Further analysis of Ergon's efficiency in the light of customer consultations

A report prepared for Ergon in the context of AER's preliminary decisions on the Queensland DNSPs

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Executive Summary

Background

In April 2015, the Australian Energy Regulator ('AER') released a preliminary decision concerning the allowable revenue for Ergon along with a decision in respect of Energex. At the same time, the AER released final decisions in respect of the NSW and ACT distribution network service providers ('DNSPs'). The preliminary decision determined, *inter alia*, that Ergon's total allowable operating costs were 10% below the level of operating costs proposed by Ergon.

Customer consultations

Subsequently, Ergon commissioned a customer consultation exercise that aimed to determine customers' views on Ergon's proposed expenditure areas in the light of the preliminary decision. The consultation demonstrated:

- support for the 6.5% reduction in Ergon's charges at broadly current levels of service;
- support for immediate savings that impacted Ergon rather than the customers themselves (particularly in respect of supply reliability);
- a preference for greater than 6.5% reductions in charges if they derived from reduced back office (and similar) costs, but not from other areas such as supply reliability;
- a quarter of respondents expressed concern that reduced prices might result in reduced supply and service reliability, with 10% expressing concerns over job losses and outsourcing.

Ergon asked Synergies Economic Consulting to review the efficiency implications of these findings. These results indicate that customers place a high value on supply reliability, and are willing to forego further decreases in charges (beyond those that they are offered) in order to forestall reduced reliability, quality or safety of the network, deterioration in general service levels and increases in supply outages.

The importance of allocative efficiency

In Synergies view, this consultation highlights the importance of considering allocative efficiency when reviewing DNSP efficiency. Allocative efficiency typically refers to whether, given relative prices, inputs are used in the proportion which minimises the cost of production.

Allocative efficiency can also refer to outputs; a DNSP is allocatively efficient in its choice of outputs when it maximises the value of its output mix to customers (for a given level of inputs). It is particularly important to address allocative efficiency of outputs when important outputs are not priced or traded in markets and when price for outputs are not cost reflective. This is the case for DNSPs; no prices are set for supply reliability, and the prices of other outputs such as customers, circuit length and peak demand are not set on a cost reflective basis.

Supply reliability

The customer consultation demonstrates that one output in particular, reliability of supply in terms of reduced interruptions and more rapid restoration of supply, is particularly highly valued by customers. Since supply reliability is highly valued, allocative efficiency demands that resources (operating costs and capital) are directed to it.

If the benchmarking used to determine operating cost efficiency does not include supply reliability, a DNSP that dedicates additional resources to supply reliability will appear inefficient relative to a DNSP that dedicates a lower level of resources but delivers an inefficiently low level of supply reliability.

Synergies benchmarked Ergon's operating cost efficiency using data envelopment analysis ('DEA') which included duration of interruptions as an output to represent supply reliability. The results of this model indicated that Ergon's operating cost efficiency is approximately 16.3% greater than the AER estimated for the preliminary decision.

Synergies believes that benchmarking has an important role in informing regulatory decision making. However, in presenting this analysis, we reiterate our previously expressed concerns with the AER's use of benchmarking to determine allowed revenue for operating costs. The purpose of this report is to demonstrate that it is necessary for benchmarking assessments to take account of both input and output allocative efficiency and that the failure to do so results in an incomplete assessment of efficiency. That assessment is informed by appropriate customer consultations.

Output allocative efficiency

This efficiency score was based on quantity rather than cost based benchmarking. If the value that customers place on uninterrupted supply is very high as the survey indicates, social efficiency requires that DNSPs dedicate more inputs to ensure that reliability. If the value that customers place on uninterrupted supply is low, social efficiency requires that DNSPs dedicate fewer inputs to ensure that reliability. A DNSP whose mix of outputs does not reflect the relative values that customers place on those outputs exhibits allocative inefficiency.

Synergies examined the extent to which high values on supply reliability might affect Ergon's apparent efficiency using a 3 output (customer numbers, circuit length, SAIDI) 2 input (opex, capital) DEA model and adjusting the relative weights of outputs or inputs as appropriate. This model was used because it is the best representation of the DNSP's production technology that can be accommodated within the degrees of freedom limitations of the underlying data.

Under this model Ergon's overall technical efficiency (which includes scale effects) is 59% ranging on a year by year basis between 51% and 64%. Ergon's controllable efficiency is 62% ranging on a year by year basis between 52% and 74%. Using this model it is possible to assess the impact that increasing or decreasing the relative price of supply reliability has on DNSP efficiency.

The AEMC has made assessment of the Value of Customer Reliability (VCR) at the state level of between $40/kWh and $60/kWh. These figures are considerably higher (of order 50-200 fold) than the typical cost of energy that is normally supplied. Synergies examined the efficiency consequences of applying weights of 50 and 100 to supply reliability.

If the appropriate relative output weight (value) of supply reliability is 50, then Ergon's implied overall efficiency (in the sense of maximising the value of its outputs rather than their quantities) given its current inputs, customer numbers and circuit length is 64%, 5% above its technical efficiency score. This would imply an output allocative efficiency score given its current outputs of 92%. If the appropriate relative output weight (value) of supply reliability is 100, then Ergon's implied overall efficiency given its current inputs, customer numbers and circuit length is 93%, 34% above its productive efficiency score. This would imply an output allocative efficiency score given its current outputs of 63%.

This suggests that Ergon may well be operating efficiently in an environment that places a very high value on supply reliability and rapid restoration of supply after failure (e.g. after a natural disaster). The customer survey gives some support to this. What may appear to be inefficient operating costs could well be efficient, in so far as they enable Ergon to maintain high levels of supply reliability.

Input allocative efficiency

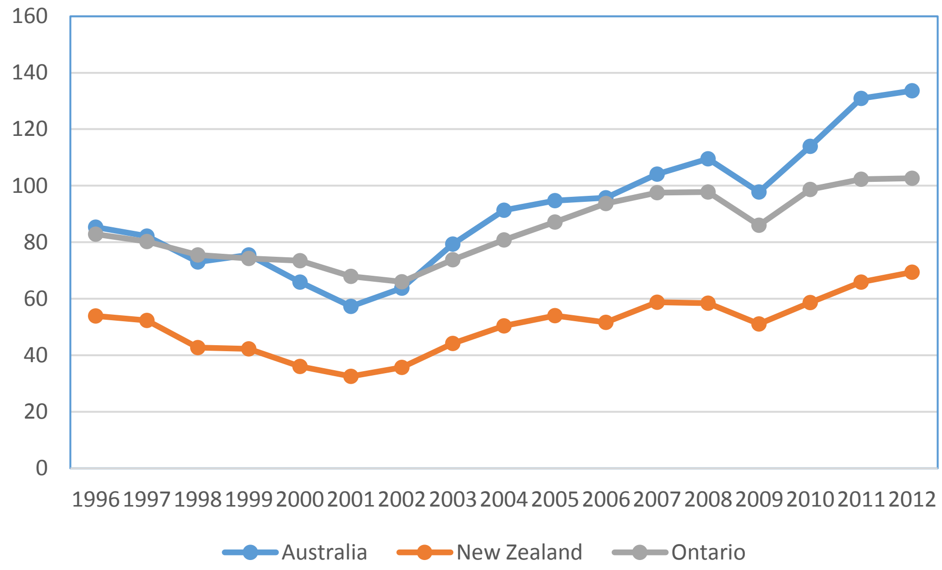
A DNSP is allocative efficient when it uses the least cost mix of inputs for a given set of outputs. Allocative efficiency therefore depends upon the relative price of inputs and the mix of inputs that the DNSP selects. Differences in relative prices can arise because:

- firms that are included in the benchmark sample face different relative costs of inputs; and/or
- firms face changing relative costs over time, but are unable to respond effectively to those changes by adjusting their use of inputs in the short or even the medium term.

In respect of the former, two firms facing different relative costs may well be cost efficient in their own markets but may exhibit different productive efficiency. The latter is a well understood issue that faces firms that make large, long-lived and sunk capital investments at a point in time. These assets then dictate the production function of the firm for the duration of their existence. The level of necessary operating costs is determined, in large part, by past capital investment decisions. This issue has been formalised in the 'putty clay' models widely applied to investment in energy markets.

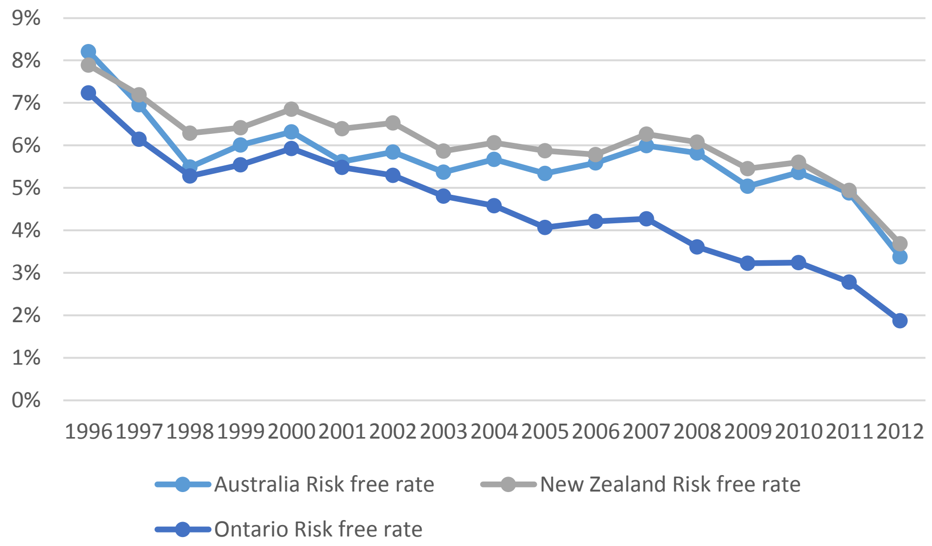
There have been significant changes in relative costs of capital and labour over the last 15 years. In particular, the cost of labour has risen significantly while the cost of capital has fallen, illustrated in the following charts.

Relative labour costs (hourly compensation costs, relative to US$)



Source: US Bureau of Labour Statistics

Risk free rates across Australia, New Zealand and Ontario



Sources: RBA, RBNZ, Statcan.

To examine the possible effects of these changes on efficiency measure, Synergies examined the impact of changing the relative weight of capital to 80% of current levels and the relative weight of labour to 120% of current levels (i.e. higher labour costs and lower capital costs). Under this scenario Ergon would currently exhibit an allocative efficiency score of 95%. Under the converse change in relative weights, if labour costs were 80% of current levels and capital costs were 120% of current levels, then Ergon would currently exhibit an allocative efficiency score of 84%.

For business that exhibit 'putty clay' type characteristics because of very large costs of changing existing capital in the face of changing relative prices, decisions over investment costs and operating costs in the past, which at the time were allocatively efficient (i.e. least cost), may appear inefficient when relative prices change. These allocative efficiency scores provide an indication of the possible extent of this effect.

These sensitivities suggest that investments made by Ergon, and presumably others, particularly in the period 2000 to 2006, when labour costs were relative lower than today and capital costs relatively higher, would translate into an apparent inefficiency of perhaps 15% when compared to a greenfield network developed at current relative prices.

Regulators responsible for assessing current operating cost efficiency should therefore assess the degree to which current operating costs and apparent inefficiency are contingent upon past investment choices.

Other factors

A number of other aspects of Ergon's operations were considered to be important by customers. Notable amongst these was the value that they placed on maintaining local depots, particularly in regional areas. The number and location of maintenance depots is not typically considered to be an output expected from a DNSP. Nor would Synergies advocate that it is treated as such.

However, if customers value the local presence because it is associated high service standards and rapid restoration of supply in the event of a supply interruption, then it is appropriate to take it into account in a quantitative assessment of efficiency.

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1 Introduction

In April 2015, the Australian Energy Regulator ('AER') released a preliminary decision concerning the allowable revenue for Ergon along with a decision in respect of Energex. At the same time, the AER released final decisions in respect of the NSW and ACT distribution network service providers ('DNSPs'). The preliminary decision determined, *inter alia*, that Ergon's total allowable operating costs were 10% below the level of operating costs proposed by Ergon. The preliminary decision also included a response to the criticisms of the AER's application of benchmarking to determine allowable operating costs submitted by the DNSPs generally.

Subsequently, Ergon commissioned a customer consultation exercise[1] that aimed to determine customers' views on Ergon's proposed expenditure areas in the light of the preliminary decision. The introduction to the consultation noted that:

> Research conducted in 2013 with Ergon Energy's residential customers uncovered a desire for price stability with no significant reduction in service quality or reliability. In this same research, Ergon Energy's business customers stated that they are more focused on price reductions, even if it meant decreased supply reliability. Through the work conducted by Ergon Energy in developing their 2015-2020 regulatory proposal, Ergon Energy believe that they can deliver this, potentially with a 6.5% discount on the service fee passed onto customers.
>
> There are indications that the Australian Energy Regulator (AER) believe that customers are expecting more significant discounts and are expecting Ergon Energy and other distributors in Australia to make dramatic reductions to reduce underlying costs of providing their service in order to deliver larger price reductions for customers.

Broadly, the results of the consultation indicated:

- broad support for the 6.5% reduction in Ergon's charges (without necessitating any significant changes to supply reliability, their network maintenance and safety standards, their customer service offering or things like the management of local depots or their storm response capability), with the greatest level of support from regional Queensland businesses;
- support for immediate savings that impacted Ergon rather than the customers themselves. Broadly, there was support for cost savings in areas such as back-office staff, community messaging etc. but a notable lack of support for reductions in costs in areas such as restoration after natural disasters, and restoration and maintenance of supply reliability;

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1 Colmar Brunton 19 June 2015 *Ergon Energy. Customer' Investment Priorities. Draft*

- a preference for greater than 6.5% reductions in charges from around half of respondents provided the saving derive from the identified areas (e.g. back office) and not from valued areas (e.g. supply reliability and recovery);
- in so far as respondents expressed any concerns over further discounts, a quarter expressed concerns over supply and service reliability, with 10% expressing concerns over job losses and outsourcing.

Ergon has asked Synergies Economic Consulting to review the efficiency implications of these findings. Broadly speaking, customer consultations of this type indicate the value that customers place on the different services and outputs that DNSPs provide. These results indicate that customers place a high value on supply reliability, and are willing to forego further decreases in charges (beyond those that they are offered) in order to forestall reduced reliability, quality or safety of the network, deterioration in general service levels and increases in supply outages.[2]

The results of these consultations therefore shed some light on allocative efficiency. Broadly speaking, allocative efficiency requires that firms use the least cost mix of inputs to produce the highest value set out outputs, in so far as they are able to change the mix of either. Synergies examines this issue as follows:

- in section 2 we review what is meant by allocative efficiency;
- in section 3 we review allocative efficiency from the perspective of outputs, having regard to the results of the customer consultation;
- in section 4 we review allocative efficiency from the perspective of inputs;
- in section 5 we summarise our conclusions; and
- in attachment A, we set out further data envelopment analysis.

Synergies believes that benchmarking has an important role in informing regulatory decision making. However, in presenting this analysis, we reiterate our previously expressed concerns with the AER's use of benchmarking to determine allowed revenue for operating costs. The purpose of this report is to demonstrate that it is necessary for benchmarking assessments to take account of both input and output allocative efficiency

[2] They also indicate that customers value other aspects of Ergon's services, such as maintaining depots in regional areas, which may only be partially related to the outputs that Ergon supplies. For example, in respect of maintaining regional depots, customers may be placing a value on maintaining regional employment (which is not an Ergon output) or implicitly recognising a link between maintaining supply reliability and quality of service by maintaining a local presence and capability.

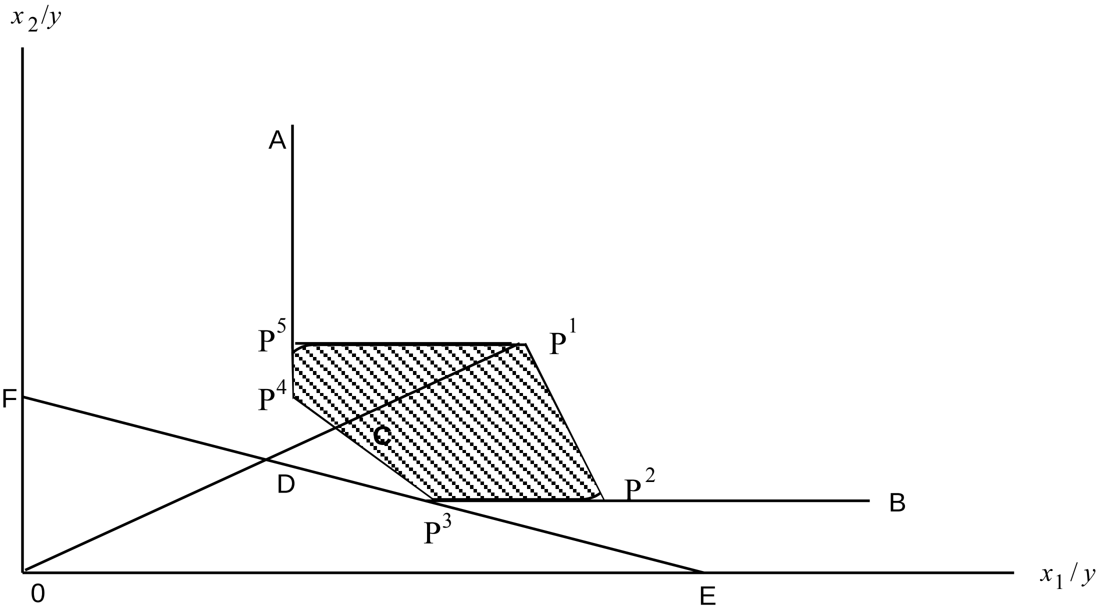
and that the failure to do so results in an incomplete assessment of efficiency.[3] That assessment is informed by appropriate customer consultations.

3 We have not addressed the further issue of the relationship between allocative efficiency and environmental factors, e.g. low density networks with higher exposures to extreme weather face greater challenges in maintaining system reliability.

2 Allocative efficiency

Allocative efficiency typically refers to whether, given relative prices, inputs are used in the proportion which minimises the cost of production. Figure 1 illustrates measures of efficiency for a firms that uses two inputs, X_1 and X_2 (typically capital and labour), to produce a give level of output, *Y*. The production function[4] for *Y* units of output, *AB*, represents the observed mix of inputs used by efficient firms to produce *Y*. It therefore represents the substitution possibilities between inputs. It is apparent from this diagram that firm can use different mixes of capital and labour.

Figure 1. Allocative efficiency in a data envelopment analysis framework



Firm P[1] is technically inefficient; it does not use the minimum *quantity* of inputs. Given the production function *AB*, firm P^1 should be able to produce *Y* using the quantity and mix of inputs given by point *C*; it would be technically efficient if it did so. Its technical efficiency score is given by the ratio $0C/0P^1$.

However, point *C* may not represent feasible least cost production for firm P^1. That depends upon the relative prices of the inputs. This is illustrated by the line *FE*, which represents the relative prices of the two inputs. In this example, the relative price of input X_1 is lower than that of X_2 so efficiency demands that the firm uses greater quantities of X_1 than X_2, provided it is possible to substitute between them. In this case substitution is possible. The least cost mix of inputs to produce *Y* is then found at the point where the relative cost line is tangential to the production function, point P^3 in this instance.

4 In this illustration, the production function is defined by three frontier firms, P^3, P^4 and P^5. The efficient frontier is the piecewise linear curve between them, AC. Firm P^1, which sits behind this frontier is inefficient.

Firm P^1 would need to resemble firm P^3 in order to be both technically and allocatively efficient. The *allocative efficiency score* for firm P^1 is given by the ratio *0D/0C*. The *overall efficiency score* of for firm P^1 is given by the ratio $0D/0P^1$. The *technical efficiency score* for firm P^1 is given by the ratio $0C/0P^1$.

2.1 Allocative efficiency and outputs

It is possible to extend this framework to outputs. Firms typically have some choice over their mix and quantity of outputs. This is most apparent for, say, a supermarket that can choose the shelf space to allocate to different products. The efficient allocation rule will depend on the relative value of the individual products. The supermarket is allocatively efficient in its choice of outputs when it maximises the *value* of sales, not solely the volume of sales.

In competitive markets, firms produce the allocatively efficient mix of outputs through the process of profit maximisation. In markets such as utilities, where competition is absent and regulation stands in its stead, different approaches are needed to assess whether suppliers are providing the socially efficient mix of outputs.

2.2 The AER's approach to allocative efficiency

In November 2014, the AER set out three notions of efficiency that it considered relevant to its benchmarking. It defined *productive efficiency* as producing outputs at least cost, *allocative efficiency* in which resources are allocated to their highest value use, and *dynamic efficiency* as timely responsiveness to customer tastes and productive opportunities.[5] It then stated that:[6]

> We consider that the benchmarking techniques in this report primarily assist us in forming a view on the productive efficiency of distributors. However measuring productive efficiency will assist us in assessing whether distributors are allocatively and dynamically efficient. Measuring productive efficiency will assist us in determining the efficient prices/revenues for services promoting allocative efficiency. Measuring productive efficiency over time provides an insight into the dynamic efficiency of distributors.

Synergies accepts that efficient pricing may will promote allocative efficiency in both inputs and outputs, but doubts whether this will be realised when one of the most important outputs of each DNSP, namely its supply reliability, is unpriced. Further,

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5 In practice, the AER's benchmarking-derived measures of efficiency are quantity based rather than cost based and are confided to operating costs so it is not possible to conclude from the efficiency scores alone whether each DNSP is minimising total costs. Synergies uses the term 'productive efficiency' to refer to minimising input quantities.

6 AER November 2014 *Annual distribution benchmarking report* 10.

Synergies does not find the definitions of the different notions of efficiency particularly useful given the benchmarking that the AER has undertaken.

The benchmarking that the AER undertook was essentially a measure of technical efficiency (i.e. the extent to which a firm uses greater quantities of inputs to produce a unit of output than its peers).

2.2.1 Inputs

The AER used benchmarking to assess efficient operating costs. In the stochastic frontier analysis ('SFA') estimates of efficiency, the AER '*used network services opex deflated by a price index comprising labour and materials and services price indexes to proxy the quantity of opex inputs*'[7] using purchasing parity exchange rates as a means of placing three different jurisdictions onto a common base in the econometric measures. One cannot say from this whether a particular firm would lower its overall costs by increasing the quantities of capital that it employs and decreasing the quantity of labour without knowing:

- the degree to which the inputs can, indeed, substitute for each other; and
- the relative prices of different the inputs.

In respect of substitution possibilities between operating costs and capital cost (broadly, labour and capital), the Cobb Douglas production function used in the SFA assumes a constant elasticity of substitution. Synergies has considerable doubts as to whether this assumption is robust even in a greenfield setting (i.e. in the hypothetical world in which a new DNSP is set up and has complete choice over its mix of capital and labour and responds solely to relative input prices); as such there are reasonable grounds for believing that substitution possibilities are very limited for some types of DNSP activities. Synergies is more doubtful still in the real world where operating costs are contingent on capital expenditure decisions that may have been made two or three decades previously and cannot now be changed; these may (by dint of the legacy capital decisions) even restrict forward looking substitution possibilities.[8]

Accordingly, while Synergies understands the formulation of the SFA modelling undertaken by the AER, it is not likely to deliver robust estimates of efficiency unless both capital and operating costs are included as inputs in the production function, and the relative prices of each are considered (i.e. allocative efficiency).

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7 Economic Insights, 17 November 2014 *Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSP* 12.

8 For example, Ergon's past adoption of 132kV for large parts of its network places some restrictions on the network assets (and associated operating costs), including maintenance capital, that it can choose in the future.

2.2.2 Outputs

The AER identifies that allocative efficiency requires that firms dedicate resources where they achieve most value. In this regard it is notable that the AER has characterised DNSPs as producing multiple outputs (energy, connected customers, ratchetted peak demand, network length and reliability of supply).[9]

In Synergies view, one can reasonably represent the production function of a DNSP with four outputs: connected customers, peak demand, network length and reliability of supply. A three output representation comprising connected customers, network length and reliability of supply is workable since there is typically a high degree of correlation between customer numbers and peak demand. Synergies does not consider that it is reasonable to omit supply reliability as either an output or as an output qualifier in any measure of efficiency.

DNSPs do not set a price for supply reliability and are unlikely to do so, so the AER's contention that it can determine efficient prices/revenues for services [so] promoting allocative efficiency appears inapt. Allocative efficiency demands that DNSPs direct more resources to those services that customers value most, and fewest to those that customers value least.[10] If supply reliability is highly valued, efficiency demands that resources (operating costs and capital) are directed to it. If the benchmarking does not include supply reliability, a DNSP that dedicates additional resources to supply reliability will appear inefficient relative to a DNSP that dedicates a lower level of resources but delivers an inefficiently low level of supply reliability.

2.3 The basic DEA model

To examine these output allocative efficiency questions, Synergies adopted a DEA model comprising two inputs, operating costs and capital,[11] and three outputs, customer numbers, circuit km and total minutes of supply interruptions. Because of the inclusion of supply reliability in the analysis, the database was confined to NZ and Australian DNSPs. To remain consistent with the AER's SFA analysis, DNSPs with fewer than 20,000 customers were excluded. This model was used because it is the best representation of the DNSP's production technology that can be accommodated within the degrees of freedom limitations of the underlying data. The overall efficiency scores from this model are set out in Figure 2.

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9 The formulation used in its MTFP analysis of Australian only DNSPs.

10 It should be noted that, in this regard, the relative costs share associated with producing these outputs (which Economic Insights estimated using a Leontief Production Function in its MTFP analysis) does not necessarily represent the value that the consumer puts on each.

11 Operating costs were the same as those adopted by the AER. Capital was the total value of capital stock.

Supply reliability in this analysis is represented as an output in terms of SAIDI minutes of unplanned interruption. This is a negative output in the sense that an increase in its value indicates a reduction rather than an increase in output. It was converted to a positive output by subtracting the value for each DNSP from the largest observed value in the sample.

Figure 2. Overall technical efficiency scores from the 3 output, 2 input model

	Overall technical efficiency
ActewAGL	50%
Ausgrid	46%
Citipower	89%
Endeavour	57%
Energex	60%
Ergon	59%
Essential	76%
Jemena	90%
Powercor	95%
SA Power Networks	84%
Ausnet Services	76%
TasNetworks	63%
United Energy	93%

It should be noted that this model does not reflect the SFA model that the AER used to assess operating cost efficiency in that it included capital as an input and supply reliability as an output. Synergies believes that this representation of the DNSP production function is superior to that adopted by the AER.[12] Notwithstanding this, attachment A below presents the results of DEA modelling using only operating costs as an input, which suggests that Ergon is more efficient that the AER figures indicate.

Under this 3 output, 2 input model Ergon's overall technical efficiency (which include scale effects) is 59% ranging on a year by year basis between 51% and 64%. Ergon's controllable efficiency is 62% ranging on a year by year basis between 52% and 74%.

[12] It should also be noted that DEA estimates the degree of slack for each input. In other words, it estimates the extent to which a DNSP would have to reduce each of the inputs to meet the frontier. Hence, it is possible to determine the extent to which operating costs exceed efficient operating cost even when multiple inputs are included in the model.

3 Mix of outputs

DNSPs have somewhat limited output substitution possibilities. DNSPs have an obligation to supply so they cannot choose to substitute between the number of customers that they serve, the peak demand that they choose to meet and the circuit km they choose to construct. These are largely governed by the nature and disposition of their customers.[13] However, they do have some choice over their level of supply reliability. They can decide to increase supply reliability (i.e. reduce the duration and frequency of interruptions[14]) albeit at the expense of increased resources.

The socially efficient level of an output such as supply reliability will arise in competitive markets. The quantity supplied will be determined when the marginal cost of increasing supply reliability is equal to the marginal benefit from so doing. Marginal benefit, in this case, is the willingness of customers to pay for the increase in reliability. The price of supply reliability will be equal to its marginal cost. DNSPs are natural monopolies and do not set a price for supply reliability. It is therefore not possible to determine whether the level of supply reliability provided by the DNSPs is socially efficient solely having regard to its marginal costs and prices.

Notwithstanding this, the customer consultation/survey conducted by Colmar Brunton indicated that customers would prefer, all other things being equal, lower prices rather than higher prices. This was tempered by a desire not to see any deterioration in supply reliability or service quality more generally, and for rapid service restoration after natural disasters. This reinforces the high value that customers place on supply reliability. Hence, in Synergies view it is not possible to form conclusions as to the efficient level of operating costs (indeed, both operating cost *and* capital) without recognising supply reliability.

The SFA modelling upon which the AER relied to assess efficient operating costs included DNSPs from Ontario for which no supply reliability data was available. Accordingly, the model was incapable of resolving two important determinants of efficiency, namely whether:

- the degree to which apparent differences in operating cost efficiency were a reflection of differences between the DNSPs in supply reliability; and/or
- the degree to which apparent differences in operating cost efficiency were a reflection of differences between DNSPs in the operating costs of securing a given level of supply reliability.

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13 DNSPs can in principle have some influence on peak demand and, albeit much less directly, location through pricing but in practice the drivers of these DNSP outputs are better considered as exogenous.

14 Measured through SAIDI.

3.1 Models including supply reliability

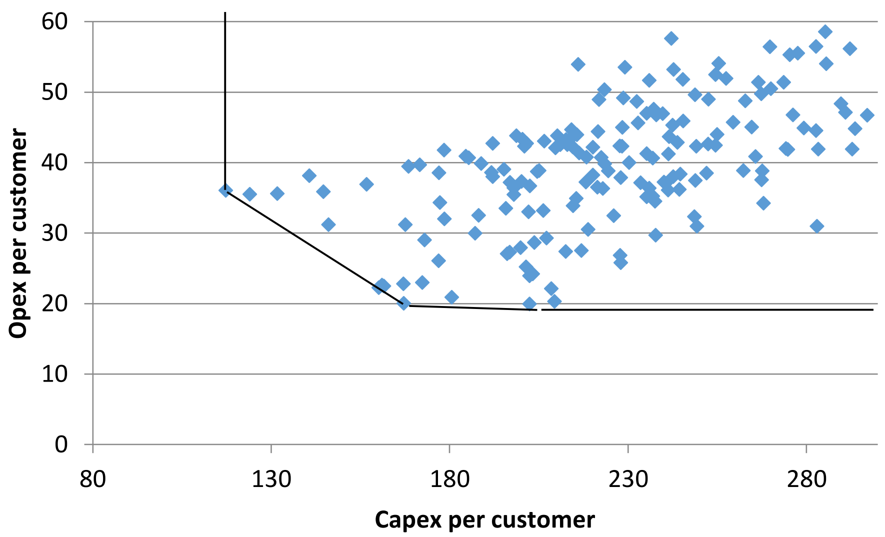
The AER's database included DNSP data from Australia, New Zealand and Canada. The Canadian data did not include any SAIDI data on minutes of operation per customer. Nor did it include any data on the value of the capital stock of the DNSP. As a result, it was not possible to develop models that included SAIDI as an output and both capital and operating costs as inputs in order to give a more rounded view of efficiency.

The New Zealand and Australian data included both, but the number of observations was insufficient to replicate the SFA and other econometric modelling undertaken by the AER. Synergies therefore used data envelopment analysis ('DEA')[15] to model Ergon's efficiency using a range of specifications, each of which included supply reliability as an output. To reflect the analysis undertaken by the AER, the database was truncated to remove DNSPs with fewer than 20,000 customers. This resulted in 248 observations in total comprising 31 DNSPs over 8 years for each.

3.1.1 Examples of frontiers

DEA constructs a piecewise linear frontier as illustrated (for a single output for operating costs and capital) in Figure 3. The DEA models used in this analysis comprised three and four outputs and one or two inputs, so Figure 3 is merely an illustration in one output dimension.

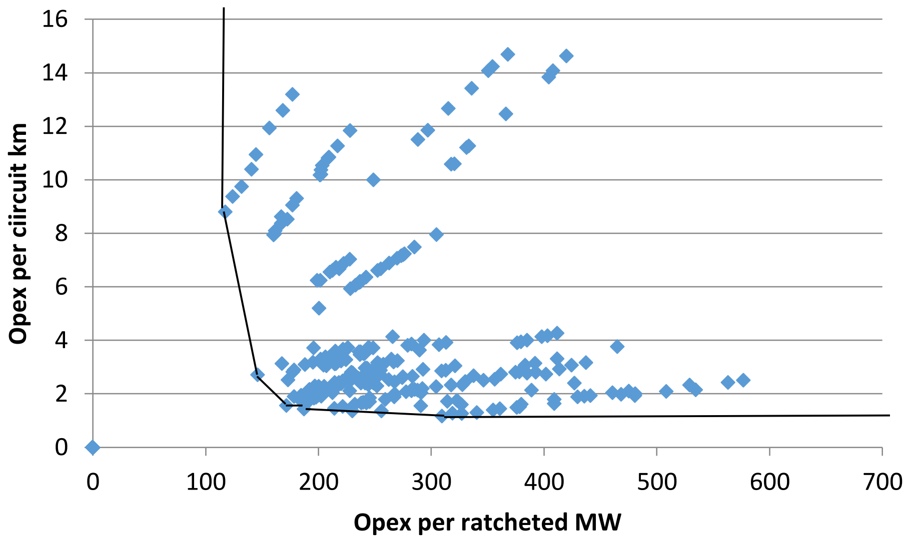
Figure 3. Frontier showing capex/opex substitution for number of customers



[15] Synergies is aware of the advantages and disadvantages of DEA which have been explored in detail by Synergies, Economic Insights and others. Synergies adopted DEA because it easily allows for the decomposition of scale, technical and allocative efficiency and because it does not make any prior assumptions about the production function.

Figure 3 is an example of a frontier in input space. Frontiers can also be shown in output space. Figure 4 shows the relationship between operating costs per circuit km and operating costs per ratchetted MW across the overall sample. As one would expect, the frontier indicates little or no substitution.

Figure 4. Frontier showing MW/circuit km substitution for operating costs



3.2 Estimating the impact of relative prices

It is not possible to determine from the survey results the valuation that customers place on ensuring that there is no deterioration in reliability of supply. One can only conclude that it is a more important consideration than price decreases below 6.5%. However, it is possible to assess the impact that increasing or decreasing the relative price of supply reliability has on DNSP efficiency.

3.2.1 Impact of adjusting weights

It is difficult to assess precisely the output weight that should be applied to outputs since it is not possible to robustly determine the value that customers place on each. What is clear is that the value of unserved energy is high. The AEMC has made assessment of the Value of Customer Reliability (VCR) at the state level of between $40/kWh and $60/kWh, although others have estimated values considerably in excess of these figures. These figures are considerably higher (of order 50-200 fold) than the typical cost of energy that is normally supplied. Accordingly, Synergies assumed value weights of 1 (i.e. simple productive efficiency), 50 and 100.

If the appropriate relative output weight (value) of supply reliability relative to the other outputs is 50, then Ergon's implied overall efficiency (in the sense of maximising the value of its outputs rather than their quantities) given its current inputs, customer numbers and circuit length is 64%, 5% above its technical efficiency score. This would imply an output allocative efficiency score given its current outputs of 92%. If the appropriate relative output weight (value) of supply reliability is 100, then Ergon's implied overall efficiency given its current inputs, customer numbers and circuit length is 93%, 34% above its productive efficiency score. This would imply an output allocative efficiency score given its current outputs of 63%.

3.2.2 Conclusions

This suggests that Ergon may well be operating efficiently in an environment that places a very high value on supply reliability and rapid restoration of supply after failure (e.g. after a natural disaster). The customer survey (supported by estimates of VCR) gives some support to this. What may appear to be inefficient operating costs could well be efficient, in so far as they enable Ergon to maintain high levels of supply reliability.

3.3 Other factors referenced in the survey

A number of other aspects of Ergon's operations were considered to be important by customers. Notable amongst these was the value that they placed on maintaining local depots, particularly in regional areas. The number and location of maintenance depots is not typically considered to be an output expected from a DNSP. Nor would Synergies advocate that it is treated as such.

However, if customers value the local presence because it is associated high service standards and rapid restoration of supply in the event of a supply interruption, a quite likely proposition, then it is appropriate to take it into account in a quantitative assessment of efficiency.

4 Mix of inputs

A DNSP is allocatively efficient when it uses the least cost mix of inputs for a given set of outputs. The efficiency benchmarks that the AER has used to date have not examined allocative efficiency but have focused on productive efficiency, namely whether DNSPs are using the minimum quantity of operating costs (expressed in quantity terms, effectively labour equivalents) for a given set of outputs.

For the reasons set out above in section 2 above, the cost minimising mix of inputs can differ from the productively efficient mix if relative prices of inputs differ. In practice, differences in relative prices can arise because:

- firms that are included in the benchmark sample face different relative costs of inputs in their locations; and/or
- firms face changing relative costs over time, but are unable to respond effectively to those changes by adjusting their use of inputs in the short or even the medium term.

In respect of the former, two firms facing different relative costs may well be cost efficient in their own markets but may exhibit different productive efficiency. The latter is a well understood issue that faces firms that make large, long-lived and sunk capital investments at a point in time (determined by the relative costs of capital and labour at the time of the investment). These assets then dictate the production function of the firm for the duration of their existence. The level of necessary operating costs is determined, in large part, by past capital investment decisions.

For DNSPs, the level of capital and labour are to some extent complementary; DNSPs need a certain quantum of operating costs in order to operate a particular capital base. DNSPs would face very large adjustment costs if they sought to modify their capital stock in response to a change in the relative costs of labour and capital. These adjustment costs mean that capital stock changes only slowly in response to changes in relative input costs. This issue has been formalised in the 'putty clay' models widely applied to investment in energy markets.[16]

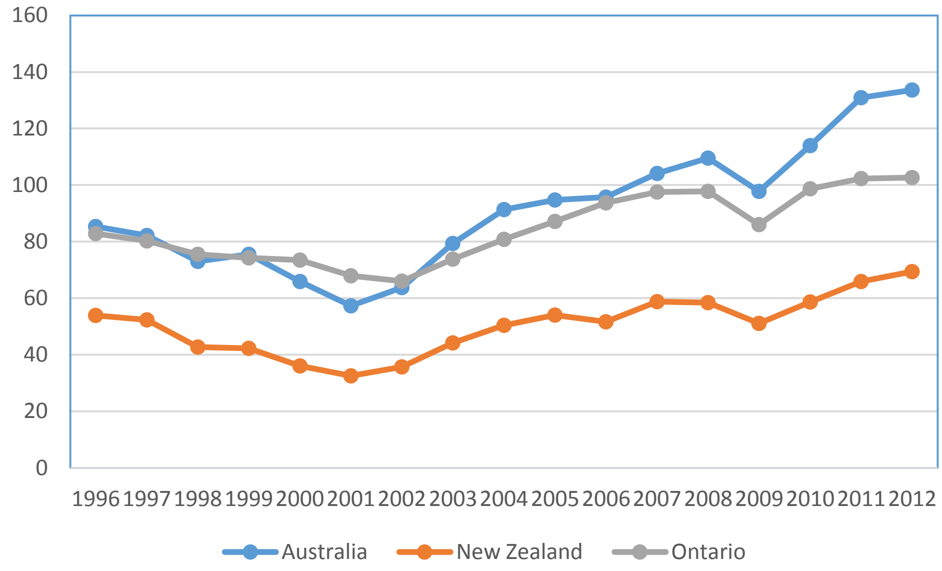
In a productive efficiency paradigm this putty clay market characteristic implies that a DNSP that made efficient investment decisions at a time of relatively high capital costs and relatively low labour costs will appear productively inefficient when compared with a DNSP that made efficient investment decisions at a time of relatively low capital costs and relatively high labour costs.

16 See, for example, Pindyck R D, Rotenmberg J (1983) 'Dynamic Factor Demands and the Effects of Energy Price Shocks' *American Economic Journal* 73(5) 1066-79.

4.1 Differences in relative costs

There are some important differences in relative costs across jurisdictions and across time that are relevant to efficiency measurement. Figure 5 shows relative labour costs across the three jurisdictions in the AER's database. It shows a considerable difference in hourly wage rates likely to be relevant to the capital versus operating cost decisions of DNSPs. It would tend to suggest, all other things being equal, that Australia and Ontario would adopt more capital intensive less labour intensive production technologies than New Zealand.

Figure 5. Relative labour costs (hourly compensation costs, relative to US$)



Source: US Bureau of Labour Statistics

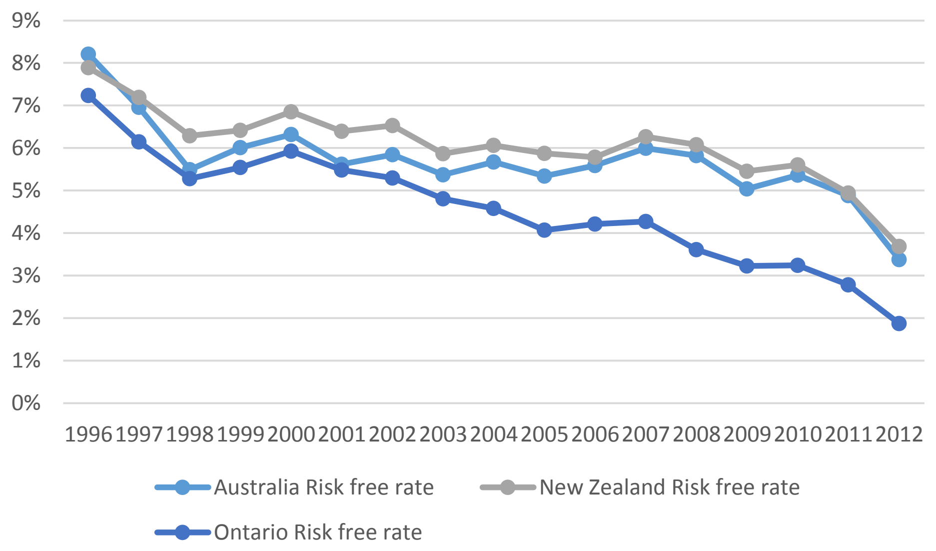
It also shows rising labour costs over time, which would indicate that DNSPs making efficient investments in 2000 (when labour costs are low) would adopt labour intensive technologies. That technology would appear productively inefficient when compared with investments made in 2011/12.

Figure 6 shows risk free rates of return in the three jurisdictions examined by the AER. Risk free rates, represented by government bond rates, is one of the main determinants of the allowed return on capital for regulated DNSPs. The figure shows sustained and significant reductions in cost of capital over the period 2000 to 2012, particularly in Ontario. This would suggest that:

- a DNSP investing in 2000 would adopt a low capital, high labour production technology in order to minimise costs; and
- a DNSP investing in 2012 would adopt a high capital, low labour production technology in order to minimise costs.

Under a productive efficiency benchmarking paradigm that focuses solely on operating costs expressed in quantity terms, the approach adopted by the AER, a DNSP that makes the balance of its investment close in time to 2012 would appear to be more efficient that a DNSP that makes the balance of its investment close in time to 2000.

Figure 6. Risk free rates across Australia, New Zealand and Ontario



Sources: RBA, RBNZ, Statcan.

4.2 Estimating the impact of relative prices

It is clear from the foregoing that the cost of capital and labour (the predominant component of operating cost) incurred by DNSPs in different across jurisdictions and across time. The relative cost of operating costs is directly related to wage rates. The relative cost of capital is related to the user cost of capital, which is a function of economic depreciation and risk free rates of return embodied in WACC.

Synergies examined the impact of changing the relative weight of capital to 80% of current levels and the relative weight of labour to 120% of current levels (i.e. higher labour costs and lower capital costs). Under this scenario Ergon would exhibit an allocative efficiency score of 95%. Under the converse change in relative weights, if labour costs were 80% of current levels and capital costs were 120% of current levels, then Ergon would currently exhibit an allocative efficiency score of 84%.

4.2.1 Implications

For business that exhibit 'putty clay' type characteristics because of very large costs of changing existing capital in the face of changing relative prices, decisions over investment costs and operating costs in the past, which at the time were allocatively efficient (i.e. least cost), may appear inefficient when relative prices change.

These sensitivities indicate that investments made by Ergon, and presumably others, particularly in the period 2000 to 2006, when labour costs were relatively lower than today and capital costs relatively higher, would translate into an apparent inefficiency of perhaps 15% when compared to a greenfield network developed at current relative prices.

This suggests, at a minimum, that regulators responsible for assessing current operating cost efficiency should assess the degree to which current operating costs and apparent inefficiency are contingent upon past investment choices.

5 Conclusions

Ergon commissioned a customer consultation exercise that aimed to determine customers' views on Ergon's proposed expenditure areas in the light of the preliminary decision. The consultation demonstrated:

- support for the 6.5% reduction in Ergon's charges at broadly current levels of service;
- support for immediate savings that impacted Ergon rather than the customers themselves (particularly in respect of supply reliability);
- a preference for greater than 6.5% reductions in charges if they derived from reduced back office (and similar) costs, but not from other areas such as supply reliability;
- a quarter of respondents expressed concern that reduced prices might result in reduced supply and service reliability, with 10% expressing concerns over job losses and outsourcing.

These indicate that customers place a high value on supply reliability, and are willing to forego further decreases in charges (beyond those that they are offered) in order to forestall reduced reliability, quality or safety of the network, deterioration in general service levels and increases in supply outages.

Synergies examined the extent to which high values on supply reliability might affect Ergon's apparent efficiency using a 3 output, 2 input DEA model and adjusting the relative weights of outputs or inputs as appropriate. The results indicate is that Ergon's is not operating inefficiently in an environment where customer place a very high value on supply reliability. Rather, what appear to be inefficient operating costs may well be efficient in so far as they enable Ergon to maintain high levels of supply reliability.

Synergies also examined the allocative efficiency of inputs using the same basic model. The results suggest that investments made by Ergon, and presumably others, particularly in the period 2000 to 2006, when labour costs were relative lower than today and capital costs relatively higher, would translate into an apparent inefficiency of perhaps 15% when compared to a greenfield network developed at current relative prices.

Regulators responsible for assessing current operating cost efficiency should therefore assess the degree to which current operating costs and apparent inefficiency are contingent upon past investment choices.

A Further data envelopment analysis

The AER noted that DEA analysis prepared by Synergies and included with Ergon's proposal was not comparable with their own analysis of operating cost efficiency because the Synergies models included both operating costs and capital as inputs; the AER's model examined operating cost efficiency only. While Synergies considers that models that include both operating costs and capital provide more robust estimates of technical efficiency, Synergies accepts that the results were not directly comparable.

Figure 7 shows the technical efficiency scores from two different DEA models in which the only modelled input is operating costs. The 4 output model includes ratchetted peak MW, number of customers, circuit km and total minutes of unplanned interruption (SAIDI). In Synergies view, the inclusion of SAIDI as an output is critical for estimating operating cost efficiency, not least because DNSP can reduce supply interruptions (or, more properly, speed up restoration) by increasing the number of employees dedicated to that task.

Figure 7. DEA technical efficiency scores

	4 Output, 1 input model	3 Output, 1 input model
ActewAGL	36%	36%
Ausgrid	88%	84%
Citipower	90%	86%
Endeavour	93%	74%
Energex	98%	98%
Ergon	67%	62%
Essential	93%	93%
Jemena	61%	61%
Powercor	86%	86%
SA Power Networks	93%	91%
Ausnet Services	72%	72%
TasNetworks	62%	58%
United Energy	94%	94%

Because of the inclusion of SAIDI in the analysis, the database was confined to NZ and Australian DNSPs. To remain consistent with the AER's SFA analysis, DNSPs with fewer than 20,000 customers were excluded.

Due to its reliance on linear programming to construct a piecewise linear frontier around the most efficient firms, DEA results are typically sensitive to the complexity of the underlying representation of the production function and to changes in the data. Accordingly, Synergies estimated technical efficiency scores using a 3 output model (ratchetted peak MW omitted as an output) rather than the 4 output model. The results were modestly sensitive to this change, but the rank of the scores across the DNSPs was consistent.

A.1 Ergon's efficiency score

The foregoing analysis indicates that Ergon has a pure technical efficiency score of between 62% and 67%[17] Subject to the caveats previously expressed, Synergies believes that the average of these figure (64.5%) is a reasonable indication of Ergon's unadjusted operating cost pure technical efficiency (i.e. without having regard to environmental factors, data issues and other considerations).

These figures represent the results of the pure technical efficiency model under variable returns to scale. That is, they do not explicitly identify the contribution of scale efficiency. Under the constant returns to scale DEA model, Ergon's overall technical efficiency is approximately 8% lower at 56.5%. Ergon exhibits a scale efficiency score of 91% and shows decreasing returns to scale. Typically, scale inefficiency (of 9%) is considered to be uncontrollable by the DNSP. Accordingly, 64.5% represents the best estimate of Ergon's controllable operating cost efficiency.

These efficiency scores compare with the figure of 48.2% estimated by the AER. Synergies accepts that there are shortcoming in the DEA modelling qualitatively similar to the shortcomings that the AER has accepted in its own SFA modelling. By way of example, the models do not capture all of the factors that affect DNSP operating costs. Accordingly, Synergies would expect that similar adjustments would need to be made to these DEA scores as were made to the AER's SFA scores.

In effect, then, these DEA estimates which, importantly, take account of one of the main drivers of DNSP operating costs, supply reliability, that was omitted from the AER's operating cost efficiency measures, indicates that Ergon's operating cost efficiency is 16.3% higher than the AER estimated. The difference is material.

It follows that allowed revenues based on these more robust efficiency scores would deliver demonstrably superior long term outcomes for customers than allowed revenues based on the AER's estimates.

17 SAIDI was included in the model, which is volatile from one year to the next across most of the DNSPs. As a result, the annual efficiency scores for Ergon vary by plus or minus 10% from these figure. Similar variability in scores is observed across the other Australian DNSPs.