TasNetworks Distribution and United Energy). However, there remain a number of companies that are found to be far from the efficient frontier.

We next considered changing the production function to make use of the variable returns to scale (VRS) frontier with an input optimisation orientation. It is well established that there may be economies of scale in electricity distribution, as some costs of operating are fixed, while other costs increase relatively slowly with network size. However, in order to justify the use of the VRS frontier it is also necessary to believe that at large scale there could be diseconomies of scale. We consider that this may be justified in the context of Australia, where some of the networks operate over vast service regions that could give rise to such diseconomies. For example where service regions become very large and sparsely populated, it becomes necessary to pay for expensive and extended aerial inspection of networks, and provide overnight accommodation for field operatives undertaking work very far from depots. The results of the one input, four output model assuming VRS is shown in Figure 30 below.

Figure 30: DEA results with energy delivered, ratcheted maximum demand, customers and circuit length as key outputs – assuming VRS, input orientation



Source: AER/EI dataset, Frontier analysis

We now find nine firms located on the efficient frontier, with one (Energex) very close to it. Only ActewAGL, Jemena Distribution and AusNet Distribution are located far from the frontier and, in the case of two of these (ActewAGL and

Jemena Distribution) the gap from the frontier arises mostly as a result of including the CitiPower in the sample. If we drop CitiPower from the sample, on the basis of its unique characteristics, we find that all but one of the Australian firms (AusNet Distribution) have efficiency scores above 90%.

What is it then reasonable to conclude from this analysis? In our view, we would not hold up this analysis as clear evidence of uniform efficiency in the Australian sample. It is almost certain that there will be some variation in managerial performance, albeit we do not conceive differentials of the kind indicated by the EI analysis. Instead, we view this analysis as confirmation of the vast heterogeneity of circumstance that prevails in the Australian sample. In the presence of this heterogeneity, revealed by differences in mix and scale of some very simple, high level cost drivers, we may understand from this analysis that the DEA method has failed to find a peer for many firms in the sample. That is to say, many of the Australian networks appear to operate under fairly unique circumstances, and seeking to compare their performance using high level cost driver metrics is likely to be very challenging indeed. In our view, these results lend further support to the true SFA results presented in Section 3.2, which again demonstrated that the majority of the residual variation in the sample could be explained by latent heterogeneity.

In our view this strongly indicates that the AER has misdirected itself at this price control. The Australian data suggests widespread heterogeneity, but unfortunately the remedy that AER chose to adopt was to collect international data from a sample that did not share the same types of heterogeneity – the Ontario and New Zealand data that drives the international results generally relates to smaller companies, with different operational challenges which are met using different business models. As a consequence, even when the international data is added in, there are still no effective peers to many members of the Australian sample, in particular Essential and Ergon.

Instead, the AER should have focussed on improving its own RIN data to remove and/or understand the causes of variation over time and between networks. Above all, it should have invested significant time and effort in understanding the heterogeneity that exists in its sample, and how that heterogeneity should be taken into account in a sound benchmarking analysis.

5 Quality of Australian data

Accurate, reliable and comparable data on opex are an essential prerequisite for any reliable benchmarking exercise. Whilst the AER has gone through an extensive process to develop an Economic Benchmarking RIN dataset, given the nascent nature of this dataset, errors and inconsistencies in the data are inevitable. Problems with the data may arise due to:

- Potential lack of clarity about the meaning of certain variables that must be reported on;
- DNSPs' lack of experience in collating and reporting the data;
- The need to build up new information systems, or re-orient old systems, to retrieve and report the required data, which can be a costly exercise for some businesses; and
- The inability of the variables specified in the RIN templates to capture adequately network features that are likely to be important drivers of heterogeneity and associated costs.

It seems apparent that a number of networks struggled, in their first attempt, to compile the RIN data for benchmarking, in part because some of the data sought by the AER were not available in some cases and needed to be back-cast. A number of DNSPs' (Ausgrid, Essential Energy and Jemena Electricity Networks) submissions to the AER, along with the RIN data, commented on the weaknesses of the data, and urged the AER to be cautious in its application of these data for benchmarking purposes. However, it appears that the AER has addressed those concerns in only a cursory manner, and has been willing to apply the data with much more confidence than is warranted, given the circumstances. The AER's approach, in this regard, stands in contrast to regulators in Europe, such as Ofgem who, despite many more years' experience with benchmarking than the AER, still proceeds with greater caution when interpreting its modelling results.

Our review of the RIN data guidance provided by the AER suggests that there is considerable room for interpretation by DNSPs in how certain data are classified and reported, and this could have a material impact on benchmarking results if not accounted for properly.

The AER's benchmarking analysis focuses on opex alone, without a proper assessment of the tradeoffs between opex and capex. This too could provide a false picture of relative cost efficiencies between networks.

Finally, the AER appears not to have accounted for potentially major differences in the scope and volume of activities of the networks being benchmarked.

5.1.1 Basis of preparation

A key limitation of the AER's RIN data is that it is based on eight years of back-cast information, which may not reflect actual outturn information for the DNSPs. The AER's guidelines specify that if a DNSP cannot populate an input cell in the Templates with Actual information, it must provide the '*best estimate*' it can. Because the back cast dataset requires DNSPs to populate input cells going back a number of years, the AER acknowledges that DNSPs are likely to have estimated some data.[45] Going forward, however, the AER proposes to collect RIN data from the DNSPs annually, based on outturn information.

We note that the historic benchmarking data used by regulators in Europe is typically based on outturn information collected annually rather than back-casts of best estimates.

It seems to us that when compiling a standardised dataset for benchmarking purposes, where none has existed previously, some back-casting will be inevitable. Hence, we do not necessarily wish to criticise the AER for the process it has followed for compiling the RIN data. However, in our view, when the AER uses the RIN data for benchmarking, it needs to be acutely aware of the likely limitations of the data.

One benefit of compiling several years of RIN data at once is that the data from any one network is likely to be reasonably consistent over time. However, this also carries major risks. For instance, if a network misinterprets how it ought to report certain data (which is very possible the first time it reports RIN data), that mistake may be propagated through the full eight years of information reported. That, in turn, would distort comparisons with other networks not just for a single year but for all years that the data are reported. Such misreporting over the entire period would impact directly on the measures of "inefficiency" derived by EI's modelling.

RIN data errors and inconsistencies may arise for a number of reasons, including the following:

- The quality of historical records kept by different networks is likely to vary considerably.
- It may not be possible to retrieve certain data from legacy information systems that have since been superseded. And, it may be difficult for a given network to marry together data from old and new systems in a seamless way if the way in which information has been recorded has changed over time (e.g. with changes in IT systems).

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45 AER (2013), 'Economic benchmarking RIN for distribution network service providers – Instructions and Definitions', November, Pages 4 – 5.

- Key personnel with important institutional knowledge may have moved on.
- Networks may have faced time and resourcing constraints in compiling the RIN data to the AER's timetable, and may not have had sufficient opportunity to undertake the full due diligence required when back-casting several years of historical information, which is no trivial exercise.
- Even with extensive consultation on the RIN templates, and the reporting guidance available from the AER, there may have been considerable variation between networks in the interpretation of reporting requirements, and practices surrounding the classification of data into ambiguously-defined reporting categories. These challenges are likely to be especially large when networks are completing RIN data for the first time, and have had not had the benefit of learning and improvement over time.

Whilst the AER appears to have gone through a process of checking the RIN data for obvious errors and inconsistencies, neither the AER nor EI seem to reflect seriously in their analysis that some major errors and inconsistencies could persist. This is evidenced by the fact that the AER and EI have translated the modelled efficiency scores very mechanistically into required opex reduction targets.

EI describes the AER's data auditing process as follows:[46]

> "Upon receipt of the draft data the AER commenced a detailed data checking process with any apparent errors or anomalies being notified to DNSPs for explanation or correction. Data were checked against other pre–existing reporting sources and subjected to extensive ratio and other filtering 'sanity checks'. The documented basis of preparation statements were checked in detail to identify any differences in the way DNSPs had interpreted the instructions provided. All RIN data were published on the AER website following receipt of final audited/certified data. DNSPs were then given an additional period in which to lodge cross submissions on other DNSPs' data where any differences in bases of preparation had been identified by the DNSP."

In respect of the effectiveness of the AER's ratio and other analysis we provide a brief review in Section 5.1.2. In respect of the 'Basis of preparation' reports submitted along with RIN responses, a number of DNSPs raised concerns about the quality of the data and their usefulness for benchmarking purposes. For instance, Table 15 below summarises a number of reservations expressed by Ausgrid, Essential Energy and Jemena about the 2006-2013 RIN data for economic benchmarking. As far as we can see, neither EI nor the AER made any allowances for these concerns when undertaking the benchmarking analysis.

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46 Economics Insights, Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs, 17 November 2014, p.3.

Table 15: Concerns raised by some DNSPs about quality of RIN data for benchmarking purposes

DNSP	Comment in 'Basis of preparation' report	Page
Ausgrid	In previous consultations on the RIN, we have raised significant concerns with providing historical data in the form required by the AER. In this document Ausgrid outlines its concerns in relation to the detailed templates.	p.4
	As noted in the sections on data quality, there is recognition by the AER that data quality from best estimates will not be of a robust quality, and may not pass audit and reviews. This document identifies where material has been developed from best estimates but this should not imply that Ausgrid in any way supports the data being used for the purposes of economic benchmarking.	p.4
	The Economic Benchmarking RIN provided for a very compressed period of two months between submission of the unaudited and audited information. During this period Ausgrid received emails from AER staff on almost 50 issues in relation to the unaudited responses. Some of these issues requested changes and additions to the RIN templates. We note that AER's requests came at a point in the process where the auditors were reviewing, and in some cases had reviewed our responses. The AER's request for changes to our response was not contemplated in the Notice issued to us, and meant that we were not afforded a proper opportunity to comply with the timelines of the Notice. The auditors had to revisit material leading to increased costs, confusion as to the status of particular information at any given time, and increased the likelihood of administrative errors in providing our final response to the AER.	p.5
	In 2011 there was a material change in the Annual Reporting Requirements from the AER. As a result, Ausgrid has completed Table 3.1.1 according to the categories reported in the current Annual Regulatory Requirements. Ausgrid has 'backcast' the FY2006 to FY2010 numbers by using these categories.	p.12
	In FY2010, Ausgrid implemented an integrated asset management system. The integrated asset management system has resulted in generic costs being allocated to more direct categories. This has made it difficult for Ausgrid to backcast on the same basis as the FY2013 year. Management has made assessments in the previous years to align the cost categories. Ausgrid found minor differences in the accounting system for previous years and has adjusted the Corporate Finance function costs to align to the Regulatory Accounting Statements.	p.12
Essential	In previous consultations on the RIN, we have raised significant concerns with providing historical data in the form required by the AER. We continue to raise our concerns in relation to the detailed templates for economic benchmarking purposes and have outlined in this Basis of Preparation where caution should be applied by the AER in the application of the data to economic benchmarking models	p.6
	We consider that the application of economic benchmarking to guide regulatory decision making would result in error, leading to outcomes that are detrimental to the long term interests of customers. Our view is based on the following reasons: □ As noted in the section on data quality, there is recognition by the AER that data quality from best estimates will not be of a robust quality, and may not pass	p.7

	audit and reviews...	
	The totals used for the compilation of this expenditure was ultimately sourced from previous RINs for the respective years, and are therefore considered to be reliable. However, the split into the different categories is based on assumptions and estimates so caution should be used when using it for benchmarking or decision making purposes.	p.17
Jemena	JEN notes that approximately 68% of the information provided (by cell) is estimated, of which JEN considers only 16% to be reliable estimates for the purposes of regulatory analysis and/or decision making (colour-coded as yellow, refer to JEN's colour coding explanation in Annexure 2 of JEN's RIN response). JEN has also provided its best estimates for the other 84% of estimated information (colour coded as orange and red) because the RIN compels JEN to do so. However, JEN does not consider these estimates to be reliable or fit for the purpose of regulatory analysis or decision-making.	p.1, covering letter
	Where JEN cannot populate an input cell in the Excel templates with actual information, it has provided its best estimate, considering data availability constraints, JEN's limited knowledge of how the information may be applied or interpreted and JEN being unaware of a superior estimation technique at the time. As such, JEN cautions the AER from using this data to inform regulatory decisions without first confirming with JEN its understanding of the methodologies used, availability of data and any other limitations that may exist. Because the back cast dataset requires JEN to populate input cells going back a number of years, JEN has estimated some variables.	p.vii

Source: Ausgrid, Essential Energy and Jemena 'Basis of preparation' response to economic benchmarking RIN

EI states in its report:[47]

> "While no dataset will likely ever be perfect, the AER's economic benchmarking RIN data provides the most consistent and thoroughly examined DNSP dataset yet assembled in Australia… Given the extensive process that has been gone through in forming the AER's economic benchmarking RIN database to ensure maximum consistency and comparability both across DNSPs and over time, the database is fit for the purpose of undertaking economic benchmarking to assess DNSP opex efficiency levels and to estimate models that can be used to forecast future opex partial productivity growth rates."

Given the very real scope for data errors described above, owing to the newness of the RIN data collection process and the lack of opportunity for learning and refinement, it is surprising to us that EI and the AER apparently have such confidence in the reliability of the modelling results. Given that this is its first attempt at using these data for benchmarking purposes, and given the relatively limited scope for iterative testing, we would have expected a more cautious and tempered application of the modelling results to derive opex reduction targets.

The AER's approach stands in stark contrast to the more measured and iterative approach taken by Ofgem in Great Britain, where benchmarking has been applied for many years. There, a significant and co-ordinated effort from both the regulator and all the network companies in the industry has been made to compile a consistent and reliable dataset for benchmarking.

Ofgem has spent a decade or more improving its cost reporting procedures to facilitate the benchmarking analysis that it considers necessary. Ofgem has become increasingly cognisant of the importance of robust data over time, driven in particular by experiences at DPCR3 (in support of a price control running from 2000 to 2005) and DPCR4 (running from 2005 to 2010). At DPCR3, Ofgem noted that there were important differences in companies' capitalisation policies that made comparative analysis difficult. In light of this it became necessary for Ofgem to make adjustments to the data to ensure comparability, based on a detailed investigation by accounting advisers, and to put in place clearer guidance and reporting procedures going forward. At DPCR4, Ofgem then discovered further difficulty in undertaking its "opex" benchmarking, as despite the revised guidance it uncovered materially different practices across companies in respect of how and where they reported costs associated with addressing faults. This required Ofgem to, once again, investigate these differences and propose corrections in a short space of time, and to modify its preferred benchmarking approach.

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47 Economics Insights, Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs, 17 November 2014, p.3.

Based on these experiences, Ofgem devoted significant attention to improving its data capture, implemented at the beginning of DPCR4 to provide better data to support DPCR5. It created extremely detailed regulatory reporting packs (RRPs) supported by detailed Regulatory Instructions and Guidance documents (RIGs) that defined at a high level of detail how and where costs should be reported in order to enhance comparability in aggregate, and in respect of each disaggregated cost category. Rather than waiting until a price control review was due, Ofgem required companies to report costs in their RRPs annually, and began a process of visiting each company annually to discuss the basis of the preparation of these submissions, to understand significant movements from year-to-year within company, and to examine reasons for apparently material differences in items reported across companies. Through repeating this exercise Ofgem has been able to identify and largely iron out any divergence in reporting approaches and create a detailed, fairly comparable and reliable panel of data from which to work. This extensive work is now able to support a wider range of benchmarking and enhances transparency, to the benefit of all participants and stakeholders.

The degree of detail in Ofgem's definition of each cost category for cost reporting is illustrated in Ofgem's definition of tree cutting costs summarised in Table 16 below.

Table 16: Ofgem's definition of tree cutting in the UK

Includes…	Excludes…
The felling or trimming of vegetation as part of a Capital Scheme	General inspection costs relating to wires that are subject to vegetation and not performed solely as part of a tree cutting contract or to ensure vegetation has been cut appropriately (include under Inspections & Maintenance)
The felling or trimming of vegetation to meet ESQCR requirements	Costs of assessing and reviewing the tree cutting policy (include under Network Policy)
The inspection of vegetation cut for the sole purpose of ensuring the work has been undertaken in an appropriate manner	Data collection and manipulation relating to vegetation (include under Network Design & Engineering)
Inspection of tree-affected spans where included as part of a tree cutting contract.	The cost of managing the tree cutting contract , except as stated under included costs
	The cost of procuring the tree cutting contract except as stated under included costs (include under Finance & Regulation)

Source: Ofgem price control reporting rules: Instructions and Guidance; RF 58/10.

The inclusions and exclusions associated with the reporting of tree cutting, as identified by Ofgem, are informative and revealing, as they provide an indication of the kinds of discrepancy in reporting practice that may have been present during the initial stage of regulatory reporting in Great Britain (and may also be so in Australia), and which have been identified and resolved through experience and iteration.

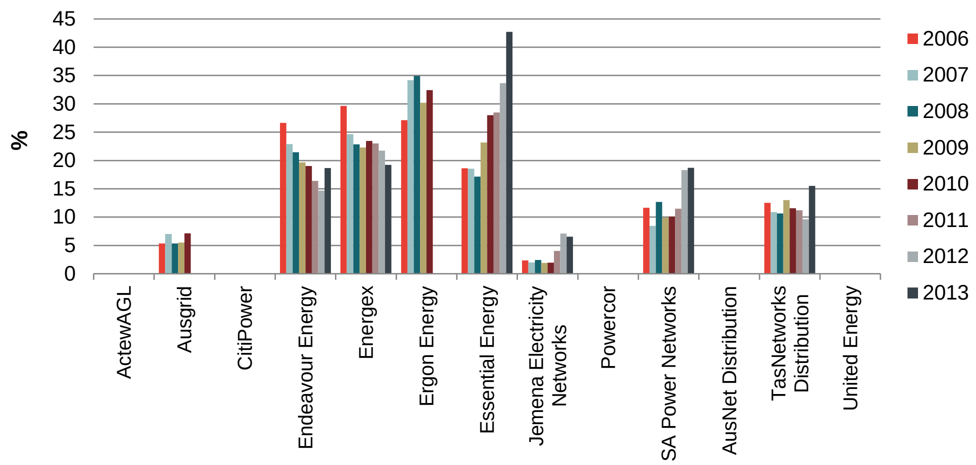
The AER does not provide regulatory reporting guidance that is as detailed and prescriptive as that published by Ofgem. Whilst the AER has gone through a process to develop RIN templates, when set against Ofgem's experience, it would be naïve for the AER to think that the RIN data obtained to date is sufficiently free from errors and inconsistencies as to warrant the degree of confidence the AER has placed in its modelling.

We have not had the opportunity to undertake an exhaustive audit of the RIN data within the very limited time available to prepare this report. We point out here two apparent inconsistencies in the RIN data across networks that we have been able to identify from our limited review of the data. These relate to inconsistencies in the reporting of: vegetation management costs; and provisions.

Vegetation management costs

As Figure 31 shows, five DNSPs (ActewAGL, CitiPower, Powercor, AusNet Distribution and United Energy) report no expenditure on vegetation management.

Figure 31: Vegetation management costs as a proportion of opex



Source: AER RIN data

This is puzzling since as shown in Table 17, all of these networks reported vegetation management spans between 2009 and 2013, and a number of the networks that have not reported vegetation management costs are from Victoria, which has suffered major bushfires within the past five years. It is not clear to us whether this means that certain DNSPs have omitted vegetation management costs in their RIN responses, simply not incurred these costs (e.g. because local authorities take responsibility for vegetation management), or reported these costs elsewhere or within broader categories of opex. As the Figure above shows, vegetation management can be a large cost (proportionally) for some networks, so omission or misclassification of these costs could have important implications for the benchmarking analysis. EI's report does not investigate this issue.

Table 17: Total vegetation management spans

DNSP	2009	2010	2011	2012	2013
ActewAGL	34,744	34,744	34,744	34,744	34,744
Ausgrid	745,190	745,190	754,663	759,175	762,626
CitiPower	2,816	3,148	3,477	4,243	3,432
Endeavour Energy					301,973
Energex					214,259
Ergon Energy	307,596	375,386	383,257	388,570	435,992
Essential Energy	321,467	321,778	321,860	322,183	322,105
Jemena Electricity Networks	43,416	46,209	65,315	59,121	68,896
Powercor	34,106	29,445	33,033	51,919	55,675
SA Power Networks			44,773	91,015	84,916
AusNet Distribution	145,518	166,552	166,228	188,521	184,143
TasNetworks Distribution					15,118
United Energy	29,720	29,720	29,720	29,720	29,720

Source: AER RIN data

Provisions

We understand that the measure of opex used in EI's benchmarking analysis excludes provisions made by the DNSPs.[48] We have checked the opex data used by EI and in all cases (except the Queensland networks, for whom feed-in-tariffs were removed) the opex measure corresponds to the category 'Opex for network services' reported by the DNSPs in the RIN templates. The DNSPs are also required to report provisions within the RIN templates. As Table 18 below shows, there are no standard reporting conventions for provisions.

48 Whilst EI does note in its report that "Net changes in provisions are included" (p.14), the measure of opex used by EI in its econometric models matches 'Opex for network services' reported by the DNSPs, which excludes provisions.

Table 18: Provisions made by DNSPs in any year between 2006 to 2013 *(Source: AER/RIN data)*

ActewAGL	Ausgrid	CitiPower	Endeavour	Energex	Ergon Energy	Essential	Jemena	Powercor	SA Power Networks	SP AusNet	TasNetworks	United Energy
Employee Entitlements Provision	Employee Benefits	Accident Compensation	Employee Benefits	Dividends	Restructuring	Dividend	Doubtful Debts	Accident Compensation	Annual Leave	Doubtful Debts	Long Service Leave	Annual Leave
Redundancy Provision	Restructuring Costs	Customer Refunds	Self Insurance	Site Restoration - Toowoomba	Employee Benefits On-Cost Provisions	Employee Entitlements	Claims/ Compensation	Uninsured Losses	Long Service Leave	Employee Entitlements	Annual Leave	Long Service
Public Liability Provision	Insurance	Uninsured Losses	Defined Benefits Superannuation	Site Restoration - Other	Rehabilitation	Environmental Remediation		Customer Refunds	Workers Compensation	Uninsured Losses	RBF	Work Cover
Transmission Use Of System Refund To Customers	Other	Employee Entitlements	Other	Public Liability Insurance	Other	Business Restructuring		Stock Write Down	Self Insurance	Environmental Provisions	SAF (Part)	Environmental
Workers' Compensation		Doubtful Debt	Dividend	Employee Benefits	Annual Leave	Workers' Compensation		Employee Entitlements	Income Protection Scheme	License/ Regulatory Fees	Public Holidays	Transition
Legal Expense Provision		Environment		Redundancy	Long Service Leave	Defined Benefit Superannuation Obligations		Doubtful Debt	Environmental - Demolition And Site Restoration	Miscellaneous	Sick Leave	Employee Separation Cost
				Overhead Service Line Inspections	Vested Sick Leave	Provisions - Other (Insurance, Heritage Site Remediation)		Restorations (Vegetation Management)	Employee Bonuses	Superannuation	Time Bank	
				Environmental Offsets	Super On Employee Entitlements			Redundancies			Workers Compensation	
				Home Suite							Restructuring	
				Other							Payroll Tax	
											Others	

It is possible, in principle, that some DNSPs have mistakenly reported certain costs that actually ought to be classified as opex for network services as provisions.

For instance, according to the RIN data available:

- SP AusNet classified 'License/Regulatory Fees' as a provision. Typically, these costs are treated as opex items rather than provisions.
- Powercor recorded 'Restorations (Vegetation Management)' as a provision. It is unclear if some DNSPs have recorded restoration costs related to vegetation management as an opex item, and the RIN reporting guidance does not provide clear instructions on how these costs should be treated; no other DNSP reported such provisions between 2006 and 2013.
- SA Power Networks recorded provisions for 'Employee Bonuses'. Other DNSPs may have included any such provisions within their labour costs.

If the benchmarking analysis conducted by EI did exclude provisions from the measure of opex, and if a DNSP had mistakenly reported certain costs as provisions, that DNSP would look more efficient than it actually was.

5.1.2 Reporting guidelines

Consistency of opex reported

There appear to be a number of areas of ambiguity in the instructions and guidance issued by the AER in relation to how the RIN templates should be completed by DNSPs. For instance, 'opex' is defined very broadly by the AER as: "The costs of operating and maintaining the network (excluding all capital costs and capital construction costs)".[49] Opex must be reported in Table 3.2 of the AER economic benchmarking data templates for DNSPs in six categories:

- Opex for network services;
- Opex for metering;
- Opex for connection services;
- Opex for public lighting;
- Opex for amounts payable for easement levy or similar direct charges on DNSP; and
- Opex for transmission connection point planning.

49 AER, Economic benchmarking RIN for distribution network service providers Instructions and Definitions, November 2013, p.46.

It is the first category of opex, 'Opex for network services', that EI has used as DNSPs' measure of inputs in its benchmarking exercise.[50] Given that only one of these six categories of opex was used in the benchmarking exercise, it matters how DNSPs have classified costs within this category. If costs within this category are over-reported or under-reported, the results of any benchmarking exercise could be rendered unreliable.

In relation to the reporting of opex for network services, the AER's instructions to DNSPs state the following:[51]

> "Table 3.2 is intended to collect consistent Opex line items for economic benchmarking. Network Services Opex is requested as this is the core service which we intend to benchmark. Other services are collected so that their impact on productivity can be assessed and they can be incorporated or excluded from the services being benchmarked if necessary.
>
> The Opex categories in this table are not intended to be mutually exclusive or collectively exhaustive. This means that the totals of Opex in this table may be greater or less than DNSP's actual Opex. Further, Opex may be double counted within the line items."

The fact that opex need not be reported in a mutually exclusive way between different categories would make auditing the way in which opex has been classified challenging and time-consuming. Further, as noted earlier, there is relatively little by way of guidance from the AER on what precisely should be counted as opex for network services. Given the scope for misclassification, it is not clear to us that the AER has allowed sufficient time to do appropriate checks on the data to ensure consistency between networks. Finally, it is unclear how the potential for double counting of line items referred to above has been addressed by EI and the AER when compiling the data used in the benchmarking exercise.

In order to understand how consistently DNSPs have reported opex, we analysed the benchmarking RIN data published by the AER. The actual number of categories of opex reported by DNSPs, between 2006 and 2013, is very large (i.e. nearly 160 uniquely-named categories). Often, individual networks have different naming conventions for what appears to be ostensibly similar categories of costs. For instance different DNSPs reported costs labelled:

- 'Call centre', 'Customer service', Customer service (incl. Call Centre), 'Customer services (inc call centre)' and 'Contact centre and customer relations';

50 Economics Insights, Economic benchmarking assessment of operating expenditure for NSW and ACT electricity DNSPs, 17 November 2014, p.12.

51 AER, Economic benchmarking RIN for distribution network service providers Instructions and Definitions, November 2013, p.20.

- 'Corporate finance function', 'Debt management costs' and 'Debt raising costs';
- 'IT', 'IT planning and operations', 'IT planning, infrastructure and operations';
- 'Regulatory', 'Regulatory compliance expenditure' and 'Regulatory Reset';
- 'Vegetation', 'Vegetation Control' and 'Vegetation Management'.

This is a small sample of cost categories that are similar in appearance.

It appears from the varied ways in which DNSPs have reported the data that there is very little standardisation in reporting conventions. This makes it very difficult to check if the overall measure of opex used in the benchmarking exercise has been recorded consistently by DNSPs. This suggests to us that there is a strong case for further standardisation of RIN data reporting, particularly if the data collected are intended for use in benchmarking analyses.

If benchmarking is conducted on a measure of opex that has not been reported consistently by all networks, the results of any benchmarking may be unreliable. This is because those networks that have overstated network operating costs will appear less efficient than they actually are, and those that have understated network operating costs will appear more efficient than they actually are.

Figure 32 below reports total opex reported by DNSPs for 2013 alone, split into 23 opex categories (the data represented in this Figure are reproduced in tabular form in Annexe 2). Given the very large number of different opex categories within which DNSPs report costs, in order to present the data graphically, we had to aggregate together 'similar' costs.[52] The extent of variation in the proportions of different cost categories, across DNSPs, is immediately striking. This marked variation may be due to at least two reasons:

- Firstly, this may be further evidence of the inconsistency with which different DNSPs report the same costs.
- Secondly, this may be evidence of genuine operational differences between networks, which manifests as differences in cost structures.

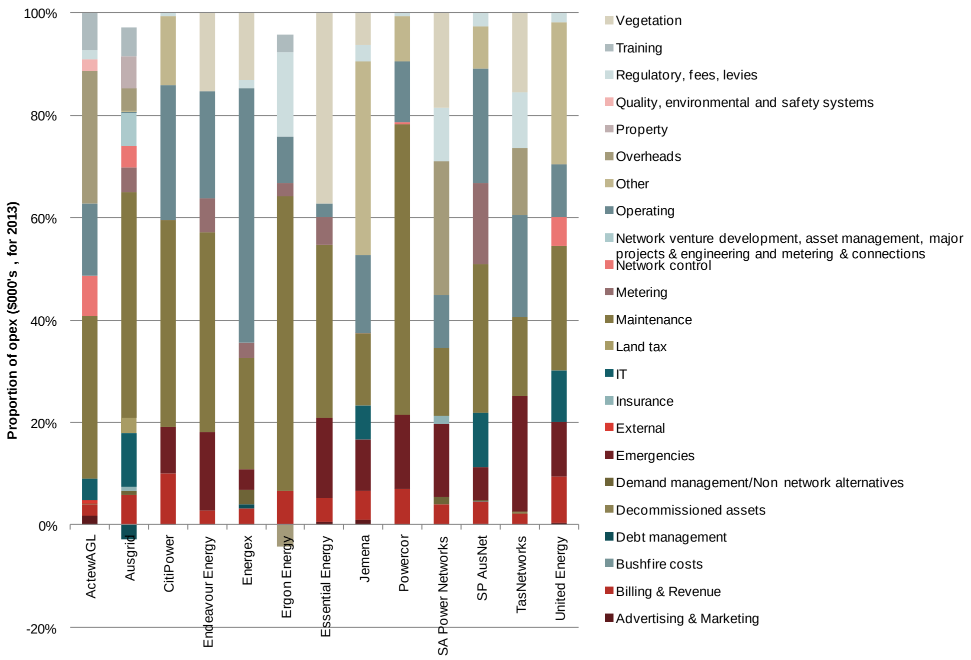
Should the majority of these reported differences arise from differences in the ways in which networks are actually operated, this would provide yet further evidence of the extensive heterogeneity of circumstance that exists in the Australian sample. It would also cast further doubt on the wisdom of benchmarking opex, in the face of material differences in business models.

52 For the avoidance of doubt, we do not claim that these are opex categories that the AER or DNSPs should necessarily use for the purposes of classifying costs. Nor do we claim that the way which we have allocated individual costs to different categories is completely precise. Our use of the 18 categories reported in Figure 32 is purely for the purposes of exposition.

Moreover, these material differences in how opex is reported also give rise to a related concern in respect of whether costs may be being allocated consistently across the boundary between opex and capex.

In our view the AER should have investigated these data issues carefully, and (a) resolved any major inconsistencies that have the potential to distort the benchmarking analysis; and (b) consider if/how any genuine differences in genuine operational differences between networks should be accounted for in the benchmarking exercise.

Figure 32: Proportional split of opex categories, by DNSP



Source: AER RIN data, Frontier analysis

Controllable vs. non-controllable costs

We understand that the AER has not asked DNSPs to report controllable and non-controllable costs separately. Non-controllable costs can include expenditure such as the cost of easements, local taxes, regulatory fees and levies. These costs can vary significantly between networks and, in principle, should not affect a regulator's assessment of relative efficiency and therefore should be excluded the measure of opex used in the benchmarking exercise.

We note that, by contrast to the AER's practice, Ofgem undertakes benchmarking assessments on controllable costs alone. Furthermore, the guidance that Ofgem provides about what may be classified as uncontrollable costs is very specific.

5.1.3 Tradeoff between opex and capex

It is well-recognised by regulators in Europe that there exist trade-off opportunities between opex and capex for most networks. A network might choose to spend more on maintenance expenditure (an example of opex) and less on refurbishment expenditure (an example of capex), or vice versa. These choices may be driven by, amongst other considerations, average asset age and condition.

For instance, a network might do very little fault/condition monitoring opex work if their assets are either very new or very old (and therefore approaching rapidly the need for replacement). If DNSPs are at different points in their investment cycles, certain networks may be favouring, for good efficiency reasons that benefit customers, opex over capex or vice versa.

There appears to have been no assessment of this by either EI or the AER when undertaking the benchmarking analysis.

If the benchmarking analysis had been done on a total expenditure basis (as Ofgem and the OEB do), then the tradeoffs between opex and capex that networks may be making would not matter to the overall assessment of relative efficiency. If DNSPs have made different but nonetheless efficient opex/capex choices, an opex-only benchmarking exercise would be an inadequate means to assess relative efficiencies. This is because a network that has favoured opex rather than potentially more costly capex (given the age profile of its assets) would likely be identified as less efficient than a network that has chosen to undertake more capex because it has reached an optimal point to replace its assets. In addition, if a network undertakes a major capex programme then it is likely to also incur incremental head office/back office opex to support that programme. Hence, any opex-only benchmarking assessment may need to take account of any scaling up of opex due to large, ongoing capex requirements. The AER and EI have not presented any analysis that checks if this is the case in this instance.

5.1.4 Differences in scope of activity

As noted in section 4, we have found evidence of very extensive heterogeneity in the scope of activities of the Australian DNSPs. For instance Table 19 shows that CitiPower (one of the frontier networks identified by EI) serves an area that is orders of magnitude smaller than Essential Energy and Ergon Energy (among the least efficient networks according to EI's analysis). As EI recognises correctly, the largest networks tend to have high voltage assets, which results in those DNSPs incurring incremental opex.

Table 20 orders the DNSPs according to EI's efficiency rankings, and also presents network length over 66kV and service area. It is immediately clear from this table that the networks identified by EI are those that do not own high voltage assets, and also tend to be those serving the smaller regions. The exception to this appears to be ActewAGL, which owns relatively few high voltage assets and serves a relatively small region. This is suggestive that, with the exception of ActewAGL, EI's model tends to favour small networks over large networks.

Table 19: Service area by DNSP

DNSP	Service area (kms^2)
CitiPower	157
Jemena Electricity Networks	950
United Energy	1,472
ActewAGL	2,358
Ausgrid	22,275
Energex	25,064
Endeavour Energy	25,120
TasNetworks Distribution	68,000
AusNet Distribution	80,000
Powercor	145,651
SA Power Networks	178,200
Essential Energy	775,520
Ergon Energy	1,698,100

Source: Data provided by Networks NSW

Table 20: Length of network over 66kV, service area and EI efficiency rankings

DNSP	EI efficiency rank	Line length over 66kV	Service area (kms^2)
CitiPower	1	0	157
Powercor	2	0	145,651
SA Power Networks	3	0	178,200
United Energy	4	0	1,472
AusNet Distribution	5	0	80,000
TasNetworks Distribution	6	0	68,000
Jemena Electricity Networks	7	0	950
Energex	8	1266	25,064
Endeavour Energy	9	1341	25,120
Essential Energy	10	1896	775,520
Ergon Energy	11	3059	1,698,100
Ausgrid	12	1715	22,275
ActewAGL	13	192	2,358

Source: Rankings derived from EI model results; data obtained from AER RIN data and from Networks NSW

This provides further evidence to suggest that the EI model may be failing to account for the cost-increasing circumstances faced by those operating rural networks, and/or of those operating networks of very large scale. As a conclusion to this section, it may be helpful to the reader for us to provide some practical examples of differences in cost that will clearly not be adequately controlled for by EI's modelling. To illustrate the kinds of material differences that we consider are likely to exist in the Australian sample we discuss below vegetation management and inspections/patrol costs.

- **Vegetation management**: at first glance, one may consider that circuit length may provide a proxy for the volume of vegetation management that a company may need to undertake, and hence captures adequately the driver of this significant element of opex. Such a presumption is false. Vegetation management activity is likely to vary enormously across companies for reasons entirely uncontrolled for by any variable in the EI sample. From discussions with Networks NSW, we understand that these reasons could include:
  - differences in rainfall, which govern vegetation growth rates and the frequency with which spans need to be recut;

  - differences in species of vegetation, which again determine growth rates;
  - differences in vegetation cover by service region;
  - differences in the ease of access to vegetation – vegetation in difficult bush terrain will be more expensive to manage than vegetation on an urban street;
  - differences in the proximity of network assets to tree cover (i.e. some networks may have the ability to avoid having assets near vegetation owing to the location of their customers, whereas others will not);
  - differences in bushfire risk;
  - differences in responsibility for vegetation management between local councils and utility; and
  - differences in the clearance that must be cut around network assets, which will determine the volume of cutting required when addressing a span.

  The EI model controls for none of these factors and given the scale of vegetation management expenditure this alone may account for a significant proportion of measured "inefficiency"

- **Inspection and patrol costs**: again, at first glance, one may consider that circuit length may provide an adequate proxy for the volume of inspections and patrol work that is necessary. Again, such a presumption is false. Operators serving a densely populated region are likely to have assets in close proximity to one another (i.e. a meshed network with many assets closely located). They are also more likely to have multiple circuits located along a given route.

  In contrast, an operator of a rural network would tend to have assets located far from one another and a significant proportion of single circuit network. Travel time is an important factor to take account of when reviewing the costs involved in inspecting a given volume of assets. The operator of a rural network may face significantly more challenging terrain in which to work, which may add further to travel time, and may increase transport costs. Furthermore, we understand from Networks NSW that aerial inspection may be more preferable or feasible than on-the-ground inspection, depending on the nature of the geography/terrain/distances being inspected. The costs of aerial and on-the-ground inspection can differ significantly, and therefore can affect the relationship between inspection activity and costs significantly. For the very largest networks, travel distances away from depot may become so large as to require flights and/or overnight accommodation. EI's model would not control at all for such differences in circumstance.

6 The AER's application of its benchmarking results

The outcome of any benchmarking exercise is typically some measure of the distance between each operator's observed cost and the model's estimate of efficient cost. It is then necessary to decide how these "efficiency" scores might be translated into cost allowances. Numerous approaches have been adopted by different regulators around the world. Some examples (variously used individually or in combination) include:

- deriving efficiency scores based on the absolute frontier of performance but allowing operators off the frontier some time to achieve that level of performance (i.e. a glide path);
- applying a less demanding frontier (e.g. based on average performance or the upper quartile) but perhaps requiring that level of efficiency immediately;
- putting in place an allowance based partly on the operator's own costs and partly on the efficient cost level identified by the benchmarking model; and
- creating a number of groups of operators that are regarded as having similar efficiency and requiring the same moderated improvement from each.

While one will not typically find these approaches described as such, each of these approaches has the effect of altering the balance between the proportion of residual variation that the regulator ultimately deems to be arising from inefficiency, and that which arises owing to latent heterogeneity.

There is clearly an element of judgement and regulatory discretion in which of these broad approaches to adopt. Such judgements might be based on, for example:

- the quality of the data underlying the benchmarking analysis;
- the availability of a sufficiently comprehensive set of cost driver data;
- an assessment of the robustness and accuracy of the benchmarking model;
- an assessment of the extent to which historic costs may be expected to accurately reflect future costs; and
- the impact of cost disallowances on the financeability of companies.

The 'inefficiencies' identified by AER's preferred econometric model are in the range 40% to 55%. Despite the material flaws in the AER's analysis and weaknesses in the available data, it has applied its results deterministically to disallow a very significant portion of the opex of the NSW NSPs over the 2014-2019 period, making two adjustments to the catch-up target:

- The AER has provided a further 10% allowance for those operating environment differences not completely captured by its preferred benchmarking model.
- The AER has compared the NSW networks' efficiency to a weighted average of all networks with efficiency scores above 0.75 (i.e. 75%).

Notwithstanding these cost adjustments, the AER's has proposed a material (24% - 43%) reduction in opex for all of the NSW DNSPs, without allowing a transition period.

6.1.1 Choice of benchmark

The AER has compared the NSW networks' efficiency to a weighted average of all networks with efficiency scores above 75%. These networks include CitiPower, Powercor, United Energy, SA Power Networks and AusNet. The AER has used an average of their efficiency scores, weighted by customer numbers as the benchmark for all other networks in the sample.

Considering the issues associated with the quality and comparability of the AER's Australian and international data, we note that the AER's choice of benchmark is both more onerous and arbitrary that targets used by regulators in Europe and worldwide. For example:

- The OEB in Canada uses the efficiency rankings derived from its econometric benchmarking models to group networks into five distinct cohorts. The cohort judged to be most efficient faces an efficiency adjustment, known as a 'stretch factor' of 0% p.a. The cohort identified as least efficient is assigned a stretch factor of 0.6% p.a., which is materially less onerous than the efficiency discounts proposed by the AER. Importantly, the OEB views the stretch factors it sets as designed to encourage networks to become more efficient over time, and not punitive measures for inefficiency. A notable difference between the AER's and the OEB's approach is that the OEB does not translate measured relative inefficiency between networks mechanistically into cost reductions.
- Similarly, Ofwat (the regulator of water companies in England and Wales) has in the past used its benchmarking to split the water and sewerage companies into five efficiency bands that each received the same moderated efficiency discount subject to a glide path.
- Ofgem, in its recently completed RIIO-ED1 investigation in Great Britain used an upper quartile target in its benchmarking for its electricity distribution regulatory control in Great Britain. Ofgem's reason for targeting the upper quartile, and not the frontier firm, is because it recognises that the

modelling involves uncertainty, so caution is warranted when applying the results. Additionally, Ofgem has made use of an interpolation procedure where final allowances are made up of 25% of the companies' submitted costs and 75% of its benchmarking models. This is despite the fact that:

- Ofgem uses a 'toolkit' of approaches to determine its benchmarking target, including top-down econometric models, bottom-up unit cost analysis, bottom-up engineering assessments, assessments of historic costs and assessments of forecast costs, in order to provide the scope to cross check and sense check the efficiency estimates derived by any single approach.
- The quality of data available to Ofgem is significantly better than the data available to the AER, owing to the prodigious effort that has been invested in improving the underlying data, in particular the cost data.
- There has been a significant amount of engagement with the DNSPs to develop the Ofgem models in the first place, allowing them to comment on Ofgem's technique, cost driver choice, the quality of their own and other's data, cost drivers that are not adequately captured by the models, differences in business model that may be picked up as inefficiency and any circumstances otherwise unique to the company that should be adjusted for or at least understood when interpreting the results.

- In the gas sector, Ofgem recognised that there were more significant quality and comparability issues associated with the data. To account for this, it used the upper quartile, and required the gas distribution companies to close 75% of the gap to the upper quartile, rather than the total gap.
- In the previous electricity distribution regulatory control, Ofgem set separate targets for different cost categories, bearing in mind the data quality and uncertainty associated with each model. For example, an upper quartile target was used for indirect costs (which were considered less prone to year-to-year volatility and hence easier to benchmark), and an upper third target was used for network operating costs (which were considered both volatile and less fully explained by the available cost drivers).
- Ensuring data comparability is even more challenging when looking across countries. Upper quartile was considered inappropriate by the CMA even when adding a only single extra comparator to the sample of 14 electricity distribution companies regulated by Ofgem. The 5th best company was used as the target (slightly less onerous than the upper quartile) in the CMA's Northern Ireland Electricity (NIE) against the electricity distribution networks in Great Britain.
- The regulator in Norway moderates the results of its benchmarking by setting allowed cost in line with 40% of the companies' submitted costs, and 60% of the "efficient" benchmarked costs derived from its model.

We make the following observations about the efficiency target that the AER has applied in this case:

- The AER has targeted the weighted average of efficiency scores in excess of 75%. However, the AER's efficiency scores have not been normalised so the most efficient network is 100% efficient (i.e. the network found to be most efficient has an efficiency score of less than 100%). Hence, a 75% efficiency score is difficult to interpret.
- In any case, 75% is too onerous a threshold given the very severe issues of data quality and comparability (particularly given the use of international data) and implausibly large spread in results.
- Comparators that the NSW networks are expected to target and match include companies such as CitiPower, which are very clearly outliers in the analysis with such different operating regions and circumstances as to render that challenge completely inappropriate.
- Despite the fact that AER's weighting of its efficiency scores by customer numbers is intended to soften the efficiency target, this approach is entirely arbitrary.

6.1.2 Adjustments for exogenous factors

To attempt to account for factors not controlled for in the modelling, EI undertakes an exercise that results in an allowance of 10% for exogenous uncontrolled for factors. While it is welcome that EI acknowledges the imperfection of its benchmark, we take no comfort from this adjustment, as we consider it incomplete, inadequate and arbitrary.

EI's efficiency results are manifestly flawed and hence inappropriate starting point from which to consider minor adjustments. The very significant issues we have identified throughout this report all point to very material heterogeneity across the Australian networks, which has not been controlled for, and there is no reason to suppose that a 10% tolerance captures these adequately. We regard the 10% uplift as arbitrary, based on a very incomplete exploration of possible differences, as we have evidenced above.

6.1.3 Timing and magnitude of reductions

The AER's analysis is insufficiently robust, as evidenced in the sections above, to justify such large and immediate opex reductions for the DNSPs. For all the reasons set out here, we consider the mechanistic application of the efficiency scores derived by EI to be highly risky for companies and their customers.

We understand from Networks NSW that opex cuts of the scale proposed can be delivered only through very significant cut backs to the workforce of the affected DNSPs, which would inevitably have significant consequences for the ability of those companies to maintain prevailing levels of operational performance, network condition and safety. We consider it very likely, based on the balance of evidence we have seen, that the discounts proposed are very materially overstated, and the diminution of network standards that would follow from their application could give rise to cut backs that would take many years to reverse if they were subsequently revealed to be flawed. Given the significant heterogeneity in operating conditions between the networks, and the failure of EI's modelling to account properly for this heterogeneity, there is a material risk that if cuts of the magnitude proposed were imposed, service levels would be compromised. EI's modelling did not account for differences in quality of service, so the impact of the cuts proposed on service levels has not been assessed. In order to protect customers from the possibility of an error, AER has a duty to consider very carefully all of the evidence before it.

Our recommendation would be for AER to abandon the EI work and replace it with more pragmatic and less ambitious benchmarking analysis better suited to the prevailing data and knowledge.

7 Recommendations for the AER: a constructive way forward

Having reviewed the work produced by EI on behalf of AER, we consider that its analysis contains a wide range of flaws. These arise as a combination of:

- the inclusion of what appears to be unreliable international data, without sufficient attempt to ensure comparability, which it is entirely inappropriate to include;
- a failure to ensure adequate consistency in data for the Australian networks;
- failure to consider sufficiently fully and rigorously all the differences in company circumstance (across not only the three countries included in the sample, but also within the Australian data) that may justify reasonable differences in cost and which are not captured in the EI model; and
- an unjustified assumption that residual variation may be presumed to arise almost entirely from managerial inefficiency, rather than latent heterogeneity.

Owing to these errors in approach, we believe that the results contained in the EI report are entirely unreliable, and should play no role in the AER's final determinations.

The scale of inefficiencies identified by AER/EI – in the range 40% to 55% – are so significant that they could only be contemplated if all of the available evidence strongly supported them. We envisage that opex discounts of the scale proposed could only be delivered through very significant cut backs to the workforce of the affected DNSPs with inevitably significant consequences for the ability of those companies to maintain prevailing levels of operational performance and network condition. In order to protect customers from the possibility of an error, AER has a duty to consider very carefully all of the evidence before it.

Had the AER/EI paid greater attention to the heterogeneity present in the Australian sample we believe that it would have been manifestly obvious that much of the "inefficiency" they find must arise from differences in circumstance. If the widely varying operational differences between networks had been taken account of, it should have been obvious that spread of efficiency scores derived by EI is implausibly large (i.e. none of the Australian companies could credibly be thought to be as inefficient as the EI study suggests).

The AER and EI have essentially failed to acknowledge, or take into account, the significant practical difficulties involved in distinguishing statistically between actual inefficiency and genuine heterogeneity of circumstances faced by different networks. A key flaw in the AER's/EI's analysis is ascribing virtually all of the uncontrolled variation between networks (that is not accounted for by statistical noise) to inefficiency, and very little, if any, to underlying heterogeneity. This cannot be a sound conclusion for all of the foregoing reasons. Yet, on the basis of that flawed analysis, the AER has sought to impose very material cost reductions on networks, which may ultimately be to the detriment of customers.

Upon review and reflection, we trust that the AER will withdraw this analysis entirely from this regulatory review, and replace it with less ambitious and more pragmatic analysis rooted in more relevant Australia-specific cross company comparisons. Our specific recommendations for the AER (for its final determinations) are the following:

- Discard the international data from its sample.
- Rely only on Australian data. However, work with the DNSPs over time to improve the quality and consistency of these data such that future benchmarking work can be undertaken with greater confidence.
- Rely on most recent evidence from 2013.
- Use simpler, less ambitious benchmarking techniques than the AER has used in the Draft Decision for NSW and ACT networks to undertake an **indicative** assessment of relative efficiencies.
- Given the weakness of any top down analysis that might be undertaken on the present data, triangulate any top down benchmarking by commissioning expert engineering advice (e.g. to review volumes and unit costs in the most important cost heads).
- Recognise explicitly that no benchmarking model is perfect, and that any modelling of this kind is subject to uncertainty (deriving from data limitations, heterogeneity in firm characteristics that is difficult to account for, model limitations and statistical noise).
- Having made an initial assessment of relative efficiencies, investigate through engagement with the businesses whether the networks identified as most efficient **and** least efficient (i.e. the 'outlier' companies) to understand if they face unique circumstances not captured in the modelling that should nevertheless be accounted for in a proper efficiency assessment.
- Apply results with an appropriate degree of caution, recognising the significant practical challenges involved in performing benchmarking analysis, and taking account the need for ongoing refinement of RIN data reporting and consistency. The AER should take note of the caution with which regulators overseas, with more experience conducting benchmarking analysis and with less challenging samples to assess, apply the results from benchmarking analysis to make efficiency adjustments to cost allowances. Examples of such regulators include the Ontario Energy Board in Canada and Ofgem in Great Britain.

While we are critical of the AER's present benchmarking exercise, it is important to stress that the authors of this piece are generally advocates of benchmarking as a review of Frontier's previously published work on the subject will reveal. Benchmarking plays a key role in regulatory proceedings, as an important component of wider incentive arrangements and in order to ensure an appropriate balancing of costs and risks between the regulated companies and their customers. We would encourage the AER to continue with benchmarking, as it is required to under the National Electricity Rules.

However, it is evident from the AER's first attempt at undertaking benchmarking analysis that there needs to be a step change in its work in this area. To ensure that benchmarking is a more robust and reliable exercise in the future, and drawing on lessons from other regulators worldwide who have more experience in the application of benchmarking, we outline the following recommendations for the AER.

- Improve regulatory reporting processes and the consistency of the Australian RIN data.
- Engage more with each network and with the industry as a whole about company-specific factors.
- Be less ambitious in the modelling techniques pursued, particularly given the apparent limitations on the data available.
- Seek further evidence through complementary benchmarking.
- Develop a regulator/sector work programme to design a richer set of cost driver variables/cost adjustments.
- Allow more time.
- Develop a less mechanistic application of benchmarking results.

We elaborate on each of these themes below.

Improve regulatory reporting processes

The AER should put in place a programme of work to ensure that all companies in the sector adopt much more consistent approaches to collating and reporting cost and cost driver information, so as to collect more consistent and reliable data across the Australian DNSPs. It is evident from an examination of the information available that there are inconsistencies (some of them material) in the way different DNSPs report RIN data. Inconsistent reporting can confound reliable benchmarking analysis (in particular when benchmarking of opex only is attempted), and considerable effort needs to be made by both the regulator and the industry to improve the consistency of the RIN data. In our experience, the achievement of high quality, consistent data is an incremental and iterative process that requires ongoing engagement between the regulator and the businesses. In the nearer term, the AER should:

- recognise explicitly the limitations of the data and the uncertainty that implies for its benchmarking analysis; and
- be less ambitious about what it can achieve with the data it presently has available.

Genuine and collaborative efforts towards improving the robustness of the RIN data may improve the confidence that AER – and the networks – can place on future benchmarking analysis.

Given the limited time and resources it has available, the AER must choose where its efforts would be best spent. We recommend that the AER not spend effort seeking to include international data in future benchmarking exercises, as the challenges one then faces in ensuring data consistency and in specifying a sufficiently complete set of cost drivers across countries can only be addressed through very extensive work with the full cooperation and participation of the relevant regulatory authority (and companies) in each country. Even then, doubts are likely to remain over the veracity of results. Instead, we recommend that the AER spend its efforts improving the quality of the RIN data, and in engaging with the DNSPs to understand any unique circumstances they may face.

By way of context, it is helpful to recall that Ofgem has undertaken a decade or more of development work in respect of its data collection (as we set out in Section 5.1.1). AER should anticipate the need to undertake a similar programme of work.

We recognise that the AER has gone through a process to develop RIN templates but, set against Ofgem's experience, it would be naïve for the AER to think that the RIN data obtained to date is sufficiently free from errors and inconsistencies as to warrant the degree of confidence the AER has placed in its modelling.

Engage more with each network and with the industry as a whole about company-specific factors

The AER should recognise that no benchmarking model is perfect, and it will almost inevitably be necessary for it to take account of factors captured poorly in, or omitted altogether from, its benchmarking model. The assessment of regional variation and company specific differences is an important part of regulatory proceedings in Great Britain, where Ofgem engages extensively with the sector on adjustments to its suite of benchmarking models. Adopting a similar approach will be particularly important in the Australian context given the very extensive variation in the size and spatial characteristics of the Australian DNSPs.

Based on our review of the Australian data and our experience of applying benchmarking techniques across Europe, it seems reasonable to say that the AER is regulating a sector with an unprecedented degree of heterogeneity of circumstance. For example, the two largest Australian DNSPs are Essential

Energy and Ergon Energy. Essential Energy serves an area significantly greater than the land area of France, while Ergon Energy serves an area significantly greater than the land area of France, the UK and Spain combined. These statistics alone ought give the AER pause to consider whether it is sensible to treat networks of such scale the same as networks that serve much smaller geographies. Yet, the AER appears to have given no particular consideration to the unique circumstances faced by these networks. Instead, the AER has relied on very crude modelling tools to capture the effects of extreme scale, rurality, and sparsity. As a result, the AER's modelling identifies these two networks as among the least efficient DNSPs in Australia. This is very surprising to us because European regulators, such as Ofgem, engage closely with networks with much less extreme characteristics than Essential Energy and Ergon Energy to understand any important factors that their modelling may have failed to capture.

Given the diversity of networks it regulates, it is unlikely to be possible to find or develop high level variables that are rich enough in information to capture well the heterogeneity between DNSPs. In order to get close to capturing all the relevant features in its model, it would likely have to include many more explanatory variables than it has. However, given the relatively small size of the Australian dataset, the AER would likely have insufficient degrees of freedom to model all the variables necessary.

It is clear to us that, given the nature of the DNSPs it regulates, the AER will not be able to reflect all the important network and environmental characteristics in an econometric model. The reality of the extremely heterogeneous nature of the DNSPs in Australia needs to become embedded in the AER's approach at this review and at future reviews. The final chapter of EI's report illustrates how this might be achieved, but is insufficient in its coverage, and places too much reliance on a flawed starting point.

Be less ambitious

A key flaw of the analysis undertaken by the AER is the application of very ambitious modelling techniques, such as SFA, to very imperfect data. Indeed, it appears that the main reason the AER has felt the need to employ overseas data, without appropriate checks for robustness and consistency, is its desire to employ sophisticated techniques such as SFA.

We recognise that the AER is obliged to undertake benchmarking under the National Electricity Rules (NER). However, the NER also provide the AER with considerable flexibility to choose the most appropriate benchmarking techniques and methodologies. The AER should not feel constrained to restrict itself to benchmarking using formal statistical techniques alone.

Given the limitations of the Australian RIN data, and the lack of time for learning and iterative improvement of the data, we recommend that the AER rely on much simpler benchmarking techniques. We reiterate that regulators in

Europe, who have had considerably more experience, and time to compile consistent data, than has the AER, typically use much simpler, and more pragmatic benchmarking techniques.

The AER has applied a very narrow interpretation of benchmarking. Its Expenditure Forecast Assessment Guideline sets out a very long list of potential benchmarking techniques, all of which would be recognised in Europe and many of which are used by regulators overseas. Whilst it canvassed in its Guideline the potential use of many alternative techniques, its assessment of relative efficiency seems to drive off only one technique, SFA, and that too in a very mechanistic fashion. Given the sensitivity of such techniques to the quality of the data, and the fact that the RIN data are very new and relatively untested, the AER should not have, in our view, placed so much reliance on statistical techniques such as SFA. Rather, in our view, the AER should have initially tried much simpler, less ambitious techniques and then aimed to build up to more complex techniques once it, and networks and customers, have greater confidence in the data and in the AER's approach to benchmarking.

Seek further evidence through complementary benchmarking

At this review hitherto, the AER appears to have put undue faith in the ability of it, and its advisers, to develop a single benchmarking model (or suite of very closely related models, all derived from the same data and missing the same wider review of factors and sense checks) that can capture very well relative inefficiency. This appears unnecessarily limiting for AER.

Drawing on our experience of practice in Europe, it is common for regulators to seek to triangulate "top down" benchmarking, of the kind produced by EI, with other sources of information, e.g. review by expert engineering consultants of unit costs, volumes of work, policies and practices in order to gain a more holistic view of network performance. If the engineering review finds evidence of inefficiency, or scope for improvements, this can strengthen the AER's confidence in applying the results from the top down model. Otherwise, it can be used as way of moderating the results by capturing objective justifications that do not lend themselves easily to being summarised in a simple variable. Although Ofgem has spent more than a decade developing its data capture methods and its benchmarking to improve outcomes, it still depends on expert review of certain types of costs that it acknowledges are very hard to compare directly across companies (e.g. IT&T costs, non-operational property costs). The AER should consider doing the same.

Develop a regulator/sector work programme to design a richer set of cost driver variables/cost adjustments

The AER should view the experience of undertaking the benchmarking analysis during this regulatory process as a first attempt that has drawn out valuable lessons for future work. These lessons relate to:

- the limitations of the RIN data, which have hitherto been untested but have now clearly been exposed as suffering from a number of weakness that need to be addressed going forward;
- the extreme heterogeneity of the networks that must be benchmarked;
- the limitations of the standard modelling tools used in benchmarking analyses; and
- the need for significant caution, judgment and engagement with networks when applying modelling results to derive relative efficiency assessments that will translate into cost allowances.

The benchmarking work undertaken to date has been restricted by the data that is available. Additional and different data could be requested and collected, and may be helpful in providing a way to capture empirically some of the differences in circumstance identified in the body of this report. We would recommend that the AER create a cost assessment working group in collaboration with the networks, tasked with developing empirical methods that may help it overcome the challenges it faces in regulating a sector within which there is such extensive heterogeneity. This may involve developing, defining and collecting additional measures, or considering methodologies to justify company specific adjustments to benchmarked costs, or the outcome of benchmarking models.

For example, the Dutch regulator (despite regulating a small country with geography/topography that is strikingly homogenous by Australian standards) has invested significant effort into investigating sources of potential heterogeneity of circumstance, and conducted industry wide studies to investigate potential differential effects arising from:

- differences in customer density;
- local taxes;
- the impact of water crossing for companies serving regions affected by sea/large inland lakes; and
- differences in cost caused by extensive differences in the penetration of distributed generation across different network operators.

Allow more time

As a matter of good practice, at future reviews, AER should seek to conduct its benchmarking analysis in a more timely manner, so as to allow more testing and scope for engagement with the networks. This would allow opportunity for the companies and their advisers to scrutinise carefully the AER's proposals, and to propose more constructive improvements. This should improve the confidence that the AER – and companies and customers – may have in the process, through allowing argument and counterargument to be assessed fully.

Develop a less mechanistic application of benchmarking results

Owing to the limitations of even the very best and most reliable benchmarking analysis, the great majority of regulators overseas do not impose the outcome of their benchmarking as reductions to allowed costs on a one-for-one and mechanistic basis. Most will seek to soften the impact, so as to allow for error and the imperfect assessment of different circumstances. For example:

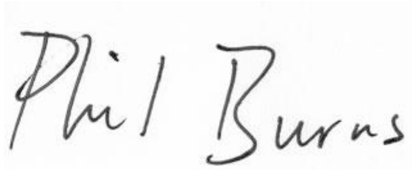
- The Ontario Energy Board (as we discuss below) uses its benchmarking to inform on relatively modest differences in "stretch factors" for the companies it regulates, with the best performers provided with a stretch factor of 0.0% per annum, and the worst performers with a stretch factor of 0.6% per annum.
- Ofwat (the regulator of water companies in England and Wales) has in the past used its benchmarking to split the water and sewerage companies into five efficiency bands that each received the same moderated efficiency discount subject to a glide path.
- The regulator in Norway moderates the results of its benchmarking by setting allowed cost in line with 40% of the companies' submitted costs, and 60% of the "efficient" benchmarked costs derived from its model.
- Ofgem, in its recently completed RIIO-ED1 investigation has made use of an interpolation procedure where final allowances are made up of 25% of the companies' submitted costs and 75% of its benchmarking models.

8 Declaration

We have read, understood and complied with the Federal Court of Australia's Practice Note CM 7 – Expert Witness in Proceedings in the Federal Court of Australia.

We have made all the inquiries that we believe are desirable and appropriate and that no matters of significance that we regard as relevant have, to our knowledge, been withheld from the Court.

Mike Huggins



Phil Burns

Annexe 1 – Opex reporting in Ontario and Australia

OEB's definition of opex

In Ontario, OM&A includes the following (from our investigations, it appears that the categories coloured in red are excluded from OM&A used to benchmark networks' costs):

- Operations
  - 5005 Operation Supervision and Engineering
  - 5010 Load Dispatching
  - 5012 Station Buildings and Fixtures Expense
  - 5014 Transformer Station Equipment - Operation Labour
  - 5015 Transformer Station Equipment - Operation Supplies and Expenses
  - 5016 Distribution Station Equipment - Operation Labour
  - 5017 Distribution Station Equipment - Operation Supplies and Expenses
  - 5020 Overhead Distribution Lines and Feeders - Operation Labour
  - 5025 Overhead Distribution Lines and Feeders - Operation Supplies and Expenses
  - 5030 Overhead Sub-transmission Feeders - Operation
  - 5035 Overhead Distribution Transformers - Operation
  - 5040 Underground Distribution Lines and Feeders - Operation Labour
  - 5045 Underground Distribution Lines and Feeders - Operation Supplies and Expenses
  - 5050 Underground Sub-transmission Feeders - Operation
  - 5055 Underground Distribution Transformers - Operation
  - 5060 Street Lighting and Signal System Expense
  - 5065 Meter Expense
  - 5070 Customer Premises - Operation Labour
  - 5075 Customer Premises - Materials and Expenses
  - 5085 Miscellaneous Distribution Expense

  - 5090 Underground Distribution Lines and Feeders - Rental Paid
  - 5095 Overhead Distribution Lines and Feeders - Rental Paid
  - 5096 Other Rent
- Maintenance
  - 5105 Maintenance Supervision and Engineering
  - 5110 Maintenance of Buildings and Fixtures - Distribution Stations
  - 5112 Maintenance of Transformer Station Equipment
  - 5114 Maintenance of Distribution Station Equipment
  - 5120 Maintenance of Poles, Towers and Fixtures
  - 5125 Maintenance of Overhead Conductors and Devices
  - 5130 Maintenance of Overhead Services
  - 5135 Overhead Distribution Lines and Feeders - Right of Way
  - 5145 Maintenance of Underground Conduit
  - 5150 Maintenance of Underground Conductors and Devices
  - 5155 Maintenance of Underground Services
  - 5160 Maintenance of Line Transformers
  - 5165 Maintenance of Street Lighting and Signal Systems
  - 5170 Sentinel Lights - Labour
  - 5172 Sentinel Lights - Materials and Expenses
  - 5175 Maintenance of Meters
- Administration
  - Billing and Collection
    - 5305 Supervision
    - 5310 Meter Reading Expense
    - 5315 Customer Billing
    - 5320 Collecting
    - 5325 Collecting- Cash Over and Short
    - 5330 Collection Charges
    - 5335 Bad Debt Expense
    - 5340 Miscellaneous Customer Accounts Expenses
  - Community Relations

  - 5405 Supervision
  - 5410 Community Relations – Sundry
  - 5415 Energy Conservation - CDM
  - 5420 Community Safety Program
  - 5425 Miscellaneous Customer Service and Informational Expenses
- Administrative and General Expenses
  - 5605 Executive Salaries and Expenses
  - 5610 Management Salaries and Expenses
  - 5615 General Administrative Salaries and Expenses
  - 5620 Office Supplies and Expenses
  - 5625 Administrative Expense Transferred - Credit
  - 5630 Outside Services Employed
  - 5640 Injuries and Damages
  - 5645 OMERS Pensions and Benefits
  - 5646 Employee Pensions and OPEB
  - 5647 Employee Sick Leave
  - 5650 Franchise Requirements
  - 5655 Regulatory Expenses
  - 5665 Miscellaneous General Expenses
  - 5670 Rent
  - 5672 Lease Payment Expense
  - 5675 Maintenance of General Plant
  - 5680 Electrical Safety Authority Fees
  - 5681 Special Purpose Charge Expense
  - 5685 Independent Electricity System Operator Fees and Penalties
  - 5695 OM&A Contra Account
- Insurance Expense
  - 5635 Property Insurance

    - 6210 Life Insurance
- Other Deductions
    - 6205 Donations
    - 6205 Donations, Sub-account LEAP Funding
- Advertising expenses
    - 5515 Advertising Expense
    - 5660 General Advertising Expenses
- Other Distribution Expenses.
    - 6015 Amortization of Premium on Debt – Credit (interest expense)
    - 5505 Supervision
    - 5510 Demonstrating and Selling Expense
    - 5520 Miscellaneous Sales Expense
    - 6215 Penalties
    - 6225 Other Deductions

Differences in cost allocation practices between Ontario and Australia

Costs excluded in Ontario opex and included/partially included in Australia opex

- Bad debts is excluded from OM&A in Ontario. It is unclear whether this has been included within opex by Australian DNSPs
- SP AusNet includes Bushfire and royal commission costs explicitly. No other DNSP includes this.
- Debt management costs are included within opex by certain Australian companies. These costs are not obviously included in Ontario opex.
- Demand management/non-network alternatives is included within reported opex by some Australian DNSPs. These costs appear to be excluded from opex in Ontario (termed energy conservation, "CDM" = conservation and demand management)

Costs included in Ontario opex and excluded/not clearly included in Australian opex

- Meter reading is included in Ontario OM&A and excluded from Australian opex:
  - Billing and collecting includes "Meter reading expense"
  - Operation expenses includes "Meter expense"
  - Maintenance expenses includes "Maintenance of Meters" expense
- Costs related to community relations (e.g. community safety program) are included in the Ontario data and excluded, but are not obviously included within the Australian opex.
- Rent is explicitly included in Ontario data. It is generally unclear if rent has been included in the Australian data. Only Ausgrid includes rent as a separate item as "Property management (excluding land tax)" and "land tax".
- Insurance (property and life) costs are included within opex by Ontarian networks. Is not clear if/how these costs are included in opex by some Australian DNSPs. Insurance costs are reported discretely by a few Australian networks (i.e. Ausgrid, SA Power networks and Energex) but not others. It is also unclear what type of insurance has been included within opex by these companies.

Costs where it is unclear if the Ontario and Australian definitions are the same

In Ontario, billing and collecting and advertising expenses includes explicitly:

- Supervision
- Meter reading
- Customer billing
- Collecting (charges, over and short)
- Miscellaneous customer accounts expenses
- Advertising expenses

Australian DNSPs appear to report these costs inconsistently so it is unclear what is included and excluded by each company. The following categories appear in within opex data (and Australian DNSPs report opex under different subsets of these categories):

- Billing & Revenue Collection
- Call centre
- Contact centre and customer relations

- Customer operations
- Customer service
- Customer service (inc call centre)
- Other customer service
- Meter reading and network billing
- Business services provided by ActewAGL retail
- Ontario expenses on regulation explicitly include only:
- Electrical safety authority fees
- Regulatory Expenses, which are defined as expenses "incurred by the utility in connection with formal cases before the board or other regulatory body ... including payments made to a regulatory body for fees assessed against the utility"

It is unclear if the regulation, license fees, levies costs are capturing the same costs consistently between Australian networks. The following costs are also reported inconsistently by Australian networks:

- FRC fees (full retail contestability)
- NEM levy
- Levies
- License fee
- GSL payments
- Electrical safety levy
- Regulatory reset
- Regulatory compliance expenditure
- Regulated miscellaneous charges
- Regulatory
- Quality, environment and safety systems

We understand that provisions are excluded from network services opex in the Australian data. According to RIN data provisions cover items such as: employee sick leave, long service leave, insurance, accident claims and pensions (see Table 3.3 Provisions for the Australian data). The Ontario opex explicitly includes some provisions such as:

- Injuries and damages
- Pensions and benefits
- Sick leave

- Insurance (property and life)

Annexe 2 – Categories of opex reported by Australian DNSPs

Table 21: Proportional split of opex categories, by DNSP (2013)

	ActewAGL	Ausgrid	CitiPower	Endeavour Energy	Energex	Ergon	Essential Energy	Jemena	Powercor	SA Power Networks	SP AusNet	TasNetworks	United Energy
Advertising & Marketing	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	1.1%	0.0%	0.0%	0.2%	0.0%	0.4%
Billing & Revenue	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bushfire costs	2.5%	6.5%	10.2%	3.3%	3.7%	9.3%	7.4%	6.3%	7.0%	5.7%	4.5%	3.1%	9.1%
Debt management	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Decommissioned assets	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Demand management/ Non network alternatives	0.0%	-3.2%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Emergencies	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%
External	0.1%	0.9%	0.0%	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%	1.9%	0.1%	0.0%	0.0%
Insurance	0.0%	0.0%	9.1%	18.1%	4.9%	0.0%	25.1%	11.0%	14.5%	20.3%	6.7%	30.4%	10.9%
IT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Land tax	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Maintenance	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%
Metering	4.8%	11.6%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	10.9%	0.0%	10.2%
Network control	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Network venture development, asset management, major projects & engineering and metering & connections	35.6%	49.7%	40.5%	46.2%	25.4%	80.3%	53.6%	15.4%	57.2%	18.9%	29.7%	21.2%	24.7%
Operating	0.0%	5.5%	0.0%	7.7%	3.6%	3.8%	8.7%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Overheads	9.0%	4.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	0.0%	0.0%	0.0%	5.9%
Property	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Quality, environmental and safety systems	15.9%	0.2%	26.4%	24.8%	58.2%	12.5%	4.4%	16.8%	11.9%	14.5%	23.0%	27.0%	10.4%
Regulatory, fees, levies	0.0%	0.1%	13.7%	0.0%	0.0%	0.0%	0.0%	41.9%	8.9%	0.0%	8.5%	0.0%	28.2%
Training	29.3%	5.1%	0.0%	0.0%	0.0%	-5.9%	0.0%	0.0%	0.0%	36.7%	0.0%	17.9%	0.0%
Vegetation	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: Frontier analysis of AER RIN data

Annexe 2 – Categories of opex reported by Australian DNSPs

Annexe 3 – Terms of reference

Networks NSW

Ausgrid Endeavour Energy essential energy

12 January 2014

Mike Huggins and Phil Burns
Frontier Economics Pty Ltd
C / - 395 Collins Street
Melbourne VIC 3000

Dear Mike and Phil,

Letter of engagement – Networks NSW – AER Draft Determination

Ausgrid, Endeavour Energy and Essential Energy (referred to collectively as Networks NSW) are distribution network service providers in New South Wales, Australia regulated by the Australian Energy Regulator (AER) under the National Electricity Law (NEL) and National Electricity Rules (NER).

The AER made a draft determination of the revenue allowances for Networks NSW on 27 November 2014. This letter confirms your engagement in relation to Networks NSW's response to that draft determination and possible legal challenge of the final determination (which is expected in April 2015) (Response).

Scope of engagement

You are engaged by Networks NSW, for the purposes of the Response, to:

a. provide economic analysis and advice;

b. prepare a written expert report (or reports);

c. appear as an expert witness for Networks NSW (if required); and

d. undertake such other work as NNSW may instruct you as the Response progresses.

A document outlining an list of questions that we require you to address in your expert report is set out in Attachment 1. These questions may be refined and developed, and added to, as the Response progresses.

A document outlining background on the regulatory regime relevant for the questions set out in Attachment 1 is included as Attachment 2.

Also enclosed is a copy of Practice Note CM7: Expert witnesses in proceedings in the Federal Court of Australia. Please ensure that your report complies with the requirements of Practice Note CM7, and also certify in your report that you have complied with Practice Note CM7.

Yours sincerely,

Catherine O'Neill
Group Manager – Strategy & Performance
Networks NSW

Networks NSW

ATTACHMENT 1

LIST OF TOPICS REQUIRED TO BE ADDRESSED

The National Electricity Objective (**NEO**) set out in section 7 of the National Electricity Law is:

> *"The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—*
>
> *(a) price, quality, safety, reliability and security of supply of electricity; and*
>
> *(b) the reliability, safety and security of the national electricity system."*

Your report should address the following topics in the context of the NEO:

a. Comment on the intrinsic challenges in carrying out bencharmking analyses in the context of electricity distributors

b. Review and comment on the approach of the AER / Economic Insights to benchmarking, including: the data compiled; selection of models (composition, technical accuracy); the domestic and international data sets used; and the method of adjustments for factors outside of the modelling process itself;

c. Comment on the use of benchmarking techniques in other jurisdictions, including any approaches taken where any benchmarking reveals apparently significant differences between the determined actual or hypothetical "benchmark" efficient operator and any of the relevant regulated entities;

d. To the extent that you consider there are any deficiencies in the benchmarking exercise that has been undertaken, please comment on whether those deficiencies can be addressed, and if so, how.

ATTACHMENT 2

BACKGROUND ON REGULATORY REGIME APPLYING TO ELECTRICITY DISTRIBUTION NETWORK SERVICE PROVIDERS IN NEW SOUTH WALES

INTRODUCTION

Networks New South Wales (**NNSW**) are the three *distribution network service providers* (**DNSPs**) in NSW – Ausgrid, Endeavour Energy and Essential Energy – regulated under the National Electricity Law (**NEL**) and Chapter 6 of the National Electricity Rules (**NER**). As such, NNSW were required to and did submit in May this year regulatory proposals to the Australian Energy Regulator (**AER**) for the determination of, among other things, their annual revenue requirements for the next regulatory control period (**Proposals**).

Chapter 6 of the NER sets out rules for the economic regulation of *direct control services* and *negotiated distribution services* provided by DNSPs. This regime requires the AER to determine the revenue allowed to be earned by NNSW for distribution services during each regulatory year, in accordance with the post-tax revenue model, described in Chapter 6 of the NER for each regulatory control period. In addition, a negotiating framework and negotiated distribution service criteria must also be determined by the AER. The process for making a distribution determination is set out in Part E of Chapter 6 of the NER.

DISTRIBUTION DETERMINATIONS

a. Under the NER, DNSPs must provide *direct control services* (which can be divided into *standard control services* and *alternative control services*) and *negotiated distribution services* on terms and conditions of access as determined under Chapters 4, 5, 6 and 7 of the NER (clause 6.1.3 of the NER). Relevantly, chapter 6 of the NER regulates:

b. for standard control services, the annual revenue requirements NNSW may earn for the provision of standard control services for which the AER must make a revenue determination (clause 6.3.2 of the NER); and

c. for negotiated distribution services, the requirements that are to be complied with in respect of the preparation, replacement, application or operation of NNSW's negotiating frameworks and the Negotiated Distribution Service Criteria (clauses 6.7.3 and 6.7.4 of the NER).

d. The making of a distribution determination is an economic regulatory function of the AER. As an economic regulatory function, section 16(1) of the NEL requires the AER to perform or exercise its function "in a manner that will or is likely to contribute to the achievement of the national electricity objective" set out in section 7 of the NEL being:

> *"The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—*
>
> *(a) price, quality, safety, reliability and security of supply of electricity; and*
>
> *(b) the reliability, safety and security of the national electricity system."*

e. In addition, if there are two or more possible decisions that will or are likely to contribute to the achievement of the national electricity objective, section 16(1)(d) of the NEL requires the AER to make a decision that it is satisfied will, or is likely to, contribute to the achievement of the national electricity objective to the greatest degree.

f. In addition, when making a distribution determination, the AER must also take into account the revenue and pricing principles set out in section 7A of the NEL:

"(2) A regulated network service provider should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs in—

(a) providing direct control network services; and

(b) complying with a regulatory obligation or requirement or making a regulatory payment.

(3) A regulated network service provider should be provided with effective incentives in order to promote economic efficiency with respect to direct control network services the operator provides. The economic efficiency that should be promoted includes—

(a) efficient investment in a distribution system or transmission system with which the operator provides direct control network services; and

(b) the efficient provision of electricity network services; and

(c) the efficient use of the distribution system or transmission system with which the operator provides direct control network services.

...

(6) Regard should be had to the economic costs and risks of the potential for under and over investment by a regulated network service provider in, as the case requires, a distribution system or transmission system with which the operator provides direct control network services.

(7) Regard should be had to the economic costs and risks of the potential for under and over utilisation of a distribution system or transmission system with which a regulated network service provider provides direct control network services."

B. OPERATING EXPENDITURE

The AER must determine whether it is satisfied that the forecast of required operating expenditure proposed by a distribution network service reasonably reflects the following criteria (clause 6.5.6(c) of the NER referred to as the **operating expenditure criteria**):

"(1) the efficient costs of achieving the operating expenditure objectives; and

(2) the costs that a prudent operator would require to achieve the operating expenditure objectives; and

(3) a realistic expectation of the demand forecast and cost inputs required to achieve the operating expenditure objectives."

The **operating expenditure objectives** referred to in clause 6.5.6(c)(1) of the NER above are set out in clause 6.5.6(a) of the NER as follows:

"(1) meet or manage the expected demand for standard control services over that period;

(2) comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;

(3) to the extent that there is no applicable regulatory obligation or requirement in relation to:

(i) the quality, reliability or security of supply of standard control services; or

> *(ii) the reliability or security of the distribution system through the supply of standard control services,*
>
> *to the relevant extent:*
>
> *(iii) maintain the quality, reliability and security of supply of standard control services; and*
>
> *(iv) maintain the reliability and security of the distribution system through the supply of standard control services; and*
>
> *(4) maintain the safety of the distribution system through the supply of standard control services."*

In deciding whether or not it is satisfied that the forecast of required operating expenditure proposed by a distribution network service reasonably reflects the following criteria in clause 6.5.6(c) of the NER, the AER must have regard to the following factors (clause 6.5.6(e) of the NER, referred to as **operating expenditure factors**):

> *"…*
>
> *(4) the most recent annual benchmarking report that has been published under rule 6.27 and the benchmark operating expenditure that would be incurred by an efficient Distribution Network Service Provider over the relevant regulatory control period;*
>
> *(5) the actual and expected operating expenditure of the Distribution Network Service Provider during any preceding regulatory control periods;*
>
> *(5A) the extent to which the operating expenditure forecast includes expenditure to address the concerns of electricity consumers as identified by the Distribution Network Service Provider in the course of its engagement with electricity consumers;*
>
> *(6) the relative prices of operating and capital inputs;*
>
> *(7) the substitution possibilities between operating and capital expenditure;*
>
> *(8) whether the operating expenditure forecast is consistent with any incentive scheme or schemes that apply to the Distribution Network Service Provider under clauses 6.5.8 or 6.6.2 to 6.6.4;*
>
> *(9) the extent the operating expenditure forecast is referable to arrangements with a person other than the Distribution Network Service Provider that, in the opinion of the AER, do not reflect arm's length terms;*
>
> *(9A) whether the operating expenditure forecast includes an amount relating to a project that should more appropriately be included as a contingent project under clause 6.6A.1(b);*
>
> *(10) the extent the Distribution Network Service Provider has considered, and made provision for, efficient and prudent non-network alternatives; and*
>
> *(11) any relevant final project assessment report (as defined in clause 5.10.2) published under clause 5.17.4(o), (p) or (s);*
>
> *(12) any other factor the AER considers relevant and which the AER has notified the Distribution Network Service Provider in writing, prior to the submission of its revised regulatory proposal under clause 6.10.3, is an operating expenditure factor."*

Networks NSW

The AER's draft decision substantially reduces the forecast operating expenditure of the NNSW businesses when compared with the revenue proposals and historical operating expenditure allowances of those businesses. This is in part based on the outcomes of the annual benchmarking report, which determined that the NNSW businesses were not as efficient as other distribution network service providers and is without any transition to enable the NNSW businesses to adjust their practices to satisfy the reduced forecast operating expenditure allowance.

Annexe 3 – Terms of reference

Annexe 4 – CVs

Mike Huggins

8.1.2 Career

Jan 2013 to date	Director, Frontier Economics
April 2010 to Dec 2012	Associate Director, Frontier Economics
January 2003 to April 2010	Manager, Frontier Economics
September 1999-December 2002	Consultant, Frontier Economics
April 1998-August 1999	Consultant, London Economics
1994-98	Economist, Energy Policy and Analysis Unit, UK Civil Service

8.1.3 Education

1996-98	Birkbeck College, London, M.Sc. Economics, with distinction
1989-92	University of Sheffield, B.Sc. (Hons) Mathematics

8.1.4 Selected experience in network regulation and benchmarking

- **CREG, Belgium:** advice on the design of an incentive to provide a sufficient level of quality of supply (2014).
- **ESB Networks, totex benchmarking:** For the upcoming regulatory review, Frontier is undertaking totex benchmarking for ESB Networks (2014).
- **Energy Networks Association:** - to carry out analysis of RPE allowances for RIIO-ED1, in particular estimating the size of the RPE allowances that the GB DNOs would receive under a range of different methodologies. (2014).
- **ESB Networks, price control support**: estimation of ESBN's cost of capital for its forthcoming price control (2014).

- **NIE networks, price control support:** led Frontier's advice to NIE on its fifth regulatory review across all aspects of its business, including the cost of capital efficiency analysis, incentive design, the regulatory treatment of pensions, real price effects, work force renewal and a miscellany of other elements of NIE's business. NIE's price control has now been referred to the Competition Commission and Mike continues to lead Frontier's advice. (2010-2014).

- **ESB Networks, price control support**: a review of recent relevant regulatory precedent to identify emerging trends and themes that may provide opportunities or threats for ESBN at its next review (2014).

- **Northern Powergrid, GB, RIIO-ED1:** advice on Ofgem's developing ideas in respect of efficiency analysis and the allowed rate of return, including preparing a response to Ofgem's recent consultation on the cost of equity (2012-ongoing).

- **ENA New Zealand:** advice on the methodologies that might be developed to forecast future costs for the electricity distribution companies.

- **Ofgem/DNO working group, RIIO-ED1:** conducted a large scale econometric analysis of the GB DNOs to develop an operational and robust totex efficiency model. This study, which was initiated by the DNOs, was eventually taken over by Ofgem and will be used as part of their efficiency "toolkit" to inform on so-called fast-track decisions and the appropriate level for regulatory allowances for ED1 more generally (2012-13).

- **Northern Powergrid, Great Britain, business plan development:** advised on the development of a well justified business plan for submission at the forthcoming RIIO-ED1 review (2011-12).

- **National Grid, price control support:** advised National Grid on the preparation of their initial and final TO business plan, as part of RIIO-T1. Advice focused on incentive design and risk modelling and the development of a network development policy, including associated modelling of the optimal approach to network reinforcement. (2011-2012).

- **Scotia Gas, efficiency analysis, RIIO-GD1:** provided an independent critique of Ofgem's approach to benchmarking at the recently completed gas distribution review (2012).

- **Ofgem, efficiency analysis under RIIO:** as part of its RPI-X@20 review Ofgem commissioned a study that looked at how its future use of benchmarking across all of the energy networks might better support its renewed focus on long term planning and the delivery of outputs under the then shaping RIIO framework. Frontier prepared a report that reviewed past conduct and present best practice, leading to a set of clear policy recommendations (2010).

- **Ofgem, outputs under RIIO:** Ofgem asked Frontier to provide it with a report that assessed how it might best define and use the outputs that it would in future ask companies to deliver under its then developing RIIO framework. Frontier, working with engineering consultants Consentec, developed a high level set of output areas and then considered the data that could be collected in each area. Based on this, Frontier developed a tiered system of output measurement and use, that focused on primary deliverables (which may be suitable for use directly in incentive mechanisms) and secondary deliverables (which should be monitored but were not apt for use in incentive mechanisms for a range of reasons). Frontier's recommendations were central to the outputs that are now established across the RIIO price controls (2010).

- **NMa, Netherlands, impact of DG on regulated networks:** led a study to investigate the differential effect of DG on the Dutch electricity distribution networks, in order to understand whether the existing treatment of DG in regulatory arrangements could be improved. Mike worked closely with an engineering advisor and discussed the issue widely with experts from the sector. (2011-2012).

- **NMa, Netherlands, transmission efficiency analysis:** prepared a feasibility study, in association with Consentec, reviewing the scope to successfully apply reference network modelling techniques in order to assess the efficiency of TenneT. (2011-2012).

- **ORES, regulatory policy, Belgium**: provided advice to ORES, an operator of both gas and electricity networks, on a range of regulatory issues. This included providing a critique of the regulator's proposed efficiency analysis (2011).

- **CE Electric:** advice on all aspects of DPCR5, including in particular advice on benchmarking, the cost of capital and the development of Ofgem's "Information Quality Incentive" mechanism. (2007-2010).

- **DTe, Netherlands, efficiency analysis:** a study to investigate the extent to which differences in cost arising from exogenous differences in connection density can be quantified and corrected for in regulatory decisions. (2007-2009)

- **DTe, Netherlands, regulatory policy:** provided DTe with an assessment of their overarching regulatory approach with a particular focus on the steps that they could take in order to make their regulatory decisions more robust. (2007)

- **Regulated gas network operator, Western Europe, regulatory advice**: assisting a gas network operator through its price control review (2004).

- **CREG, Belgium, regulatory design:** Managing Frontier's work to advise the CREG on its electricity distribution price control review, including advice on conducting efficiency analysis using DEA (2004).

- **CE Electric, UK, regulatory advice**: providing advice on a range of issues arising from a distribution price control review, in particular with regard to the incentives provided to the companies by some proposed changes to the regulatory regime (2004-05).

- **E-control, energy regulator in Austria:** Managing an exercise to produce preliminary estimates of relative efficiency to inform the gas and electricity distribution price control review (2003).

- **Ofgem, network regulation**: Provided advice on the development of Ofgem's regulation of the network monopolies, looking specifically at the inclusion of quality in efficiency analysis and the provision of clear, strong and balance incentives for efficient behaviour (2002-03).

- **A group of Northern European regulators, efficiency analysis:** Advised on the approaches that might be adopted to determine the relative efficiency of transmission system operators and how this analysis might inform regulatory policy (2001-02).

- **DTe (Dutch energy regulator), efficiency analysis:** Advised the client on the use of Data Envelopment Analysis, including data requirements (in particular the standardisation of capital costs), model selection and the policy implications of the results. The results from our DEA have underpinned the preliminary price determinations made by the regulator. In addition to advice on benchmarking techniques we have helped the client with the implementation of yardstick regulation and financial modelling. (1999-2001).

- **DTe, regulation of purchase costs:** Advised DTe on the incentive properties of a number of proposed schemes for the regulation of electricity purchase costs (2000).

Phil Burns

8.1.5 Career

2009-present	COO, Frontier Economics
1999-present	Board Director, Frontier Economics
1995-1999	Managing Consultant, London Economics
1992-1995	Research Fellow, Centre for the study of Regulated Industries
1989-1992	Economist, Bank of England

8.1.6 Education

1988-1989	MSc (Econ), Distinction, Queen Mary College, London University
1984-1987	BA (Hons), Economics and Accounting, Liverpool University

8.1.7 Selected experience in network regulation and benchmarking

- **Northern Powergrid** on the development of its "well-justified business plan" for RIIO-ED1 and subsequently support through RIIO-ED1 price control process (ongoing)
- **Northern Ireland Electricity** throughout its appeal to the Competition Commission in respect of the price control proposals made by NIAUR. Issues advised on include benchmarking/efficiency analysis and cost of capital estimation (2013)
- **Phoenix Gas** throughout its appeal to the Competition Commission in respect of the price control proposals made by NIAUR (2012)
- **UK Power Networks (UKPN)** on a major industry initiative to evaluate the feasibility of total cost benchmarking for use in ED-1, estimation of econometric models and developing a user-friendly interface to the model that can be used by the industry. The model has now been accepted as part of Ofgem's "toolkit" (2012-2013)
- **Northern Ireland Electricity** throughout its T&D price control review – advice on benchmarking/efficiency analysis and cost of capital (2012)

- **Electricity Supply Board** on ongoing regulatory policy and strategy. Our recent work includes the de-regulation of retail price controls (2007-ongoing).

- **Scotia Gas Networks (SGN)** during RIIO GD-1 (2012)

- **Phoenix Gas** during its price control review (2011-2012).

- **CE Electric** on financeability implications over Ofgem's proposals to extend regulatory depreciation asset lives from 20 years to 45, with reference to both finance theory, and the likely reaction of credit ratings agencies and investor practice and behaviour (2011).

- **CE Electric** on developments price control reviews for gas distribution and electricity and gas transmission networks which may be relevant for future electricity distribution reviews (2011).

- **A network operator** on the key aspects of producing a "well-justified business plan" that fulfils the criteria Ofgem has set out in its RPI-X@20 review (2010).

- **Ofgem** on the future role of benchmarking in regulatory reviews, in support of the RPI-X@20 review (2010).

- **Ofgem** on the future role of outputs in regulatory reviews, in support of the RPI-X@20 review (2010).

- **DTe (Dutch energy regulator), establishment of system of yardstick competition** requiring analysis of data and financial and efficiency models to standardise costs and performance, and design of targets and incentives to operationalize the regulatory model. Although controversial at the time it remains a resilient regulatory model and a recent independent review of the system confirms it continues to work effectively and to the benefit of users. (1999-2001).

- **National Audit Office** on its review of network regulation in the UK. We were been engaged to write a paper commenting on the role of incentives in regulation and the performance of UK regulators in making use of effective incentive regimes (2001).

8.1.8 Publications

Journal articles

- (2006) The Role of the Policy Framework for the Effectiveness of Benchmarking in Regulatory Proceedings, Competition and Regulation in Network Industries (CRNI), 1(2), S. 287-306, (with Christoph Riechmann, Cloda Jenkins and Misja Mikkers).

- (2005) The role of benchmarking for yardstick competition, Utilities Policy 13, 302-309, (with Christoph Riechmann and Cloda Jenkins).

- (2004) Regulatory instruments and investment behaviour, Utilities Policy 12, 211-219, (with Christoph Riechmann)

- (2004) "Regulatory instruments and their effects on investment behaviour", *World Bank Policy Research Working Paper Series*, (with Christoph Riechmann)

- *(1999) Benchmarking von Netzkosten – DEA am Beispiel der Stromverteiler in Großbritannien (Benchmarking network cost – Application of DEA to electricity distributors in Great Britain), Zeitschrift für Energiewirtschaft 23(4), (with Christoph Riechmann and John Davies).*

- (1998), Behaviour of the Firm under Alternative Regulatory Constraints, *Scottish Journal of Political Economy*, Vol. 45, No.2, pp. 133-157, (with R. Turvey and T.G. Weyman- Jones).

- (1997) Is the gas supply business a natural monopoly? Econometric evidence from the British Gas regions, *Energy Economics,* Vol. 20, pp. 223-232, (with T.G. Weyman-Jones).

- (1996) Cost Drivers and Cost Efficiency in Electricity Distribution: A Stochastic Frontier Approach, *Bulletin of Economic Research,* Vol. 48, No.1, pp. 41-64, (with T.G. Weyman-Jones).

- (1995) Regulation and Redistribution in Utilities, *Fiscal Studies,* Vol. 16, No. 4, pp. 1-24 (with I. Crawford and A. Dilnot).

- (1993) Privatisation of Railway Passenger Services. *Public Money and Management,* Vol. 13, No. 1, pp. 7-9.

Discussion papers

- (2010) *The long-run level of X in RPI-X regulation – Bernstein and Sappington revisited*. Frontier mimeo (with Tom Weyman-Jones).
- (2004) "Regulatory instruments and their effects on investment behaviour", *World Bank Policy Research Working Paper Series*, (with Christoph Riechmann).
- (2004) *Measuring market power in wholesale electricity markets*. Frontier mimeo (with Mike Huggins and Reamonn Lydon).
- (2004) *Yardstick competition – a win-win setting?* (with Cloda Jenkins, Janine Milczarek and Dr Christoph Riechmann). Paper presented to International Conference on Applied Infrastructure Research, Berlin, 9th October 2004.
- (2004) *Generators' strategies in the England and Wales electricity market: a synthesis of simulation modelling and econometric analysis*. CRI Technical Paper 16 (with Mike Huggins and Reamonn Lydon).
- (1998) *Regulatory incentives and capital efficiency in UK electricity distribution businesses* (with John Davies). CRI Occasional Paper No. 12, December 1998.
- (1998) *Information, accounting and the regulation of concessioned infrastructure monopolies* (with Antonio Estache). World Bank Policy Research Working Paper No. 2034, December 1998.

Book

(1994) Discriminatory Pricing and Accounting Method in the UK Regulated Industries. CRI/ICAEW, London. 241pp.

Other

Referee for a number of journals including the *American Economic Review*.

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