Inputs to be Used in the Economic Benchmarking of Electricity Network Service Providers

Briefing Notes prepared for
Australian Energy Regulator

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EXECUTIVE SUMMARY

The AER (2012) has indicated that economic benchmarking will be one of a suite of assessment techniques to be detailed in its forthcoming expenditure forecast assessment guidelines. The AER is consulting extensively with network service providers in developing its approach to economic benchmarking. This includes conducting a series of workshops to seek feedback on the appropriate outputs, inputs and operating environment variables to be used in economic benchmarking.

The AER has engaged Economic Insights to assist with this consultation process. These briefing notes provide background material for the third workshop on the appropriate inputs to be used for economic benchmarking of electricity network service providers (NSPs).

Inputs – issues for discussion

A number of important issues remain to be resolved with regard to the NSP inputs to be used in economic benchmarking studies. We would welcome input on the following issues discussed at further length in the paper:

1) Are the input selection criteria proposed in section 2.2 (of being comprehensive and non–overlapping, of capital input quantities accurately reflecting the quantity of annual capital service flow of assets, of capital user costs being consistent with the NSP's RAB and with ex ante FCM, and of consistency with the NEL and NER) appropriate? Are there other important criteria we should use in selecting NSP inputs?

Opex–related issues

1) Given that many NSPs outsource a significant proportion of their opex, is it feasible to disaggregate opex into labour, materials and services components?
2) How consistent is opex coverage both over time and across NSPs?
3) Is it feasible (or desirable) to strive for a common opex coverage across all NSPs even though this may not coincide with regulated coverage in all cases?
4) Is it necessary to adjust for different transmission/distribution boundaries and different system structures across NSPs? How might this be done?
5) More specific issues which will be discussed further in Phase 2 of the workstream but which are flagged here include:
   - Is there common treatment of expenditure on isolated asset refurbishment both over time and across DBs?
   - Are cost allocation practices comparable and consistent across multi–utilities?
6) What combination of price indexes would best capture the composition of NSP opex?
7) How should component price indexes be weighted to form an overall opex price index?
8) Do NSP opex input prices differ materially across Australian NSPs? If so, how?
9) How representative are high level ABS labour and producer price indexes of the opex prices actually faced by NSPs?

10) Do the water and gas industry and the generation and retail parts of the electricity industry unduly influence ABS Electricity, gas and water sector price indexes for them to be used as NSP opex price deflators?

Capital input–related issues

1) To what extent do the physical 'carrying capacities' of the main NSP assets of lines, cables and transformers reduce over time?

2) Which physical depreciation profile best approximates the physical 'carrying capacities' over the lifetime of the main NSP assets:

   - one hoss shay (no reduction throughout the asset's life)
   - hyperbolic (small decline in early years, larger decline in later years of the asset's life)
   - geometric (equal percentage decline over lifetime, ie bigger falls in early years and smaller falls in later years), or
   - straight–line (ie equal absolute reduction each year of the asset's life)?

3) Would using a physical depreciation profile other than one hoss shay overstate the decay in service potential for the NSP asset and, hence, overstate the NSP's efficiency?

4) Do high level sectoral capital goods price indexes (such as that for the overall Electricity, gas and water sector) accurately reflect the prices NSPs face for their assets?

5) How well do NSP initial capital bases used at the commencement of economic regulation represent the depreciated replacement cost of NSP assets at that time?

6) How consistently have NSP RAB values been calculated over time? Would they be suitable for use as a proxy to backcast capital service flows?

7) Can more confidence generally be placed in NSP asset register quantities or NSP RAB data in terms of accuracy and consistency?

8) Are the four suggested NSP asset groups (of overhead lines, underground cables, transformers, and other capital) the most appropriate for economic benchmarking purposes? What is the appropriate physical depreciation profile for assets in each category?

9) Is the other capital group sufficiently important to include as a separate item or should it be combined with one of the other groups? If so, which one?

10) Is the age distribution of Australian NSP assets better characterised as being 'bunched' (ie a large proportion of the network rolled out in a short period of time) or evenly–spread?

11) Would using a constant price RAB depreciation series be a suitable proxy for NSP capital services? What would be the advantages and disadvantages of using this proxy?

12) Should the user cost of capital used in economic benchmarking be consistent with the return of and return on capital components used in building blocks calculations? Are there any problems with using these measures for economic benchmarking purposes?

13) Would the endogenous user cost of capital (ie the simple residual of revenue less depreciation) be a good enough approximation to the exogenous or ex ante user of capital to use in economic benchmarking? If not, why not?

1 BACKGROUND

The Australian Energy Regulator (AER) has initiated a work stream on expenditure forecast assessment (EFA) guidelines for electricity distribution and transmission as part of its Better Regulation program (see AER 2012). This is in response to the Australian Energy Market Commission's recent rule changes for electricity network regulation (AEMC 2012). The rule changes clarify the AER's powers to undertake benchmarking and add a new requirement for the AER to publish annual benchmarking reports on electricity network service providers.

The AER has indicated that economic benchmarking will be one of a suite of assessment techniques to be detailed in the EFA guideline. The AER is consulting extensively with network service providers in developing its approach to economic benchmarking. This includes conducting a series of workshops to seek feedback on the appropriate outputs, inputs and operating environment variables to be used in economic benchmarking and their specification. The workshops will also cover the data necessary for economic benchmarking and how economic benchmarking would be used in assessing the expenditure proposals of network service providers (NSPs).

The AER has engaged Economic Insights to assist with this consultation process. These briefing notes provide background material for the third workshop on the appropriate inputs to be used for economic benchmarking of electricity NSPs. They also include a series of questions to help focus discussion at the workshop.

The following section discusses some general considerations in input measurement for economic benchmarking purposes and develops selection criteria for choosing appropriate inputs. The third section focuses on operating and maintenance expenditure (opex) inputs while the fourth section focuses on how capital inputs should be measured. Some background on the basics of economic benchmarking and why it is relevant to network regulation is presented in appendix A. Indicative input data requirements for distribution network service providers (DNSPs) and transmission network service providers (TNSPs) are presented in appendixes B and C, respectively.

2 GENERAL CONSIDERATIONS AND SELECTION CRITERIA

2.1 Durable versus non–durable inputs

Economic benchmarking examines the efficiency of NSPs in converting inputs into outputs (usually on an annual basis). Such analysis generally requires a quantity measure of each input consumed and its corresponding price (or, alternatively, the cost of its annual input). A summary of economic benchmarking methods and requirements is presented in appendix A.

Different types of inputs

It is important at the outset to recognise that key inputs have quite different characteristics that require different treatment in economic benchmarking studies. Some inputs are completely consumed within the time period measured. This makes their measurement relatively straightforward as the relevant quantity and cost of these inputs are the amount of those inputs purchased in that year. These inputs include labour, materials and services. But other inputs – generally referred to as capital inputs – are durable and may last several years or, in the case of NSPs, several decades. NSP capital inputs generally consist of lines, cables and transformers.

Measuring capital input quantities

Capital inputs (or the use of assets) always present one of the major measurement difficulties in economic benchmarking studies. Being durable inputs that are not fully consumed in one time period, their cost has to be allocated over their lifetime and changes in their service capacity allowed for as they (potentially) physically deteriorate over time. Consequently, it is necessary to form estimates of the quantity of capital inputs used in the production process each year – generally known as the flow of capital services. This has to be distinguished from estimates of the quantity of the total stock of capital (which will be capable of providing inputs to annual production over several years or several decades, depending on the assets and their age).

The quantity of input or capital service that is available each year from an asset will depend on the physical depreciation profile of the asset (ie the extent to which the asset's capacity reduces over time due to wear and tear and other forms of deterioration). Some assets have little, if any, physical deterioration over time and their flow of capital services remains relatively constant over their lifetime. These assets are said to have 'one hoss shay' (also known as 'light bulb') physical depreciation characteristics. Other assets deteriorate more over time and are able to provide progressively less capital service flow as they get older. These assets may have:

- geometric physical depreciation profiles (capital services fall sharply from when the asset is first used)
- straight–line physical depreciation profiles (capital services fall by the same amount each year over the asset's lifetime) or,

- hyperbolic depreciation profiles (capital services fall gradually for most of the asset's life but then fall sharply towards the end of the asset's lifetime).

It is important to note here the difference between physical depreciation and the rate of depreciation used in forming the regulated asset base (RAB). The physical depreciation profile reflects changes in the asset's ability to provide annual capital service flow (ie the quantity of annual input provided to the production process). The regulatory depreciation rate, on the other hand, simply allocates the original cost of the asset over its lifetime. Assets with one hoss shay physical depreciation characteristics (ie no or very little annual physical depreciation) will still have annual regulatory (and financial) depreciation as the original cost of the asset is spread over its lifetime. Looking at this another way, the financial value of the one hoss shay asset falls each year as it can supply its constant capital service flow for one less year going forward.

The capital service flow or quantity of annual input to production from an asset or group of assets cannot be directly observed. Consequently, it is necessary to use proxy measures of capital service flow. The capital service flow is usually assumed to be proportion to the capital stock (because the capital stock is observable whereas the service flow is not and because a directly proportional relationship appears reasonable).

Physical measures (eg MVA–kilometres of lines or kVA of transformers) are often used as a proxy for capital service flow from assets thought to have one hoss shay physical depreciation profiles. In principle the constant price undepreciated (or gross) capital asset value could also be used to proxy the service flow from an asset with one hoss shay physical characteristics (although it would likely be less accurate than using direct physical quantities), In practice the constant price depreciated (or net) asset value is sometimes used as a proxy for the capital service flow from an asset. But this generally involves the implicit assumption that the asset's physical depreciation profile is of a form other than one hoss shay (eg geometric).

Since relatively few input components can be incorporated in economic benchmarking studies, it will be necessary to aggregate up the capital service flow from many assets into a small number of aggregate capital service flows (or quantities of annual capital input). What proxy is best used to represent these aggregated capital services will depend on several considerations including:

- the likely physical depreciation profiles of the constituent assets
- the robustness of the data used in forming the proxy – the more accurate the data is and the fewer assumptions that have to be made in deriving the proxy, the better, and
- whether the depreciation profile of the aggregate will mirror that of its constituent components.

Measuring annual capital input costs

Just as the quantity of the annual capital service flow (ie the quantity of capital's contribution to annual production) has to be distinguished from the quantity of the capital stock available, then so does the cost of capital's annual input to production have to be distinguished from the total asset value. When an asset is purchased, it will provide input to the production process over an extended period. Consequently, its cost should be spread over that same period. But in addition to the initial cost of the asset, there is also an opportunity cost of holding the asset each year. This opportunity cost may be offset to some extent if the asset is subject to capital gains (its price increases over time).

The NSP's total asset value will change from year to year based on financial depreciation (which reduces the asset value in the next year) and capex (which increases the asset value in the next year).

The annual cost of holding assets is generally referred to as the user cost of capital. Simple applications of the user cost contain three components:

- depreciation (which spreads the initial cost of the asset over its lifetime)
- plus the opportunity cost (which reflects the return funds used to purchase the asset would have earned had they been invested elsewhere)
- minus capital gains (which reflects increases in the price of the asset).

In building blocks the equivalent concepts are the return of capital (depreciation less inflation allowance) and the return on capital (opportunity cost).

In addition, building blocks reviews implicitly incorporate another important principle, that of ex ante financial capital maintenance (FCM). This means that, at the start of a regulatory period, a regulated business's forecast annual cost of capital is calculated in such a way that its financial capital would be maintained in present value terms. The relevant measure of financial capital is based on the NSP's RAB and the calculation is done using the regulatory weighted average cost of capital (WACC) as the discount rate. This provides the NSP with an incentive to achieve efficiency improvements and thereby improve its returns.

Since the building blocks method involves setting the price cap for each NSP at the start of the regulatory period, forecasts have to be made of the annual revenue requirement stream over the coming regulatory period and of the quantities of outputs that will be sold over that period. Since the opening RAB for the regulatory period will be (largely) known, the annual revenue requirements for the upcoming regulatory period can be forecast based on forecasts of opex, capex and depreciation based on assumed asset lives. Once the forecasts of annual revenue requirements and output quantities have been made, the P_0 and X factors are set so that the net present value of the forecast operating revenue stream over the upcoming regulatory period is equated with the net present value of the forecast annual revenue requirement stream. Whether financial capital is in fact maintained in practice will, of course, depend on actual outcomes during the regulatory period, including the NSP's efficiency performance.

For economic benchmarking to be used as part of building blocks reviews, it will be important to use annual user costs of capital in economic benchmarking that approximate the way capital costs are calculated in the building blocks review. That is, exogenous user costs based on the WACC should be used which are consistent with ex ante FCM. But there are potentially an infinite number of annual user cost profiles that will satisfy FCM and these could lead to quite different measured efficiency outcomes. Similarly, simply using the WACC in an exogenous user cost formula will not necessarily ensure FCM (depending on the formula). To reconcile the various components and ensure internal consistency between economic benchmarking results and the building blocks process, the annual user cost in economic benchmarking should be calculated in approximately the same way as the corresponding building blocks components. Its dollar value should then approximate the sum of the corresponding building blocks return of and return on capital components.

The construction of exogenous user costs consistent with building blocks methods is illustrated in the Economic Insights (2010) model for the AEMC which uses a simplified version of the AER's (2008) post–tax revenue model. Economic Insights (2012a, section 5.6) contains an application of this method to Victorian gas distribution businesses.

Using capex is not appropriate

The discussion above highlights the importance of using measures of the capital services flow as the quantity of capital and the annual user cost of capital as the associated annual input cost of capital in economic benchmarking studies. This allows the appropriate measure of inputs to be formed when comparing outputs produced to inputs used in deriving efficiency results. It is, hence, not appropriate to use capex as an input in its own right in economic benchmarking studies. Capex represents the purchase of new capital assets rather than having direct relevance to the annual use of capital inputs. Capex makes an indirect contribution to the appropriate capital measures by being part of the change in asset value from year to year (along with depreciation) and the new assets will make an additional (usually small) contribution to the overall capital services flow.

While regulators make use of various ratio indicators in assessing the reasonableness of forecast capex (and, in some cases, 'totex' which is the sum of opex and capex), it will not be appropriate to use either capex or totex as inputs in economic benchmarking studies. This is because, except under rare circumstances, these measures will approximate neither the service flow from capital inputs (both old and new) nor the annual user cost of capital which are the concepts relevant in measuring economic efficiency.

Capital construction activities are excluded

The focus of economic benchmarking will be on the efficiency of operating and maintaining the network (AER 2012, pp.64–5). This means that the use of the NSP's own resources associated with the construction of new assets should be excluded from the input coverage. There is a risk otherwise that the cost of new assets will be counted twice – once through the NSP's expenditure on labour, materials and services used in constructing new assets and again when the asset enters the NSP's RAB. In practice, the construction of completely new lines will commonly be contracted out. There are, however, a number of grey areas such as the treatment of pole replacement which could be consider opex or, alternatively, be capitalised into the RAB. These issues will be addressed further in Phase 2 of the workstream.

The focus on operating and maintaining the network is again consistent with the building blocks regime where included labour, materials and services costs are only those used as part of operating and maintaining the network (ie opex). Labour, materials and services used in constructing new assets is excluded from opex. Rather, the cost of constructing new assets enters the allowed cost base as part of the RAB. It will, of course, be desirable that capitalisation policies (ie what is considered construction of a new asset versus what is considered repairs and, hence, part of opex) be as comparable as possible across NSPs.

2.2 Criteria for selecting NSP inputs

AER (2012, p.62) proposed that two broad criteria be included for selecting the input measures to be used in economic benchmarking studies. These were that the input choice be consistent with the National Electricity Law (NEL) and National Electricity Rules (NER) and that it be reflective of the production function. The latter requirement was characterised as ensuring all inputs used by NSPs are included and that inputs should be 'mutually exclusive and collectively exhaustive'. In other words, there should be no double counting across inputs and no omission of inputs. It was noted that where costs are shared across NSP and other business activities, the share of those costs allocated to the NSP activity should reflect its contribution to the production of NSP outputs.

In light of the discussion in section 2.1, Economic Insights believes there is merit in expanding the selection criteria for the choice of inputs to be used in economic benchmarking to the following:

1) input coverage is comprehensive and non–overlapping
2) measures of capital input quantities are to accurately reflect the quantity of annual capital service flow of assets employed by the NSP
3) capital user costs are to be based on the service provider's regulatory asset base (RAB) and should approximate the sum of the return of and return on capital components used in building blocks, and
4) be consistent with the NEL and NER.

The first selection criterion restates the AER's selection criterion of being reflective of the NSP production function. That is, the choice of inputs should capture all the key inputs used by the NSP in producing its output while ensuring no inputs (such as own construction of capital inputs) are double–counted. It also requires that where costs are shared between NSP and other business activities, costs allocated to the NSP activity should accurately reflect the contribution to production of NSP outputs.

The second selection criterion requires the capital input quantity used in economic benchmarking to accurately reflect the quantity of annual capital service flow of the assets employed by NSPs (that is, the depreciation profile used in forming the capital input quantity needs to be consistent with physical network asset depreciation characteristics). Energy network assets are generally characterised by relatively little decline in their service capacity over their lifetime (provided they are properly maintained). Overestimating the rate of decay in annual capital input service potential would bias efficiency comparison results.

The third selection criterion requires the annual user cost of capital measure used in economic benchmarking to approximate the return of and return on the RAB components used in building blocks regulation calculations. The annual user cost of capital can be calculated in many different ways which can produce a wide range of annual user cost profiles over the asset's life while still satisfying underlying desirable properties such as using the WACC and being consistent with ex ante financial capital maintenance. Since we are dealing with assets that generally last several decades, such differences in the profile of annual user costs can lead to material differences in measured efficiency over short periods. This arises because the annual user cost of capital is the weight given to capital inputs relative to opex inputs in economic efficiency calculations. To ensure consistency between economic benchmarking results and building blocks calculations it is desirable for the economic benchmarking analysis to use capital costs calculated in approximately the same way as the corresponding building blocks components. Their dollar value should then approximate the sum of the corresponding building blocks return of and return on capital components.

The fourth selection criterion recognises that the NEL and NER provide a framework for reviewing NSP expenditure. Within this framework the AER must accept regulatory proposals where they reflect the efficient costs of delivering outputs. The input variables for economic benchmarking should therefore enable the AER to measure and assess the relative productive efficiency of NSPs in the National Electricity Market (NEM).

2.3 Issues for discussion

This section has summarised some of the general considerations in specifying the inputs to be used in the AER's economic benchmarking. The focus has been on the implications for input choice and measurement of the differences between durable and non–durable inputs and appropriate selection criteria for choosing inputs to include. We would welcome input on the following issue:

1) Are the input selection criteria proposed in section 2.2 (of being comprehensive and non–overlapping, of capital input quantities accurately reflecting the quantity of annual capital service flow of assets, of capital user costs being consistent with the NSP's RAB and with ex ante FCM, and of consistency with the NEL and NER) appropriate? Are there other important criteria we should use in selecting NSP inputs?

Specific issues relating to non–durable (opex) and durable (capital) inputs will be raised at the end of the following two sections.

3 OPEX INPUTS

Most network economic benchmarking studies have included two broad input categories: opex and capital. Some North American studies have separated opex into separate labour, materials and services components. However, with the increase in contracting out, separate measures of labour input have become increasingly difficult to obtain and potentially unrepresentative. Most Australian network economic benchmarking studies have consequently included just one aggregate opex input component.

Opex satisfies the selection criteria set out in section 2.2 for inclusion as an input component in economic benchmarking studies. Opex covers an important part of NSP inputs and needs to be included for input coverage to be comprehensive. Actions required to ensure opex is not overlapping and is comparable both over time and across NSPs will be discussed below. Opex also plays a significant role in the NER where it is identified as a key input component.

Since opex covers a diverse range of inputs that are consumed in the production process each year, it is generally not practical to measure the quantity of opex by aggregating up the quantities of each individual component of opex input. Instead, the quantity of opex input is generally measured indirectly by deflating the value of opex inputs by a representative input price index. The price index used for deflation will typically be a weighted average of labour and materials and services input price indexes where the weights reflect high level information available on the approximate composition of opex.

The main issues involved in measuring opex inputs include:

- the coverage of opex activities
- the extent of capitalisation of asset refurbishment
- the appropriate allocation of corporate overheads in ‘multi–utilities’
- the treatment of related party margins, and
- choosing the appropriate opex price index to use.

3.1 Opex inputs coverage

Opex includes all costs of operating and maintaining the network, including inspection, maintenance and repair, vegetation management and emergency response. Depreciation and all capital costs (including those associated with capital construction) should be excluded.

Common coverage of opex activities is highly desirable both over time for each NSP and also across NSPs. It is also important that opex included in economic benchmarking studies reflect only input usage in the relevant year. This may necessitate the removal of accounting–related adjustments from opex reported in regulatory accounts and some degree of adjustment to reflect common coverage over time. For example, Economic Insights (2012a, p.20) noted the following adjustments to Victorian gas distribution business (GDB) data to ensure a greater level of consistency in coverage and to ensure like–with–like comparisons over time:

> ‘the opex values supplied by the GDBs were consistent with the GDBs’ Regulatory Accounts but the focus has been on ensuring data reflects actual year–

> to–year operations. A number of accounting adjustments such as allowance for provisions have been excluded as they do not reflect the actual inputs used by the businesses in a particular year which is what we need for TFP purposes. To ensure consistency in functional coverage throughout the period, for those years prior to the introduction of FRC [Full Retail Contestability] each GDB's opex is increased by the amount of expenses incurred in the early years of FRC. In these early years FRC was expected to have only affected opex (and not capital) requirements.'

There should ideally be uniform treatment of asset refurbishment in cost reporting over time and also across NSPs where possible. That is, items such as isolated cases of pole replacement or sleeving of poles should be consistently capitalised (or not as the case may be). Changes in reporting practices over time can give the appearance of improving or worsening opex efficiency when no change in actual efficiency may have in fact occurred. These issues will be covered further in Phase 2 of the current project.

Similarly, consistent and rigorous allocation of corporate overheads over time is important. Changes in corporate overhead allocation policies across businesses in a 'multi–utility' may otherwise give the false appearance of opex efficiency improvements or deteriorations for NSP operations. Most cost allocation methodologies leave a relatively wide band of justifiable overhead cost allocations across constituent businesses. The important requirement for robust and reliable economic benchmarking results is that the allocation method used remains as consistent as possible over time for each NSP and preferably is as similar as possible across NSPs.

Opex requirements will also depend on the operational boundaries and system structure an NSP faces. For example, DNSPs with wider distribution functional boundaries taking their power at higher voltages and then having multiple stages of transformation will require higher opex use than DNSPs with narrower functional boundaries and/or simpler systems taking their power at lower voltages and then only requiring one stage of transformation. The best way of addressing these issues will be discussed further in Phase 2 of the project.

3.2 Opex inputs price index

Opex input price index issues will be discussed in detail in Phase 2 of the project. Some of the primary issues are flagged in this section.

The majority of opex costs comprise labour costs (both direct and contracted). Remaining opex costs cover a wide range of materials and services spanning operational consumables, office activities and contracted and in–house professional services. In deriving the implicit quantity of opex inputs we need a price index to deflate annual opex cost. This price index is a weighted average of the key opex components' prices. Ideally this weighted average price index would reflect as closely as possible the prices faced by each NSP. However, this information is not readily available and so most economic benchmarking studies have instead used high level input price indexes compiled by national statistical agencies. These indexes have the advantage of being prepared independently of the NSP but, being high level indexes formed from a usually small sample of industry transactions, may not accurately reflect the input prices actually faced by the NSP. As a result, scope for error is introduced relative to the alternative approach where direct information on quantities purchased by the NSP is available. As noted above, the diverse composition of opex and the high prevalence of contracting out of opex activities generally preclude the direct quantity approach whereas it is readily implementable for NSP capital inputs.

PEG (2004) developed an opex price deflator for electricity DNSPs made up of a 62 per cent weighting on the Australian Bureau of Statistics' (ABS) Electricity, gas and water sector Labour cost index (currently called the Labour price index) with the balance of the weight being spread across five Producer price indexes (PPIs) covering business, computing, secretarial, legal and accounting, and advertising services. If labour price indexes are only available at a much broader sectoral level that not only takes in the electricity supply chain as a whole but also the water and gas industries, then there is increased scope for error using the deflation method to indirectly obtain NSP opex input quantities. This could be more of a problem for the PPIs used to deflate the materials and services component of opex as available PPIs relate to the economy as a whole rather than NSPs.

Another issue that has to be decided in forming an opex price index is the appropriate measure of labour prices to use. The two most commonly used measures are average weekly ordinary time earnings (AWOTE) and the labour price index (LPI). AWOTE shows average employee earnings from working the standard number of hours per week and includes agreed base rates of pay, over–award payments, penalty rates and other allowances, commissions and retainers, bonuses and incentive payments (including profit share schemes), leave pay and salary payments made to directors. It excludes overtime payments, termination payments and other payments not related to the reference period. It will reflect changes in earnings due to change in the composition of the workforce over time.

The LPI, on the other hand, is a measure of changes in wage and salary costs based on a weighted average of a surveyed basket of jobs. It excludes bonuses and also excludes the impact of changes in the quality or quantity of work performed and compositional effects such as shifts between sectors and within firms.

Another issue commonly encountered, particularly with regard to PPIs, is changes in index coverage and, in some instances, termination of price indexes being published by the ABS. This can usually be solved by 'splicing' the nearest new price index onto the previously used series as done in Economic Insights (2012a) in response to changes to the ABS PPIs following the major industrial reclassification undertaken by the ABS in 2007.

3.3 Data requirements

Appendix F of the AEMC (2011) final report for the review into the use of TFP in prices and revenues determinations contains a list of variables considered necessary to support calculation of TFP. The list is based on the Economic Insights (2009a) data report and was designed to cover the principal NSP productivity study specifications previously used in Australia. While the DNSP lists were compiled in the context of a review of the potential use of productivity–based regulation, they are effectively the same as those required to support the use of economic benchmarking techniques to assess NSP efficiency in assessing building blocks expenditure forecasts (and in annual benchmarking reports). We therefore suggest that these lists are a useful starting point for consultation on the collection of data to support economic benchmarking.

The variables from the AEMC (2011) lists required to support calculation of the variables discussed in section 3.2 for DNSPs and TNSPs are presented in appendixes B and C, respectively, to these briefing notes.

The lists contain a disaggregation of opex into network operating costs and several categories of network maintenance costs. While sub–components of opex could be included in economic benchmarking studies as separate inputs, common practice has been to only include aggregate opex. However, having (consistently reported) disaggregated opex data available provides a useful means for checking the consistency and comparability of included data and of helping to identify the sources of differences in estimated efficiency.

3.4 Issues for discussion

This section has summarised the main considerations in specifying the opex inputs to be used in the AER's economic benchmarking. A number of important issues remain to be resolved in practice and we would welcome input on the following issues in particular:

1) Given that many NSPs outsource a significant proportion of their opex, is it feasible to disaggregate opex into labour, materials and services components?
2) How consistent is opex coverage both over time and across NSPs?
3) Is it feasible (or desirable) to strive for a common opex coverage across all NSPs even though this may not coincide with regulated coverage in all cases?
4) Is it necessary to adjust for different transmission/distribution boundaries and different system structures across NSPs? How might this be done?
5) More specific issues which will be discussed further in Phase 2 of the workstream but which are flagged here include:
   - Is there common treatment of expenditure on isolated asset refurbishment both over time and across DBs?
   - Are cost allocation practices comparable and consistent across multi–utilities?
6) What combination of price indexes would best capture the composition of NSP opex?
7) How should component price indexes be weighted to form an overall opex price index?
8) Do NSP opex input prices differ materially across Australian NSPs? If so, how?
9) How representative are high level ABS labour and producer price indexes of the opex prices actually faced by NSPs?
10) Do the water and gas industry and the generation and retail parts of the electricity industry unduly influence ABS Electricity, gas and water sector price indexes for them to be used as NSP opex price deflators?

4 CAPITAL INPUTS

As discussed in section 2.1, capital inputs (or assets) always present one of the major measurement difficulties in economic benchmarking studies. Being durable inputs that are not fully consumed in one time period, their cost has to be allocated over their lifetime and any changes in their service capacity allowed for as they (potentially) physically deteriorate over time. Consequently, it is necessary to form estimates of the quantity of capital inputs used in the production process each year – generally known as the flow of capital services – and of the annual user cost of capital inputs. How this should be done and some of the relevant issues will be discussed in the following two sections.

Capital inputs satisfy the selection criteria set out in section 2.2 for inclusion as an input component in economic benchmarking studies. Capital inputs make up the major part of NSP inputs and need to be included for input coverage to be comprehensive. Capital inputs also play a significant role in the NER where they are identified as a key input component. The second and third selection criteria relate to how capital inputs should be included in economic benchmarking studies and will be discussed further below.

4.1 Measuring capital input quantities

Section 2.1 discussed the primary considerations for how durable inputs should be included in economic benchmarking studies. We noted that the capital service flow or quantity of annual input to production from an asset or group of assets cannot be directly observed. Consequently, it is necessary to use proxy measures of capital service flow. Since relatively few input components can be incorporated in economic benchmarking studies, it will be necessary to aggregate up the capital service flow from many assets into a small number of aggregate capital service flows (or quantities of annual capital inputs). No proxy measure for capital service flow will be perfect and what proxy is best used to represent these aggregated capital services will depend on several considerations including:

- the likely physical depreciation profiles of the constituent assets
- the robustness of the data used in forming the proxy – the more accurate the data is and the fewer assumptions that have to be made in deriving the proxy, the better, and
- whether the depreciation profile of the aggregate will mirror that of its constituent components.

Physical depreciation profiles of individual NSP assets

Energy network industry assets are typically subject to little physical deterioration over their lifetime and continue to supply a relatively steady stream of annual services over their lifetime, provided they are properly maintained. Consequently, their true physical depreciation profile is more likely to reflect the ‘one hoss shay’ or ‘light bulb’ assumption than that of either declining balance or straight–line depreciation. That is, they produce roughly the same service for each year of their life up to the end of their specified life rather than producing a given percentage or absolute amount less service every year.

AER (2012, pp.66–8) discussed some of the issues associated with deriving a proxy for an individual NSP asset capital service flow. The AER acknowledged that assets may have higher failure rates at the start of and at the end of their lives. Early asset failures may occur due to bedding in problems but are likely to be relatively uncommon. Asset failures are more likely towards the end of the asset's life and the uncertainty surrounding timing of final failure is often recognised by use of a Weibull distribution for the asset's expected length of life. However, for most of the asset's life, it is likely to be providing a relatively constant service flow and the AER agreed physical depreciation for individual NSP assets can be approximated by a one hoss shay model.

If it is accepted that the major NSP assets have a physical depreciation profile similar to one hoss shay, then one suitable proxy for the quantity of capital input is the physical quantity of the asset. In the case of energy networks it is feasible to use the physical quantity proxy as there are relatively few asset types and readily available means of aggregating asset capacities (eg Lawrence 2003 and Economic Insights 2009b use MVA–kilometres to separately sum overhead line and underground cable capacities and kVA to sum transformer capacities). Accurate information on asset quantities will be readily available from NSP asset registers.

There are alternative proxies available for one hoss shay physical depreciation profiles, such as the constant price gross capital stock (ie no depreciation is deducted from the asset value), but these are likely to be less accurate (as will be discussed below) than the direct physical quantity proxies.

Some economic benchmarking studies have used capital input quantity proxies that involve physical depreciation profiles other than one hoss shay. These have generally involved using the constant price depreciated asset value as the proxy for capital service flow. For example, geometric physical depreciation profiles result from using simple applications of the perpetual inventory method to form asset values in constant prices.

We are of the view that capital service flow proxies based on physical depreciation profiles other than one hoss shay are unsuitable for the major NSP assets. Economic Insights (2009b, pp.63–4) summarised the situation as follows:

> 'Suppose an EDB installs 100 MVA–kilometres of line with a 50 year life. In the first year of the asset's life it will have a service potential of 100 MVA–kilometres. The question is how does this change over time? The one hoss shay approach would say that it remains at 100 MVA–kilometres for the next 49 years. The geometric approach … would say that this progressively declines – in fact relatively rapidly – so that by the 49th year the service potential of the line might only be, say, 2 MVA–kilometres.
>
> 'While any simple proxy will be an approximation to the true underlying pattern of change in the service potential, those familiar with the operational characteristics of the electricity distribution industry agree that the service potential of the 100 MVA–kilometre line will change little over its lifetime. It may deteriorate to, say, 95 MVA–kilometres towards the end of its life but it will certainly not deteriorate rapidly and end up near zero at the end of its life. The geometric profile … thus has little to recommend it for measuring the

> productivity of energy distribution industries and the one hoss shay proxy will be far more appropriate.'

If the decay in the annual capital input quantity available to the production process is overestimated (eg by using a proxy for capital service flow that assumes a geometric physical depreciation profile) then the NSP's efficiency will be correspondingly overestimated and economic benchmarking will be compromised. This is because using, for example, a proxy that assumes geometric physical depreciation will indicate that an NSP with old assets is using little capital input quantity compared to an NSP with new assets of the same rating. The NSP with old assets will then appear to be very efficient compared to the NSP with new assets, all else equal. If the assets actually have one hoss shay characteristics then the capital input quantities of the two NSPs will in fact be similar. Because NSP capital inputs are long–lived, this issue assumes particular importance and emphasises the importance of using a capital input quantity proxy that accurately reflects the assets' one hoss shay characteristics.

Robustness of data considerations

Economic benchmarking needs to accurately reflect the quantity of output produced per unit of the quantity of input used. It is thus critical to have accurate measures of prices and quantities. It is likely to be desirable to use direct quantity measures wherever possible and minimise reliance on 'indirect' quantities derived by deflating values by a price index. This is because price indexes are formed at a much more aggregated and broad sectoral level (eg the overall Electricity, gas and water sector) and may not accurately reflect the prices of NSP capital goods.

Infrastructure industry capital goods price indexes from official statistical agency sources are likely to further be prone to small sample problems. Because NSP augmentation projects may be lumpy at times, particularly for TNSPs, it will be hard for statistical agencies to keep up with the costs that NSPs actually face in undertaking larger projects. This will particularly be the case where there is strong competition for key inputs such as construction labour from other rapidly expanding sectors of the economy. Conversely, statistical agency sampling from a small number of projects may produce volatile and unrepresentative price indexes for NSPs as a whole.

A further robustness problem with using asset value–based proxies relates to the quality of the asset value data itself. In Australia NSPs have been subject to economic regulation for a relatively short period compared to the length of life of their assets and there were generally no accurate records of the historic cost of assets available at the commencement of economic regulation. As a result, opening asset values for NSP RABs were generally formed using depreciated optimised replacement cost (DORC). The often subjective and circuitous nature of DORC valuations has been well documented by Johnstone (2003). DORC valuations have proved to be quite contentious and Australasian regulators stopped doing periodic DORC updates, choosing instead to draw a 'line in the sand'. In the case of some NSPs, the initial DORC values were further adjusted, interalia to protect pre–existing cross subsidies between consumers. While the quality of subsequent RAB roll–forward mechanisms has progressively been improved, the absence of a historic cost initial starting value and the relatively subjective nature of DORC–based initial values compromises the efficacy of asset value–

based proxies for capital service flows.

Using depreciated asset value–based proxies also assumes that the asset value has been calculated on a consistent basis over time. However, large changes in depreciation allowances, among other things, have occurred over relatively short time periods (see, for example, Economic Insights 2009c, p.17). Simply using observed annual regulatory depreciation rates as the basis of forming the capital input quantity using the depreciated asset value approach could lead to significant distortions in economic benchmarking results.

Being engineering organisations, NSPs keep relatively meticulous records of their stock of physical assets. Additions and deletions of line, cable and transformer capacity are all accurately recorded to the day. The quality of physical asset data has improved even further in recent years with the advent of geographic information systems which pinpoint each asset's exact location and its physical attributes. Physical data are, therefore, very robust and will provide a very accurate representation of asset quantities. If the one hoss shay physical depreciation profile is accepted, then physical data will provide a very robust and direct estimate of capital service flow.

On data robustness grounds direct physical quantity measures are clearly preferable to asset–value based capital service flow proxies. In Australia, indirect asset–value based proxies are doubly compromised by the absence of historic cost initial values and the general need to use much more aggregate level price deflators that may not reflect the asset prices paid by NSPs.

Asset aggregation considerations

AER (2012, p.68) notes that an argument has been advanced that, while individual NSP assets may all have one hoss shay physical depreciation characteristics, under certain assumptions, the aggregate of many different such assets may not have a one hoss shay physical depreciation profile. An example is quoted from the US Bureau of Economic Analysis that suggested that, under certain assumptions, the aggregate of many one hoss shay assets could even have something approaching a geometric depreciation profile.

The so–called 'portfolio effect' quoted in the Bureau of Economic Analysis example depends on there being a large number of firms with a wide spread of asset ages. In the case of the Australian NSPs there are relatively few firms and the age characteristics of the assets are likely to be similar. Indeed, the NSPs have previously highlighted the 'bunched' nature of previous network rollouts and the likelihood of an impending 'wall of wire' as assets all of similar age require replacement. These characteristics mean that this 'portfolio effect' argument in favour of geometric depreciation in aggregate is unlikely to apply in this case.

It needs to be recognised that the US Bureau of Economic Analysis is one of the few government statistical agencies currently using geometric depreciation in forming its aggregate capital stock measures. It should also be noted that the Bureau of Economic Analysis is not the US government agency with primary responsibility for producing official productivity statistics. Rather, this is done by the US Bureau of Labor Statistics.

The Bureau of Labor Statistics has been at the forefront of recognising that aggregate capital service flow measures should be delinked from constant price depreciated asset value measures. The Bureau of Labor Statistics has pioneered the use of 'productive capital stock' measures to proxy aggregate capital service flows. These productive capital stock measures make use of asset age–efficiency profiles. The age–efficiency profiles are assumed to be hyperbolic in shape (ie little deterioration in the early stages of the asset's life but more in the later years).

A key parameter in the hyperbolic age–efficiency profile can be set to influence the degree of curvature. A value of one for this parameter leads to a flat or one hoss shay profile while a value of zero would give equal deterioration each year (ie approximate straight line deterioration). The Bureau of Labor Statistics, the ABS and Statistics New Zealand have all adopted the hyperbolic age–efficiency profile in their productivity studies and set this parameter at 0.5 for equipment and 0.75 for structures. That is, they are assuming closer to one hoss shay deterioration for structures in aggregate. This is the complete opposite of the aggregate geometric deterioration profile used by the Bureau of Economic Analysis and very different to the straight–line profile which would be used in NSP constant price RAB–based proxies. The particular characteristics of NSP assets mean they will be closer again to the one hoss shay end of the spectrum than structures in aggregate.

While the main statistical agencies adopt a practice for calculating aggregate productive capital stocks and service flows which assumes a depreciation profile close to one hoss shay depreciation, the area of aggregation is one that could benefit from further research. At this stage we are not persuaded that aggregation considerations mitigate against the use of physical quantity–based proxies for NSP capital service flows and are of the view that such measures best satisfy the second selection criterion in section 2.2 of accurately reflecting the quantity of annual capital service flow of assets employed by the NSP.

It is desirable to include four capital input categories including overhead lines, underground cables, transformers and other capital[1]. The quantity of overhead and underground lines can be measured directly by their delivery capability (eg in MVA–kilometres) while transformers can be measured by their kVA rating. If included as a separate category, the quantity of other capital input usually has to be measured indirectly given its diverse composition and small size.

Capital input requirements will also depend on the operational boundaries and system structure an NSP faces. For example, DNSPs with wider distribution functional boundaries taking their power at higher voltages and then having multiple stages of transformation will require more capital inputs than DNSPs with narrower functional boundaries and/or simpler systems taking their power at lower voltages and then only requiring one stage of transformation. The best way of addressing these issues will be discussed further in Phase 2 of the project.

Using RAB depreciation as a proxy

AER (2012, p.71) propose another proxy measure for capital service flows in the form of RAB depreciation. The AER argues that considerable effort is currently invested in compiling RAB data and the depreciation variable may provide potential for constructing a

[1] Other capital includes some substation components, building fitouts and vehicles. It is generally a very small percentage of total asset value and has sometimes been combined with one of the other categories.

measure of capital service flow as it should, in principle, reflect the quantity of assets in operation each year.

Economic Insights is of the view that this potential measure warrants further investigation in Phase 2 of the project. In principle it could produce a series with some similarity to a one hoss shay proxy as each asset has its cost spread over its projected life in equal annual proportions. The sum of these annual nominal depreciation amounts across assets when deflated by an appropriate capital goods price index could, hence, have similar characteristics to a physical quantity–based proxy.

However, this proxy would be subject to the same limitations as other indirect proxies. While depreciation allowances have been increasingly standardised for new capex, the lack of a direct link between initial capital bases and historic cost mean that the initial capital base component of RAB depreciation will be less accurate. There will also be error introduced by assumed asset lives for both initial capital and subsequent capex not equalling actual realised asset lives (something that is not an issue with direct quantity–based proxies). The AER (2012, p.71) also noted that asset lives allowed in RAB depreciation differ across jurisdictions and relative to asset lives assumed in the AER's other assessment models.

Apart from these consistency issues, a RAB depreciation–based proxy would still need to be deflated by a capital goods price index representative of prices paid by NSPs (as opposed to the consumer price index deflation used in forming the real RAB). We have already noted the potential error this introduces given that most available capital goods price indexes are at a much more aggregate level than the NSP industry.

4.2 Measuring annual capital user costs

In section 2.1 we noted that the cost of capital's annual input to production has to be distinguished from the total asset value. When an asset is purchased, it will provide input to the production process over an extended period. Consequently, its cost should be spread over that same period. But in addition to the initial cost of the asset, there is also an opportunity cost of holding the asset each year. This opportunity cost may be offset to some extent if the asset is subject to capital gains (its price increases over time).

Just as capital service flow quantities could be measured either directly (using physical data) or indirectly (using deflated asset value data), then the annual cost of using capital inputs can also be measured either directly or indirectly. The direct approach involves applying a formula which includes an estimated depreciation rate, a rate reflecting the opportunity cost of capital and other factors such as taxation effects to the value of assets. This approach is also often referred to as being 'exogenous' as it does not depend on the outcome realised in the measurement period. It is effectively an ex ante measure of the shadow annual user cost of capital. The indirect approach, on the other hand, simply uses the residual of revenue minus operating costs. It is often referred to as being 'endogenous' as it measures the realised residual which is then allocated to capital. It is an ex post measure of the annual capital cost.

The sophistication of the direct annual user cost formula used in NSP economic benchmarking studies varies widely depending on the quantity and quality of relevant data available. An example of a basic before–tax annual user cost formula is given by:

(1) $$u = \underset{\text{interest cost}}{rP} + \underset{\text{depreciation cost}}{\delta(1+\rho)P} - \underset{\text{capital gains}}{\rho P}$$

where: r is the nominal interest rate;

δ is the depreciation rate based on the asset's economic life;

ρ is the inflation rate of capital items; and

P is the purchase price of capital.

Although they may make a reasonable approximation, these simple exogenous user cost of capital models are not necessarily consistent with the way capital costs are calculated in building blocks reviews (eg capital gains are calculated using capital goods prices rather than the general inflation rate used in building blocks). For economic benchmarking to be used as part of building blocks reviews, the annual user cost should approximate the sum of the building blocks return of and return on capital components.

The indirect approach of allocating a residual or ex post cost to capital of the difference between revenue and operating costs has been favoured by some regulatory agencies such as the US Federal Communications Commission (1997). A key advantage of this approach is that it is easy to implement and requires minimal data. However, calculating the annual capital cost endogenously will not result in ex ante FCM–consistent capital costs, except by accident.

A number of economic benchmarking studies have used this indirect approach to measuring capital costs. While it measures realised or ex post capital costs and may provide an approximation for ex ante capital costs for network industries where there has been a longish history of building blocks regulation, we believe it would not be appropriate to use this approach in economic benchmarking to be used in building blocks reviews. Rather, an exogenous approach to forming the annual user cost of capital which is consistent with the building blocks return of and return on capital components will best satisfy the third selection criterion in section 2.2.

4.3 Data requirements

Appendix F of the AEMC (2011) final report for the review into the use of TFP in prices and revenues determinations contains a list of variables considered necessary to support calculation of TFP. The list is based on the Economic Insights (2009a) data report and was designed to cover the principal NSP productivity study specifications previously used in Australia. While the NSP lists were compiled in the context of a review of the potential use of productivity–based regulation, they are effectively the same as those required to support the use of economic benchmarking techniques to assess NSP efficiency in assessing building blocks expenditure forecasts (and in annual benchmarking reports). We therefore suggest that these lists are a useful starting point for consultation on the collection of data to support economic benchmarking.

The variables from the AEMC (2011) lists required to support calculation of the variables discussed in sections 4.1 and 4.2 for DNSPs and TNSPs are presented in appendixes B and C, respectively, to these briefing notes.

4.4 Issues for discussion

This section has summarised the main considerations in specifying the capital inputs to be used in the AER's economic benchmarking. A number of important issues remain to be resolved in practice and we would welcome input on the following issues in particular:

1) To what extent do the physical 'carrying capacities' of the main NSP assets of lines, cables and transformers reduce over time?

2) Which physical depreciation profile best approximates the physical 'carrying capacities' over the lifetime of the main NSP assets:

   - one hoss shay (no reduction throughout the asset's life)
   - hyperbolic (small decline in early years, larger decline in later years of the asset's life)
   - geometric (equal percentage decline over lifetime, ie bigger falls in early years and smaller falls in later years), or
   - straight–line (ie equal absolute reduction each year of the asset's life)?

3) Would using a physical depreciation profile other than one hoss shay overstate the decay in service potential for the NSP asset and, hence, overstate the NSP's efficiency?

4) Do high level sectoral capital goods price indexes (such as that for the overall Electricity, gas and water sector) accurately reflect the prices NSPs face for their assets?

5) How well do NSP initial capital bases used at the commencement of economic regulation represent the depreciated replacement cost of NSP assets at that time?

6) How consistently have NSP RAB values been calculated over time? Would they be suitable for use as a proxy to backcast capital service flows?

7) Can more confidence generally be placed in NSP asset register quantities or NSP RAB data in terms of accuracy and consistency?

8) Are the four suggested NSP asset groups (of overhead lines, underground cables, transformers, and other capital) the most appropriate for economic benchmarking purposes? What is the appropriate physical depreciation profile for assets in each category?

9) Is the other capital group sufficiently important to include as a separate item or should it be combined with one of the other groups? If so, which one?

10) Is the age distribution of Australian NSP assets better characterised as being 'bunched' (ie a large proportion of the network rolled out in a short period of time) or evenly–spread?

11) Would using a constant price RAB depreciation series be a suitable proxy for NSP capital services? What would be the advantages and disadvantages of using this proxy?

12) Should the user cost of capital used in economic benchmarking be consistent with the return of and return on capital components used in building blocks calculations? Are there any problems with using these measures for economic benchmarking purposes?

13) Would the endogenous user cost of capital (ie the simple residual of revenue less depreciation) be a good enough approximation to the exogenous or ex ante user of capital to use in economic benchmarking? If not, why not?

APPENDIX A: ECONOMIC BENCHMARKING

A.1 What is economic benchmarking?

Economic benchmarking of costs measures the economic efficiency performance of an NSP by comparing its current performance to its own past performance and to the performance of other NSPs. All NSPs use a range of inputs including capital, labour, land, fuel, materials and services to produce the outputs they supply. If the NSP is not using its inputs as efficiently as possible then there is scope to lower costs and, hence, the prices charged to energy consumers, through efficiency improvements. This may come about through the use of:

- better quality inputs including a better trained workforce
- adoption of technological advances
- removal of restrictive work practices
- removal of other forms of potential waste such as ‘gold plating’, and
- better management through a more efficient organisational and institutional structure.

Overall economic efficiency has several components including:

- technical efficiency which requires that the maximum possible quantity of output is produced from the quantities of inputs the NSP has available or, alternatively, that the quantity of output required is produced from the minimum possible quantity of inputs
- allocative efficiency which requires that the NSP use inputs in proportions consistent with minimising costs given current input prices
- cost efficiency which requires that the NSP produce its outputs at minimum possible cost (ie that it achieves both technical and allocative efficiency), and
- scale efficiency which requires that the NSP is operating at an optimal size.

Most economic benchmarking techniques compare the quantity of outputs produced to the quantity of inputs used and costs incurred over time and/or across NSPs. As no two NSPs operate under exactly the same operating environment conditions, it is important to allow for operating environment differences when comparisons are made across NSPs to ensure that like is being compared with like to the maximum extent possible.

The main economic benchmarking techniques include:

- total factor productivity (TFP) indexes which calculate growth rates of the total output quantity relative to total input quantity for an NSP over time
- multilateral TFP indexes which allow productivity levels as well as growth rates to be compared across NSPs
- econometric cost function models
- data envelopment analysis (DEA) which uses linear programming to construct an efficient production frontier from the included observations, and

- stochastic frontier analysis (SFA) which constructs an efficient production frontier from the included observations using statistical methods which allow for error.

These techniques aim to provide a holistic comparison of NSP cost performance. They differ from the simple benchmarking techniques currently used in building block reviews which typically examine the relativity between specific activities rather than the efficiency performance of the NSP as a whole. The economic benchmarking techniques provide a 'top down' perspective on NSP cost performance using relatively high level data compared to the 'bottom up' item by item comparisons otherwise used.

A.2 Why the current interest in economic benchmarking?

The AER's electricity NSP price reviews to date have relied heavily on expert engineering reviews and historical trending of costs based on the assumption that revealed costs are relatively efficient. However, these tools are only a subset of the methods used by other regulators and greater use of benchmarking has been frustrated, among other things, by the lack of consistent data available (see, for example, Economic Insights 2009a).

The AEMC (2012, p.viii) observed that:

> 'The Commission considers that benchmarking is a critical exercise in assessing the efficiency of a NSP and approving its capital expenditure and operating expenditure allowances. … The Commission will remove any potential constraints in the NER on the way the AER may use benchmarking.
>
> 'Whilst benchmarking is a critical tool for the regulator, it can also be of assistance to consumers, providing them with relative information about network performance on NSPs.'

In response to the recent rule changes the AER (2012) has proposed making greater use of two different streams of analysis in future reviews and reporting – category analysis and economic benchmarking. Category analysis is the more detailed of the two and attempts to link disaggregated cost data to a series of 'drivers' thought to influence each expenditure category. As such, it includes some elements of benchmarking (eg examining expenditure per unit of each explanatory variable across NSPs) and some elements of the trend analysis, revealed costs and modelling methods currently used.

The AER (2012, p.31) has indicated that it sees the higher level economic benchmarking techniques as an important checking and screening method to be used in conjunction with the more disaggregated category analysis:

> 'We are proposing to … conduct higher level [economic] benchmarking as a useful complement to category based analysis. In particular, we expect this type of analysis to:
>
> - provide an overall and higher–level test of relative efficiency, which may highlight issues that can potentially be overlooked during lower–level and detailed analysis

- facilitate benchmarking which may not be possible as part of the category analysis due to data availability, including as a transitional measure
- reinforce findings that are made through other types of analysis, otherwise highlighting potential problems in assessment methods or data.

> 'It is hoped that the input/output based economic benchmarking techniques will be sufficient to test whether the largely revealed cost–based category analysis results can be relied upon and areas where further detailed review should occur.'

In practice, economic benchmarking is likely to play an important role in reviewing the relative efficiency of historical NSP expenditure and whether base year expenditure can be trended forward or whether it may be necessary to make adjustments to base year expenditure to remove observed inefficiencies. Economic benchmarking is also likely to play an important role in quantifying the feasible rate of efficiency change and productivity growth that a business can be expected to achieve over the next regulatory period. This would include separately examining costs that are flexible in the short run (eg opex) and costs that will need to be progressively adjusted over the longer term (eg capital inputs). This could also include consideration of how scale efficiencies may change over time. An example of how economic benchmarking methods can be used to calculate the rate of partial productivity growth that should be included in an opex rate of change roll–forward formula can be found in Economic Insights (2012b).

Economic benchmarking is also likely to be central to determining whether the revealed cost approach should be used (if the NSP is found to be operating efficiently in the economic benchmarking analysis) or whether a more detailed item by item building blocks review will be necessary (if the NSP is found to be inefficient in the economic benchmarking analysis).

A.3 Broad data requirements for economic benchmarking

Economic benchmarking requires data on the price and quantity (and hence value) of all outputs and inputs and on the quantities of operating environment variables (noting that output prices may be 'shadow', or cost–reflective, prices where the output is not explicitly charged for). This then allows any of the key economic benchmarking methods – TFP indexes, multilateral TFP indexes, econometric models, DEA and SFA models – to be implemented.

The different techniques have different strengths and weaknesses and each offers a different perspective on the relative performance of included NSPs. It is noted that the non–TFP methods all require a larger number of observations to be available before they can be reliably implemented. It should also be noted that the usefulness of the frontier methods (DEA and SFA) reduces as the number of outputs is increased (because these techniques will find progressively more firms 'efficient' simply because they have unique output mixes and no other firms they can be compared with). This highlights the 'top down' nature of economic benchmarking and why it is important to concentrate on a relatively small number of key outputs.

The availability of robust and consistent data to support a range of likely specifications is a prerequisite for the introduction of economic benchmarking. A key requirement for a robust and consistent database is detailed and consistent definitions of the way key variables have to be reported. Without this, data may have been supplied inconsistently across NSPs and also through time by each NSP.

If it proves feasible to 'backcast' data using historical data, once output and input variable lists and definitions are finalised, then it would be possible to use economic benchmarking methods in building blocks reviews in the near future and certainly sooner than if completely new databases have to be established.

APPENDIX B: ELECTRICITY DNSP INPUT VARIABLES[2]

Total Distribution O&M Expenditure (opex) (excluding depreciation and all capital costs) – $m

Shared allocation of opex overheads to distribution activities (eg head office) included in above – $m

Opex by category

The costs of operating and maintaining the network (excluding all capital costs and capital construction costs) disaggregated as follows[3] *– $m:*

Network operating costs – $m

Network maintenance costs – $m

Inspection

Maintenance and repair

Vegetation management

Emergency response

Other network maintenance

Other operating costs (specify items > 5% total opex) – $m

Total opex – $m

Corporate overhead costs should be allocated to the relevant categories.

Additionally, the following item is required:

An estimate of the opex costs that would be associated with end–user contributed assets that are operated and maintained by directly connected end–users (eg transformers) if the operation and maintenance were provided by the DNSP (please describe basis of estimation). – $m

Direct employees – no

Number of full–time equivalent employees in operating and maintenance activities (including shared overhead allocation). Employee time spent on capital construction projects is to be excluded.

Direct labour cost – $m

Labour cost (including on–costs) of employees in operating and maintenance activities (including shared overhead allocation). Cost of time spent on capital construction projects is to be excluded.

Distribution System Capital Quantities and Capacities

O/H network circuit length – km

Low voltage distribution

HV 11 kV

HV 22 kV

2 Taken from AEMC (2011) and Economic Insights (2009a)

3 Illustrative disaggregation for cross checking purposes

HV 33 kV (if used as distribution voltage)
SWER
S/T 44/33 kV (if used as subtransmission)
S/T 66 kV
S/T 132 kV
(Other voltages)
Total overhead circuit km

U/G network circuit length – km
Low voltage distribution
HV 11 kV
HV 22 kV
HV 33 kV (if used as distribution voltage)
S/T 66 kV
S/T 132 kV
(Other voltages)
Total underground circuit km

Transformer Total Installed Capacity – MVA
Zone substation transformer capacity
Zone substation capacity where there are two transformation steps (eg 132 kV to 66 kV then 66 kV to 11 kV)
Zone substation capacity where there is a single transformation step (eg 132 kV to 22 kV)
Distribution transformer capacity owned by utility
Distribution transformer capacity owned by HVCs

Regulatory Asset Base Values – $m
Overhead distribution assets (wires and poles)
Underground distribution assets (cables)
Distribution substations including transformers
Sub–transmission assets (wires and poles)
Sub–transmission substations including transformers
Total – $m

RAB Reconciliation – $m
Opening value
Inflation addition
Regulatory depreciation
Actual additions (recognised in RAB)
Retirements
Revaluation adjustments
Resulting summation for asset value

Smoothed asset value wrt revaluations

Basis for initial RAB, eg DORC, adjusted DORC, historic cost, etc

Have DORC valuations been undertaken? If so, for which years?

Actual Capital Expenditure – $m

Overhead distribution assets (wires and poles)
Underground distribution assets (cables)
Distribution substations including transformers
Sub–transmission assets (wires and poles)
Sub–transmission substations including transformers
Services
Meters
SCADA and other remote control
Other – IT
Other – non IT
Total Capital Expenditure – $m

Asset Lives – estimated total and residual – years

Overhead distribution assets (wires and poles)
Underground distribution assets (cables)
Distribution substations including transformers
Sub-transmission assets (wires and poles)
Sub-transmission substations including transformers
Services
Meters
SCADA and other remote control
Other – IT
Other – non IT

Value of Capital Contributions or Contributed Assets – $m

Price Index for Labour Inputs

Price Index for O&M Expenditure

Price Index for Network Assets

APPENDIX C: ELECTRICITY TNSP INPUT VARIABLES[4]

Opex

Total Transmission opex (excluding depreciation and all capital costs) – $m

Shared allocation of opex overheads to transmission activities (eg head office) included in above – $m

Opex by category – $m
The costs of operating and maintaining the network (excluding all capital costs and capital construction costs) disaggregated as follows[5] $m :
- Network operating costs
- Network maintenance costs:
  - Inspection
  - Maintenance and repair
  - Vegetation management
  - Emergency response
  - Other network maintenance
  - Other operating costs (specify items > 5% total opex)

Total opex – $m

Corporate overhead costs should be allocated to the relevant categories.

Additionally, the following item is required – $m
An estimate of the opex costs that would be associated with end–user contributed assets that are operated and maintained by directly connected end–users (eg transformers) if the operation and maintenance were provided by the TNSP (please describe basis of estimation).

Direct employees – no
Number of full–time equivalent employees in operating and maintenance activities (including shared overhead allocation). Employee time spent on capital construction projects is to be excluded.

Direct labour cost – $m
Labour cost (including on–costs) of employees in operating and maintenance activities (including shared overhead allocation). Cost of time spent on capital construction projects is to be excluded.

Installed transformer capacity – MVA
- Transmission substations (eg 500 kV to 275 kV)
- Terminal points
- Transformer capacity for directly connected end–users owned by the TNSP

[4] Taken from AEMC (2011) and Economic Insights (2009a)
[5] Illustrative disaggregation for cross checking purposes

Transformer capacity for directly connected end–users owned by the end–user
Other (please specify)

Regulatory Asset Base Values – $m
Overhead lines
Underground cables
Transformers owned by the TNSP
Transformers owned by directly connected end–users
Other assets including:
Communications equipment
Land and buildings
Other items not elsewhere included
Total – $m

RAB Reconciliation – $m
Opening value
Inflation addition
Regulatory depreciation
Actual additions (recognised in RAB)
Retirements
Revaluation adjustments
Resulting summation for asset value

Smoothed asset value wrt revaluations

Basis for initial RAB, eg DORC, adjusted DORC, historic cost, etc

Have DORC valuations been undertaken? If so, for which years?

Actual capital expenditure – $m
Overhead lines
Underground cables
Transformers owned by the TNSP
Transformers owned by directly connected end–users
Other assets including:
Communications equipment
Land and buildings
Other items not elsewhere included
Total – $m

Asset Lives – estimated total and residual – years
Overhead lines
Underground cables
Transformers owned by the TNSP
Transformers owned by directly connected end–users
Other assets including:
Communications equipment
Land and Buildings

Other items not elsewhere included

Value of Capital Contributions or Contributed Assets – $m

Price Index for Labour Inputs

Price Index for O&M Expenditure

Price Index for Network Assets

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