Better Regulation

Expenditure forecast assessment guidelines for electricity distribution and transmission

Issues paper

December 2012

AUSTRALIAN ENERGY REGULATOR

Request for submissions

This issues paper is part of the Australian Energy Regulator's (AER) Better Regulation program of work, which follows on from changes to the National Electricity Rules announced in November 2012 by the Australian Energy Market Commission. The AER's approach to regulation under the new framework will be set out in a series of guidelines to be published by the end of November 2013.[1]

Interested parties are invited to make written submissions to the AER regarding this issues paper by the close of business, 15 March 2013.

Submissions should be sent electronically to: expenditure@aer.gov.au. The AER prefers that all submissions sent in an electronic format are in Microsoft Word or other text readable document form.

Alternatively, submissions can be sent to:

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Australian Energy Regulator
GPO Box 520
Melbourne Vic 3001

The AER prefers that all submissions be publicly available to facilitate an informed and transparent consultative process. Submissions will be treated as public documents unless otherwise requested. Parties wishing to submit confidential information are requested to:

- clearly identify the information that is the subject of the confidentiality claim
- provide a non-confidential version of the submission in a form suitable for publication.

All non-confidential submissions will be placed on the AER's website at www.aer.gov.au. For further information regarding the AER's use and disclosure of information provided to it, see the ACCC/AER Information Policy, October 2008 available on the website.

Enquires about this paper, or about lodging submissions, should be directed to the Network Operations and Development Branch of the AER on (03) 9290 1444.

1 Further details on the consultation processes and other guidelines work streams are available at http://www.aer.gov.au/node/18824.

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1 Summary and list of questions

We, the Australian Energy Regulator (AER), are responsible for the economic regulation of electricity transmission and distribution services in the national electricity market (NEM) as well as gas transportation services. We also monitor the wholesale electricity and gas markets and are responsible for compliance with and enforcement of the National Electricity Rules (NER) and National Gas Rules.

We are beginning a program of work to deliver an improved regulatory framework focused on the long term interests of electricity consumers. This follows from changes to the National Electricity and Gas Rules that were published by the Australian Energy Market Commission on 29 November 2012. Our approach to regulation under the new framework will be set out in a series of guidelines to be published by the end of November 2013.

A major element of our new approach is the publication of Expenditure Forecast Assessment Guidelines (the Guidelines) for transmission and distribution which we are required to publish by 29 November 2013.[2] The Guidelines will describe the techniques and associated data requirements for our approach to determining efficient capex and opex allowances in accordance with the objectives, criteria and factors in the NER.

This issues paper sets out our first step in consulting on the Guidelines, which we expect will formalise and standardise various techniques in expenditure assessment for transmission and distribution network service providers (NSPs). It is based upon a preliminary assessment of the methods and data sources used in our first round of network determinations as well as methods employed by other regulators such as Ofgem.

On the whole, we will be looking to significantly improve our approach to expenditure assessment and become better equipped to challenge and critically analyse the proposals put to us by regulated networks. A key feature of this issues paper, and something we wish to further discuss with stakeholders over the coming months, is the development of benchmarking techniques both at aggregated and disaggregated levels of analysis. Benchmarking has been a relatively underdeveloped area of analysis in our decisions and one which we expect it will deliver a more effective approach than relying largely on detailed, "bottom-up" assessments.

The techniques used and data collected under the Guidelines will also form the basis of our annual benchmarking reports. The first benchmarking report must be published by 30 September 2014 and the second by 30 November 2015, with subsequent reports published at least every 12 months thereafter. These reports will add to our existing publication of network performance data and provide important information for all stakeholders when discussing the efficient expenditure allowances set in transmission and distribution determinations.

In developing and implementing our guidelines we will be mindful of consumer interests as articulated in the NEO and in the revenue and pricing principles, but also as preferences are directly expressed through our new means of consumer engagement. In particular we will be taking a long term perspective, recognising consumer interests in terms of price impacts as well as on service delivery and network security arising from under and over investment. We may also take into account explicit

[2] NER clauses 6.4.5(a) and 6A.5.6(a) require that we publish the Guidelines. Transitional rules 11.53.4 and 11.54.4 set the date for their publication.

customer preferences to smooth out or defer expenditure programs in order to minimise price shocks, with proper recognition of any short term risks this may bring.

We are seeking direct input from industry and other stakeholders into the development of the Guidelines over the next 12 months. Issues raised in this paper are intended to form a basis for discussion between ourselves and stakeholders in the coming months through detailed working groups and in written submissions.

We have separately set out our overall approach to consulting on the range of new guidelines and schemes.[3] The process will include multiple consultation stages (after the issues paper and draft Guidelines) with various methods of engagement (fora, workgroups, written submissions and bilateral meetings). The next steps in consultation on the expenditure Guidelines are outlined in section 0 below.

Questions for stakeholder comment are posed throughout the issues paper and are repeated here as a summary.

Scope of current consultation

Question 1

Should we anticipate the application of some assessment techniques to gas service providers as part of this consultation?

Question 2

Do stakeholders have any preliminary comments on the development of guidelines that will be different for transmission and distribution businesses? Should consultation be separate for these businesses?

Question 3

How should linkages between expenditure assessment, information collection and storage, cost allocation and incentive arrangements be dealt with in the development of our overall assessment framework?

Objectives for expenditure assessment

Question 4

Have we appropriately characterised the role of benchmarking in expenditure assessments, and set an appropriate objective in expanding and formalising our approach in consultation with stakeholders?

3 AER, *Better regulation issues paper,* 10 December 2012.

Question 5

Do stakeholders have views on the use of revealed costs and the reliance on incentive mechanisms, and how this should change with the increased reliance on benchmarking to assess expenditure allowances?

Principles for the selection of assessment techniques

Question 6

Are there any other principles that you think that should be added to this list? Should we include principles that guide the selection of the assessment techniques to be applied in the framework and approach stage, from the list of appropriate techniques (that will be) outlined in the Guideline? If so, do you think that the principles outlined here provide appropriate guidance on technique selection?

Expenditure assessment techniques

Question 7

Are there any assessment techniques that should be considered as forming part of the guidelines? What are the relative benefits and shortcomings of each of the approaches and how could the latter be addressed?

Proposals for further work

Question 8

Do stakeholders agree with our general approach of attempting to derive quantitative relationships between expenditures and drivers? Are there better, more cost effective alternatives to assessing disaggregated expenditures?

Question 9

Do stakeholders have any in-principle comments about the level of expenditure disaggregation given our expectation that lower levels of aggregation e.g. by asset type, are likely to be conducive to more robust benchmarking and other quantitative analysis?

Question 10

Do stakeholders agree that economic benchmarking will be an important adjunct to more detailed expenditure assessments?

Expenditure assessment process

Question 11

Do stakeholders agree that the first-pass process described above is a useful and appropriate application of expenditure assessment techniques?

Expenditure incentive schemes and their application

Question 12

Do stakeholders have any views on the relationship between the assessment tools that we have identified, and our existing incentive schemes? Given the interrelationship between the two, and that our incentive schemes are to be revised over 2013, what processes should we follow to ensure there are appropriate incentives on NSPs to make efficiency gains, while at the same time implementing appropriate expenditure assessment techniques?

The guideline, benchmarking reports and determinations

Question 13

Do stakeholders have any comments on how best to manage the interrelationships between the guidelines, F&A processes, determinations and annual benchmarking reports?

Question 14

How would it be best to maintain a degree of consistency in assessment techniques and associated data reporting, while at the same time allowing improvements in techniques?

Question 15

Are there any ways the expenditure assessment process, including in preparing NSP forecasts, could be improved by linking the Guidelines, the F&A process and the NSP's obligation to notify us of its forecasting methods?

Detailed timing and transitional issues

Question 16

Keeping in mind the preference to use up to date and nationally consistent data in all benchmarking analysis, what would be the best time to issue RIN templates? Would these need to be for all NSPs? How frequently should we do this?

Question 17

Should we try and limit the collection and analysis of benchmarking data to annual benchmarking reports? Alternatively, should we focus our effort on benchmarking analysis at each draft and final decision stage, with less attention to annual benchmarking reports?

Question 18

Are there alternative, more flexible means to gather data for benchmarking purposes in annual reports and in determinations, such as requests outside the NEL provisions?

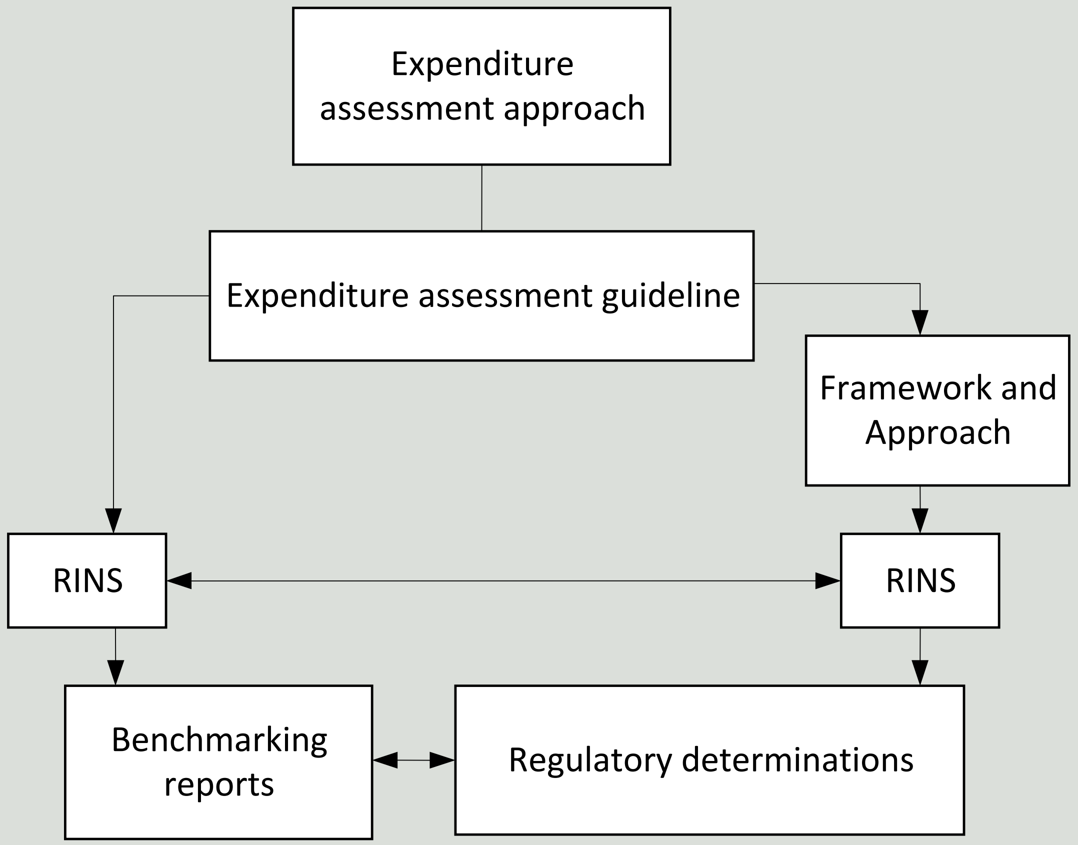
Question 19

Should we be considering the alignment of regulatory years and of regulatory control periods for transmission and distribution NSPs to overcome some of these challenges? If so, should regulatory years reflect the Australian financial year? How would the alignment of regulatory control periods be best achieved?

2 Implementing the new assessment framework

As part of this consultation we will be developing assessment methods that will form part of the Guidelines, annual benchmarking reports and network determinations, as well as form the basis of regulatory information notices (RINs) that will collect data for all of these. This section explains the relationship between these elements. It provides our initial thoughts on the scope of the Guidelines and their applicability to gas service providers as well as between electricity transmission and distribution.

Box 1 Our expenditure assessment framework



We intend to develop benchmarking techniques in our Guidelines that will be used in annual benchmarking reports as well as in regulatory determinations.

We are aiming to provide certainty and continuity in techniques across NSPs while still allowing these to evolve with new data and enhancements at each determination.

We will require consistent data from NSPs to conduct benchmarking assessments. We seek views on how to best manage this in light of needing to collect data from NSPs and publish benchmarking analysis several times a year.

Box 1 illustrates the relationship between the Guidelines, Framework and Approach process, RINs, benchmarking reports and regulatory determinations. The Guidelines will influence the Framework and Approach process and RINs. The RINs will in turn influence the benchmarking report and regulatory determinations. The benchmarking reports and regulatory determinations will inform each other.

2.1 Role of the Guidelines

The Guidelines will specify the approach we propose to use to assess NSPs' capex and opex forecasts and the information we require for the purposes of that assessment.

We consider the requirement to publish Guidelines will generate debate on our assessment approaches well in advance of determination processes, rather than having this debate take place after the draft decision stage when there is limited opportunity for change and to collect any new data to assess or justify expenditure claims. NSPs and other stakeholders will have considerable input to the development of our assessment methods as part of consultation on the Guidelines over 2013. We expect this process will work towards ensuring the assessment methods are robust and strike an appropriate balance between information burdens and improved regulatory outcomes.

The objective of the Guidelines is to develop a generally agreed approach to our expenditure assessment, which, when combined with further detailed consultation during the Framework and Approach (F&A) process, should provide NSPs with greater certainty on how we will approach the task of determining whether proposed expenditures comply with the NER requirements. Our aim would be to streamline the processes by which NSPs provide us with information as part of the determination process and in our new benchmarking reports.

We would also like to reduce the compliance burden for NSPs by avoiding the duplication of information provided in regulatory proposals. Ideally, the Guidelines and associated RIN templates should cover the information necessary for NSPs to demonstrate efficiency or compliance with capex/opex objectives.

The Guidelines would be used as the basis for considering information requirements and be discussed with NSPs as part of the F&A process. While the NER require NSPs to provide information as required by the Guidelines to accompany their regulatory proposals as set out in the F&A[4], we expect to ultimately give effect to the Guidelines through RIN templates in order to streamline compliance for NSPs (i.e. by ensuring RINs are consistent with and encompass the F&A requirements).

The Guidelines are not binding on us or NSPs, however if we depart from the Guidelines in making determinations this needs to be supported by reasons and substantiating information.

2.2 Scope of current consultation

At this point we are more concerned with developing the Guidelines for application to electricity NSPs. There are likely to be some techniques that will also be applied, in a general sense, to gas NSPs, such as benchmarking, trend analysis and expert engineering review. It is not anticipated, nor is it our intention, however, that the Guidelines would have practical implications for assessing expenditure in the gas context given different drivers for and definitions of expenditure, as well as inputs and outputs

[4] NER, clauses 6.8.2(c2) and 6A.10.1(h).

for economic benchmarking techniques. The only exceptions to this we can identify at present may be in the case of overheads assessments where expenditures and drivers may be generic to businesses in many industries.

With respect to differences between electricity transmission and distribution, much of the work around economic techniques and category based assessment in attachments A and B have been developed with distribution networks in mind. At a broad level, we consider there to be more potential for benchmarking, driver and trend analysis for distribution businesses given they are greater in number and have expenditures that reflect relatively smaller value or higher volume activities and assets than transmission businesses. In the case of transmission opex, however, we consider that the approach considered for category based assessment may be applicable but will require some different categorisations and definitions. We also note that the base step and trend approach to forecasting/assessing opex has been applied in several transmission determinations and expect to continue with this at least as a transitional measure (and for DNSPs) until other assessment techniques are fully developed. Our approach of taking sample projects to review TNSPs' capex proposals is also likely to continue (and will also be applicable to some DNSPs).

We are interested in stakeholder views on this, particularly on whether and how we should separate any working groups and consultation according to the assessment of transmission and distribution expenditures.

All techniques forming part of the Guidelines will give rise to information reporting and compliance implications. Data templates and any transitional issues in NSPs collecting new data will therefore need to be considered by us and stakeholders in tandem with conceptual issues. Relationships between the expenditure Guidelines and approaches to cost allocation, confidentiality guidelines and logistical issues around data transfer and storage will also be important. In this context, the Productivity Commission recommended that we establish a database to facilitate public access to input data for benchmarking techniques to assist stakeholders undertaking their own analysis.[5] We agree with this as we intend to develop and use a new database and implement a transparent assessment approach. Any public scrutiny and feedback will assist in refining our methods.

A final implication of our expenditure assessment is the potential overlap between analysis of historic expenditure, related party margins and our approach to ex post efficiency assessments on capex overspends. This is an area where we will need to coordinate the development of the expenditure assessment Guidelines and of the revised capex incentive framework, which will itself be covered in a separate AER capex incentive guideline.

Question 1

Should we anticipate the application of some assessment techniques to gas service providers as part of this consultation?

5 Productivity Commission, *Draft report: Electricity network regulatory frameworks*, Canberra, October 2012, p. 292.

Question 2

Do stakeholders have any preliminary comments on the development of guidelines that will be different for transmission and distribution businesses? Should consultation be separate for these businesses?

Question 3

How should linkages between expenditure assessment, information collection and storage, cost allocation and incentive arrangements be dealt with in the development of our overall assessment framework?

3 Objectives for expenditure assessment

Box 2 Our objectives

We will seek to expand the assessment techniques available to us in this workstream.

Principally, we consider benchmarking techniques would enable us to make decisions about forecast expenditure that better promote the NEO.

The requirement to publish the Guidelines and the deferment of regulatory determinations arising from the recent rule change process has provided us with an opportunity to engage with stakeholders on the best approach to assessing expenditure forecasts. This section sets out what we would like to achieve in this work stream.

Our task in assessing expenditure forecasts

Chapters 6 and 6A of the NER establish an incentive regulation framework for NSPs. Under this framework, NSPs are rewarded for outperforming the expenditure allowances set by the regulator.

Our task under this framework is to assess forecasts of levels of expenditure, as recognised by the AEMC; 'The level, rather than the specific contents, of the approved expenditure allowances underpin the incentive properties of the regulatory regime in the NEM. That is, once a level of expenditure is set, it is locked in for a period of time, and it is up to the NSP to carry out its functions as it sees fit, subject to any service standards.'[6]

There is a range of techniques that can be used to form a view about an NSP's proposed expenditure. As will be discussed in section 4.2 below, some of these techniques provide information on particular categories of expenditure, and others provide information about total expenditure. In light of this diversity, and the fact that each of these techniques provides different information about the level of proposed expenditure, part of our task in assessing the level of expenditure involves assessing the relative merits of these techniques. Where more than one technique provides relevant information, we should consider the information provided by all of the relevant techniques in forming a view about the reasonableness of proposed expenditure.

Our toolkit needs to be expanded

We have made improvements to the assessment techniques we have applied in recent resets, but are still heavily reliant on a small subset (expert engineering review and historical trending) of the complete toolkit that is available and applied by other regulators. In particular, we have not been able to make full use of benchmarking techniques in assessing NSPs' expenditure.

The key impediment to a fuller application of benchmarking to assess expenditure proposals has been the lack of a consistent reporting framework that provides information on the costs and volume of undertaking similar activities across all NSPs in the NEM. Consistent data reporting is paramount to any benchmarking approach and will be a key element of our framework. Standardising existing

6 AEMC, *Rule determination: Rule change: Economic regulation of network service providers, and price and revenue regulation of gas services*, 29 November 2012, Sydney, p. 93.

approaches into a national framework will also enable us to regulate in a more cost effective manner and allow refinements into best practice methods.

Revealed costs and incentives

In the past, we have placed significant reliance on the costs revealed by NSPs in forming a view about the reasonableness of expenditure proposals where they have been subjected to an effective incentive framework. More specific forecasting methods, namely the use of an efficient base year combined with a "step and trend" approach, have been used to assess the aggregate operating expenditure allowances of NSPs subject to a "carryover" mechanism, as per our current efficiency benefit sharing scheme (EBSS).

The effectiveness of incentive arrangements is an important consideration in whether actual, historic costs can be relied on in such a way. NSPs may be responding to varying degrees to these incentives in terms of improvements in revealed costs. However, it may also be that the expenditure allowances set by us and previous jurisdictional regulators were too high, or that NSPs have not responded to these incentives sufficiently quickly or in line with their peers.

Benchmarking would support us in assessing the extent to which NSPs are responding to the incentive framework, thereby reinforcing the revealed cost approach and base, step and trend methods. Where NSPs are not responding to the incentive framework, it may be more appropriate for us to make use of benchmarking techniques in forming a view about the proposed forecast expenditure, with less reliance on the base step and trend approach.

Question 4

Have we appropriately characterised the role of benchmarking in expenditure assessments, and set an appropriate objective in expanding and formalising our approach in consultation with stakeholders?

Question 5

Do stakeholders have views on the use of revealed costs and the reliance on incentive mechanisms, and how this should change with the increased reliance on benchmarking to assess expenditure allowances?

4 Developing Guidelines that will achieve these objectives

This section provides our initial position on how we could achieve our objectives through:

- setting out principles for the selection of assessment techniques to include in the Guidelines
- identifying a wider set of assessment techniques that could be included in the Guidelines
- our initial thoughts on further work on assessment techniques
- modifying the way in which we go about the assessment of expenditure during the regulatory determination process.

The AEMC's rule changes have also resulted in a number of new obligations in relation to expenditure incentive mechanisms. Specifically, we are required to prepare a capital expenditure incentive guideline and a capital expenditure sharing scheme. The final section of this section flags our initial understanding of how changes in our expenditure assessment approach might interact with the existing incentive schemes and new guideline obligations. We will release a separate issues paper on expenditure incentive schemes in 2013.

4.1 Principles for the selection of assessment techniques

A wide range of assessment techniques can be employed to assess expenditure forecasts. Some of these techniques are well established and regularly applied, while others are relatively new or still in development.

Each of the available techniques has advantages and disadvantages and some are most useful in specific or targeted roles. Many of the techniques are complementary to each other in that they provide a better outcome when used together. For example, the trending of expenditure from a base year is often supported by an engineering or benchmarking assessment to test the efficiency of the base year and identify any non-recurring items.

Historically, we have used the available techniques in the manner that we considered most appropriate to assess the expenditure forecasts that were presented by NSPs. This has resulted in variations in the use of the assessment techniques between determinations. While some of this variation has been due to the ways individual NSPs have provided their forecasts, some variation has also been due to the availability of relevant data at the time and, at least in respect of some early determinations, our resources and consultants involved in each determination. This also reflected the initial stages of developing our approach to regulation.

In light of the wide range of assessment techniques and the experience gained over the first cycle of determinations, we consider that there is merit in setting out principles for selecting the assessment techniques to be included in the Guidelines.

The expenditure assessment task

The NER require us to use a cost-based approach to determining building block revenue requirements. That is, future revenues must be set at levels that are expected to allow NSPs to recover efficient levels of future expenditure incurred in providing network services.

The NER formalise what we need to consider in assessing the level of expenditure that will determine revenue allowances. NSPs are required to include in their proposals the expenditure that they consider is required to meet the capex and opex objectives. The objectives are to:

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

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

(3) maintain the quality, reliability and security of supply of standard control/prescribed transmission services;

(4) maintain the reliability, safety and security of the system through the supply of standard control/prescribed transmission services.[7]

The NER expenditure criteria require us to decide whether the expenditure forecast reasonably reflects the costs of achieving the objectives. Specifically, the efficient costs, the costs that would be incurred by a prudent operator, and a realistic expectation of the demand and cost inputs required to achieve the objectives.[8] The NER also identify a number of factors we must have regard to when assessing forecast expenditure.[9]

Forecasting, or estimating the likely outcome from of a range of possible future events, requires an understanding of the many variables that influence future events. For example, the amount of expenditure incurred in providing network services depends on the type of network services provided, the number of services of each type supplied, the technological processes required to produce each type of service, and the price of the inputs required to produce the services.

In considering the efficient level of future expenditure, we can investigate the prudent and efficient amount of expenditure required to provide the services required by customers at a particular point in time. But efficiency may also include improvements in both the cost and quality of the services supplied.

Typically it is competitive pressures that encourage businesses to continually improve their product offerings (both in terms of price and quality). However, network services are not provided competitively.[10] To compensate, we may look to replicate competitive pressures in the approach used to determine expenditure allowances.

Therefore, an assessment of efficiency may not only involve an investigation of the appropriate amount of future expenditure required, but also a consideration of how the approach used to estimate future expenditure encourages efficiency.

The NER also formalise this concept of efficiency as a process of improvement. The NER provide for the operation of incentive schemes that adjust prices (and hence the return to shareholders) to

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7 NER, clauses 6.5.6(a), 6.5.7(a), 6A.6.6(a), and 6A.6.7(a).

8 NER, clauses 6.5.6(c), 6.5.7(c), 6A.6.6(c), and 6A.6.7(c)

9 The factors include but are not limited to the most recent benchmarking report, previous actual and forecast expenditures, relative prices of operating and capital inputs, incentive schemes, and consideration of non-network expenditures. See: NER, clauses 6.5.6(e), 6.5.7(e), 6A.6.6(e), and 6A.6.7(e).

10 Licences are required before a business can provide network services, and current licence holders have a monopoly in their licence area.

provide incentives for NSPs to realise improvements in the cost and quality of network services. The NER also now require that we have regard to the operation of incentive schemes in assessing expenditure.[11]

The concept of efficiency contained in the NEO and the revenue and pricing principles reflects a longer term perspective, addressing the interests of consumers and the implications investment requirements over the long term. In this context we will be assessing expenditure proposals from a whole of life perspective, with NSPs expected to provide evidence they have considered investment and operational decisions over this timeframe. Such decision making processes are expected to be embodied in the reports prepared by NSPs under the NER's regulatory investment tests for transmission and distribution, as well as network planning reports under the revised NER requirements. We expect to refer to these and broader network planning arrangements when making our decisions on efficient expenditure allowances. We also anticipate more active communication between NSPs and consumers with respect to what will be delivered by expenditure proposals and meaningful discussion around potential trade-offs in price versus service delivery outcomes.

Hence, in light of the above, our task is twofold:

1. To assess forecasts, recognising future events and circumstances that affect expenditure levels

2. To assess efficiency, noting the need to balance the dual role of the assessment approach in setting immediate price levels and encouraging ongoing expenditure efficiency

Assessing forecasts

Forecasting, or estimating the likely outcome from a range of possible future events, requires an understanding of the factors on which the future events rely. There may be numerous factors that future expenditures are contingent upon, some of which are outside the control of the NSP. For example, future expenditure incurred on replacing a wood pole on a low voltage distribution line may depend on:

- when the pole is likely to need replacing
- the location of the pole, its configuration, its proximity to surrounding structures, proximity to traffic and other hazards, its distance from the NSP's depot, access to the pole and the number of customers served from the pole
- the type of replacement pole that is to be installed
- the type of labour and work processes required to undertake the pole replacement
- the price of the pole, labour, and other materials required for the pole replacement activity
- regulatory requirements about the standard of poles to be used and the configuration of low voltage distribution lines
- regulatory requirements about the standard of work processes applied to remove and dispose of the old pole, install the replacement pole, maintain safety to the NSP's employees, and to maintain safety to the general public.

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11 NER, clauses 6.5.6(e)(8), 6.5.7(e)(8), 6A.6.6(e)(8), and 6A.6.7(e)(8).

However, for the assessment of forecasts, if the NSP's current circumstances are known, then we may only be concerned with changes to these circumstances. In this case, the number of pertinent contingent factors may be significantly reduced. For example, the NSPs have been incurring costs in connecting new customers for decades, and are likely to continue to do so for many more. As the relevant regulatory requirements may not change over the future period we may consider that the NSP's current levels of expenditure already reflect the influence of the relevant regulatory requirements, such that any forecasts based on these current or historical expenditures will necessarily also reflect the influence of these regulatory requirements.

Under this approach, factors that are often static—such as regulatory requirements, topography, and climate—may be deemed to be reflected in 'base' data and therefore not required to be specifically incorporated into an initial forecasting method. However, if a typically static factor is expected to change in the forecasting period, we may revise the initial forecast to account for the influence of the expected change on the expenditure forecast.

This leaves those contingent factors that often or typically fluctuate—such as consumer demand, input prices, and technical efficiency—as the important factors to include in forecasting methods. We must determine which factors are likely to have a significant influence on future expenditure, and the way in which these factors may affect expenditure.

Techniques designed to assess forecasts at a total level, while considering all significant factors on which expenditure is contingent, can become complex. To simplify and gain greater control over the forecasting task, we may also apply assessment techniques that consider components of the expenditure forecast separately.

To assist with forecasting, expenditure categories need only be distinguished at a level of detail sufficient to identify the effect of a contingent factor on expenditure. For example, a NSP's expenditure may be influenced by the frequency, concentration and severity of storm events that damage its assets. To forecast the effect of storm events on the NSP's future expenditure, we may wish to isolate the expenditure incurred in rectifying damage from storm events.

However, to enable reliable comparative analysis, expenditure may also be distinguished in greater detail than that required for simple forecasting.

Assessing efficiency

A simple description of efficiency is 'producing more with less'. This statement infers a relationship: more than whom, and less than whom? Investigating efficiency therefore requires comparative analysis. Actual or 'realised' efficiency can be observed by comparing a business' current productivity to its past productivity, or by comparing the productivity of one business to another. Comparative analysis that utilises such actual or 'realised' data provides an objective, transparent and replicable method for assessing efficiency.

Another method of assessing efficiency is to compare a business' expenditure to an idealised alternative that has not been directly observed from the past performance of a NSP. This type of alternative may be derived by using industry expertise on what courses of action, although not directly observed from other NSPs, may still be likely to be achieved. For example, this method may be used in situations where we conduct detailed review of individual projects, for which reliably comparable actual or 'realised' data may not be available due to the specificity of the project.

For example, in our determination for Aurora Energy for the period 1 July 2012 to 30 June 2017, we undertook an engineering review of the proposed Sandford conductor augmentation project. In the draft determination we considered that the scope of the project was too extensive and that a lower-cost option was likely available. In response to the draft determination Aurora Energy submitted a revised proposal for the Sandford conductor augmentation at a significantly lower cost.[12]

Our preference is to use objective comparative analysis based on actual or 'realised' data in the first instance and wherever possible. Efficiency can be encouraged by using the revealed data on comparative performance, as NSPs are then encouraged to either improve their performance or are rewarded for achieving comparatively superior performance. Comparative analysis creates an additional incentive for NSPs to improve performance. Not only are they encouraged to improve on existing performance, but they are encouraged to improve performance relative to their peers.

However, we may, from time to time, find benefit in using comparative analysis that is subjective in that it is not based on revealed performance. For example, a regulatory proposal lodged by another NSP may propose an innovative approach to deferring the need for network augmentation in response to increases in maximum demand. Alternatively, expert engineering analysis may find that significant improvements in performance are obtainable. We may consider this in forming a view about a NSP's regulatory proposal.

It follows that in order to conduct comparative analysis we will require expenditure to be expressed consistently across services providers and over time. At the same time, it is equally important for any comparative analysis to identify and, where reasonable, account for uncontrollable factors that may influence differences in expenditure between NSPs.

Uncontrollable factors that influence differences in expenditure across NSPs must be:

- supported by evidence, with the onus on network businesses to demonstrate these differences exist, including how they might materially impact on discrete parts of their networks
- capable of robust measurement over time and are ideally quantifiable from an independent source.

Identifying techniques that are best suited to the expenditure assessment task

There are multiple techniques that can assist us in our task of assessing forecasts and efficiency. In some instances, these techniques can be complementary. For example, economic benchmarking techniques such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA) could complement existing techniques that are confined to specific types or drivers of expenditure by providing insight on how changes in the input mix could result in increased output for a similar or lower cost of production.

In other instances, the assessment techniques may not be complementary and may seek to provide the same information. For example, we have applied a particular approach to calculating a network growth scale parameter for developing and assessing recurrent operating expenditure in past reviews. However, it would be also possible to seek to model recurrent operating expenditure using regression techniques.

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[12] AER, *Final distribution determination: Aurora Energy Pty Ltd: 2012-13 to 2016-17: Attachments*, 30 April 2012, p. 73.

In addition, assessment techniques can be applied to achieve varying degrees of accuracy. For example, in conducting comparative analysis, we could look at the average cost of responding to an increase in maximum demand, or alternatively we could seek to model the network impact of a change in demand on augmentation and demand management needs in a network area.

We need to be able to identify a set of assessment techniques that best meet our objectives in assessing expenditures. The Productivity Commission recognised that a key question was '…how to separate the wheat from the chaff' among the various competing approaches, recognising that this will typically involve balancing across various criteria. The Productivity Commission also set out its perspective of the appropriate evaluation criteria for benchmarks and benchmark practices[13].

We will need to consider costs and benefits in deciding on the techniques that should be included in the Guidelines. However, in conducting this analysis we are interested in comparing the costs of selecting a particular assessment technique to the long term benefits.

Consistent with our role as an independent regulator, we consider that the assessment techniques should enable us to form a view on forecast expenditure in a way that is objective, unbiased, transparent and replicable. The application of such techniques will promote stakeholder confidence in the regulatory process, reducing investment uncertainty and thereby promoting efficiency as required by the NER.

Further, it should be recognised that there is always a level of forecasting error in all of the techniques that we (and NSPs) apply. However, the techniques in the Guidelines should seek to minimise this to an extent that is commensurate with our role in assessing forecasts of expenditure in aggregate. We do not wish to employ techniques that draw stakeholders into a level of detail regarding immaterial amounts of expenditure, with materiality determined in the context of the inaccuracy inherent in the overall expenditure allowance and the degree of risk/ benefit sharing between NSPs and network users.

Our initial position on the principles for the selection of assessment techniques is detailed below. It should be noted that not all of these principles are going to be necessarily relevant to a decision between different techniques.

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[13] Productivity Commission, *Draft report: Electricity network regulatory frameworks*, October 2012, pp. 156–176.

Box 3 Principles for the selection of assessment techniques

Principle 1

Assessment techniques must be relevant to expenditure review task before us. Our expenditure assessment task involves:

1. Assessing forecasts – recognising future events and circumstances that affect expenditure levels
2. Assessing efficiency – noting the need to balance the dual role of the assessment approach in setting immediate price levels and encouraging ongoing expenditure efficiency

Principle 2

All else being equal, our assessment techniques should be based on objective comparative analysis and should use actual or 'realised' data in the first instance and wherever possible. However, in some instances we may find benefit in using a subjective project review.

Principle 3

Additional detail and complexity should not be added to our assessment techniques unless it improves the reliability or accuracy of the assessment of forecasting and comparative analysis beyond the levels of natural variation in exogenous factors that affect changes in expenditure.

Principle 4

If the NSP's current circumstances are reflected in current operations (expenditure, maintenance cycles, asset lives, unit rates, safe working practices etc) then we may apply assessment techniques that examine changes to these circumstances (rather than using assessment techniques that rebuild those circumstances).

Principle 5

The assessment techniques should only require expenditure to be distinguished to a level of detail sufficient to:

- identify factors that cause expenditure levels to change over time
- ensure consistency across NSPs and over time, and
- identify uncontrollable factors that influence expenditure and that differ across NSPs.

Question 6

Are there any other principles that you think that should be added to this list? Should we include principles that guide the selection of the assessment techniques to be applied in the framework and approach stage, from the list of appropriate techniques (that will be) outlined in the Guideline? If so, do you think that the principles outlined here provide appropriate guidance on technique selection?

4.2 Expenditure assessment techniques

Drawing on our direct experience in recent reviews and understanding techniques applied by other regulators, this section provides an overview of the identified techniques:

- engineering review
- trend analysis
- governance and policy reviews
- expenditure benchmarks
- modelling.

Each of these techniques is described briefly below. We also consider the differing ways in which these techniques can be applied, the sort of data required for the technique, the expertise required to apply the technique and provide recent examples where the technique has been applied.

Engineering review

Engineering reviews typically assess a set of projects or proposed activities. The review can include all expenditure, expenditure in a category or process or a sample of projects or activities. Engineering reviews essentially replicate the internal decision making processes that surround a project or activity and require a significant amount of information to be provided by the business. The more expansive the review, the greater the level of information required and the effort required to assess. We have used engineering reviews, varying in scope and intensity, in every expenditure determination we have undertaken.

The use of engineering assessments can provide a more detailed and potentially more accurate assessment than other techniques and is flexible enough to support the assessment of expenditures that are new or changing. However, this technique is relatively intrusive and costly, and is typically used to review a smaller set of sample projects. The selection process may include targeting projects or activities based on materiality, their non-recurrent nature, changes in expenditure levels, or a random sampling. We and our consultants have made extensive use of sample project reviews in transmission capex assessments. In doing so we have selected up to 25 projects that capture augmentation, replacement and non-system investments. These reviews have covered up to 50 per cent of the entire capex proposal by value.[14] While this is a significant proportion of the total, it is often the case that findings in the sample cannot be readily extrapolated to the entire proposal.

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[14] See for example: Energy Market Consulting associates, *Powerlink Revenue Determination: Technical Review - Forecast Capital Expenditure and Service Targets*, 6 September 2011, pp. A6-A7; Energy Market Consulting associates,

Because this technique is costly, time intensive and intrusive, particularly for distribution businesses, it is used in a more targeted way and typically in conjunction with other assessment techniques. It is also relevant where the particular benchmarking technique suggests that greater scrutiny for a particular expenditure item or area is required. In recent years we have used modelling and benchmarking to aid in targeting the use of engineering techniques.

Trend analysis

This technique is used to forecast future expenditure levels based on historical information. These forecasts are then used to identify variations from the expenditures proposed by the NSP.

This technique is valuable for expenditure categories that exhibit relatively consistent levels of expenditure over time and is therefore often used for categories of operating expenditures. Consistency in the reporting of information against clear and understood definitions over time is critical to the successful use of this technique.

Expenditures that are new or vary from historical norms are typically separated and considered using other techniques such as engineering reviews.

Over recent years we have employed a "base step trend" model for assessing opex proposals. NSP proposals have also been based on this approach. This model is focussed on the forecasting of operating expenditures from a base year. Expenditures for future years are developed through a set of inputs that modify the base year to account for factors such as network growth, economies of scale, labour and materials escalation as well as more discrete 'step changes', such as changes in regulatory requirements.

The process typically applied for this technique requires the identification and definition of the scope of the analysis, collection of the data, the analysis and review. The process will often also include a number of audit and review steps to ensure the validity of the information.

Governance and policy reviews

This technique considers the adequacy of the governance processes that the business has in place. The initial steps of this review require NSPs to provide documentation relating to governance, strategic planning and other business-wide processes that impact expenditures. These documents are then assessed against best practice to identify any process or informational gaps.

This technique is in essence a process review and requires expertise across a broad range of subjects including governance, strategic planning, risk management, asset management and capital or project prioritisation. Being a high-level review, the impact on the NSPs and the costs of the review are relatively low, however it may be difficult to quantify the expenditure impacts of any identified process or informational gaps.

This technique is considered more applicable to the assessment of governance processes for large projects as delegations are often provided for small and ongoing activities. In the past, we have examined governance processes in order to provide some insight at a higher level on the likely

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ElectraNet Revenue Determination: Technical Review - Advice on Forecast Capital and Operating expenditure, Contingent Projects and Performance Scheme Parameters, 30 October 2012, p. B-2.

efficiency and prudence of expenditure proposals, and to supplement findings from detailed project reviews.

It is not likely that governance reviews would be sufficient as a standalone technique for reviewing expenditures but would be useful as an adjunct to providing an assurance of the robustness of forecast expenditures.

Expenditure benchmarks

This technique seeks to provide comparable information across expenditure categories, processes or activities that are common to NSPs.

This technique covers a large variety and scale of benchmark types. A high-level benchmark could include total operating expenditure or total capital expenditure. It also includes the economic benchmarks (such as total factor productivity) discussed below which examine industry trends and frontier analysis. NSPs' processes can also be compared using benchmarks of disaggregated expenditures such as vegetation management, asset replacement, customer growth, etc. At the detailed level, benchmarks can be used to assess individual units of expenditure such as the cost to replace a pole, inspect a substation or clear a kilometre of easement.

We and our consultants have utilised numerous expenditure benchmarks in previous network determinations. Many submissions by NSPs have also included expenditure benchmarks.

There is an initial cost to establishing a benchmarking technique including identifying the target categories, establishing definitions, capturing and reporting of information, and the analysis and reporting of the benchmark outcomes. The ongoing costs of applying the benchmarking techniques usually reduce once the systems are established.

The identification of external environmental variables that may impact expenditures is important to the overall accuracy of the benchmark. This technique is typically more effective when a standardised process or activity is being assessed. High-volume activities that are common across NSPs are therefore the primary candidates for this assessment technique.

Examples of the expenditure benchmarks used in recent determinations include operating expenditure, capital expenditure and process benchmarks of the Tasmanian and Victorian DNSPs.

Modelling

This technique requires the development of a technical model to replicate the decision making process or processes of the business. The expenditure modelled may range from whole-of-business to a specific process or activity.

The models require the establishment of standardised definitions and expenditure categories, the building of the base model architecture, and the collection of standardised data across these categories from NSPs. Typically the initial models require audit and review to assess their operation and forecasts.

The models are typically data intensive and require detailed definitions. The models may also seek to make allowances for external environmental variables and recognise changes in reliability or quality of service. While the initial establishment of these models is relatively data intensive, the ongoing operation may become simpler and more mechanistic as the processes and definitions are bedded down.

This technique has the benefit of providing longer term forecasts, and the potential to compare expenditure units across regulated businesses. The models can also reference "base year" expenditure to provide a more accurate starting position and recognition of an individual NSP's circumstances. The ability to identify and quantify the impacts of external factors is limited and may add significant complexity to the model. The integration of reliability and service level outcomes can also be problematic.

Whole-of-business models have been developed by some regulators.[15] We have developed two process/activity based models covering the areas of replacement capital expenditure (repex) and augmentation capital expenditure (augex) which are explained in further detail in attachment B.

Our repex model has been recently used in reviews in Victoria and Tasmania. The augex model is currently in development and has yet to be used in a determination process.

Question 7

Are there any assessment techniques that should be considered as forming part of the guidelines? What are the relative benefits and shortcomings of each of the approaches and how could the latter be addressed?

4.3 Proposals for further work

This section outlines our current views on where we would like to work with stakeholders to expand and formalise various expenditure assessment techniques, in line with the objectives outlined in section 3. In particular, we are interested in making more robust decisions on aggregated expenditures, rather than on bottom up assessments, with a particular focus on benchmarking analysis and more sophisticated analysis of expenditure drivers.

Aside from the general explanations above, we have not attempted to explore in detail our existing methods in this issues paper given that they reflect the status quo and are relatively known to NSPs and other stakeholders. We anticipate that these techniques, such as project sampling and trend analysis, will form part of the Guidelines. We are interested in suggestions on how these techniques can be improved and combined with new methods of analysis. Where relevant, and in many cases below, we refer to these techniques in the context of category based analysis where stakeholders will be able to make meaningful comment.

The focus of our proposed work program can be broken down into two separate areas:

- category based assessment via extending our use of some techniques and better integrating others
- total expenditure assessment (capex, opex and/or totex) via economic benchmarks.

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15 T Jamasb, and M Pollitt, *Spain and Switzerland - Reference models and incentive regulation of electricity distribution networks: An evaluation of Sweden's Network Performance Assessment Model (NPAM),* 5 January 2008.

Both areas are described in general terms below, with more detail and questions for comment in attachments A and B.

Category based assessment

This approach adopts the same general principles underlying much of the cost reporting already done by NSPs where expenditures are categorised according to a particular explanatory variable or "driver" and otherwise according to organisational activities. It attempts to set efficient expenditures based around the relationship between variables and expenditures, and in doing so combines elements of:

- benchmarking – for example the expenditure per unit of explanatory variable across NSPs at a particular point in time
- revealed costs – relying on incentives to produce an efficient level of expenditure in relation to the measured explanatory variable
- trend analysis – how the driver affects expenditure over time
- modelling – through forecasting of the explanatory variables and hence the related expenditure.

Attachment B outlines some of our detailed thinking and questions for stakeholder comment. Below we summarise our general position and outline some issues for further consideration.

General approach

Our approach to driver based assessment will be firstly to attempt to benchmark an efficient base year cost per volume of expenditure driver. From this, forecast volumes could be determined via historical averages or predictive methods, such as replacement volumes from the repex model, or best practice inspection and maintenance cycles for particular asset types. Both base year and projected volumes would need to be adjusted for uncontrollable or once-off factors such as new legislative obligations, customer density, changes in the rate of demand growth and asset deterioration, as well as different target levels of risk or service performance.

The setting of benchmarks would need to take into account various issues around frontier performance, including whether the highest ranking NSPs have efficiently scoped works, incentive effects and measurement error. We will seek to test the robustness of our proposed drivers and categories and explore alternative measures with stakeholders in the coming months. We anticipate devoting considerable effort to identifying conceptual and empirical evidence of uncontrollable factors and other issues that detract from benchmarking and deriving relationships between expenditures and volume drivers. This general approach will not be possible for some individual expenditure categories which could be captured in a combined opex/capex, base-and-trend approach or subjected to various other assessment techniques.

Examples of drivers examined in the past are asset replacement and growth in maximum demand. However these previous categorisations and drivers have tended to be fairly general and could be improved to allow more robust comparisons over time and between NSPs. In particular, most direct expenditures are proportionate to asset type (for example, the cost of the asset itself and particular maintenance cycles) as well as being affected by a variety of exogenous factors which may be difficult to systematically account for at an aggregated level.

Prior work by AER and comparisons to Ofgem's approach

We have undertaken an examination of existing reporting across NSPs in the NEM, and a thorough consideration of measurable volume drivers, in order to arrive at an initial position of how categories should be separated for this purpose. The majority of the categories match the types of expenditure that have been generally used throughout the sector and in past resets, and for which our current assessment techniques have been developed. These include categories for replacements, augmentations, new customer connections, maintenance etc. However in order to derive robust relationships between driver and expenditures we suggest that further detail underneath these general categories, such as by asset type, voltage and region, may also be required.

Our analysis has also been informed by work currently being undertaken by Ofgem in preparation for its next price control determination for electricity distribution[16] as well as its recent determinations in gas distribution.[17] A key element of Ofgem's cost assessment framework is to apply regression analysis to panel data (i.e. for multiple businesses over several years) of categories of expenditure and scale variables to benchmark efficient expenditure on a per unit basis. The units are then projected forward using a variety of other analytical techniques and multiplied by the regression coefficients to derive expenditure allowances for the regulatory control period. Uncontrollable costs are accounted for outside of the regression analysis through the use of NSP specific adjustments as well as for, in limited cases, generic factors such as customer density and regional labour cost differences. Some types of expenditure are assessed through non-regression based techniques, such as detailed engineering assessment and project based reviews. Ofgem combines almost all expenditure items into aggregated capex, opex and totex regressions to supplement its category based assessments and to capture whole of business efficiency (e.g. captures trade-offs between capex and opex).

We note that the amount of information collected by Ofgem in performing this task is significantly more than we have collected in our RIN templates to date, and reflects the evolution of an approach over many rounds of price determinations. In particular, considerable effort has gone into identifying volume drivers and expenditure category definitions with NSPs over many years and is still in refinement. Ofgem's regulatory framework also incorporates various uncertainty or risk sharing mechanisms which change the nature of expenditure assessment for some items (e.g. only unit costs are determined, with expenditure allowances/ revenues fluctuating during the price control period according to volume fluctuations).

Further issues for consultation

We anticipate continuing with our current approach of analysing categories of real costs escalators (e.g. labour, various input materials). These escalators will be separately assessed and applied on top of the amount of efficient costs assessed using other techniques. We do not have a particular view at this stage on how this should be done, however have a strong preference to standardise this approach. We note that most NSPs have used methodologies developed by consultants such as SKM in the past, and also see potential to reach agreement with stakeholders on independently derived forecasts, such as those published by ABARE, Consensus Economics, state treasuries and the ABS.

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16 Available at: http://www.ofgem.gov.uk/pages/moreinformation.aspx?docid=36&refer=networks/elecdist/pricecntrls/riio-ed1/consultations.

17 Available at: http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=438&refer=Networks/GasDistr/RIIO-GD1/ConRes .

We are also mindful of different cost allocation approaches used by NSPs being a potentially major source of incomparability in benchmarks. For example, some NSPs fully allocate their costs to activities or drivers such that items like head office costs are reported against categories such as asset augmentation and replacement. Our initial position is to employ a method that is neutral to the allocation of indirect costs and so suggest requiring NSPs to allocate all costs to volume drivers. This method relies on there being reasonable methods to do so in all cases (which could differ across NSPs), otherwise we may require methods to be standardised. In this way, reported expenditures would reflect the full cost of undertaking that particular activity or responding to a particular volume driver. The application of benchmarks would similarly reflect the efficient cost of undertaking that activity in its entirety.

We are interested in stakeholder views on this approach. In particular we recognise it may have shortcomings where expenditures simply reflect arbitrary allocations of indirect costs that are unrelated or invariant to volume drivers, or vary in different ways than direct costs. It may be preferable to examine indirect costs in isolation in order to improve the robustness of relationships measured between direct costs and drivers. Ofgem's experience in examining these matters may be instructive, where expenditure on "closely associated indirects" (e.g. network planning) is examined according to different drivers than for direct costs. Similarly, "business support costs" (e.g. CEO, HR costs) are benchmarked against "metrics" across a wider variety of industries as they typically bear no discernible relationship to drivers such as asset condition/ risk or demand growth.

We are also interested in exploring similar issues in dealing with different approaches to capitalisation (the policy of reporting certain costs as capex or opex and also whether a capex or opex solution is adopted) as well as different outsourcing approaches. These may be best accounted for by examining expenditure categories simultaneously rather than in isolation. However, given the importance of benchmarking analysis we may consider mandating particular approaches to capitalisation and cost allocation across NSPs for the purposes of regulatory reporting, and seek views on alternative methods to overcome problems of incomparability in reporting.

Overall we anticipate that relationships between volume drivers and expenditures will be more robustly measured for low value, high volume type works which are recurrent in nature. Choosing categories at higher levels of aggregation, with combined volume drivers, may also assist where differences at more detailed levels of aggregation are averaged out. In considering some capex expenditure categories, Ofgem has taken averages of several years of data in order to smooth out lumpy or irregular expenditure profiles.

Category based assessment will need to consider network expenditure in total. Benchmarking assessments that only determine expenditures at the category level will, when aggregated, reflect an artificial and unrealistic benchmark NSP. Basing the expenditure assessment initially on totex also promotes benchmarking across DNSPs because it ensures that it is the total cost of addressing a particular need that is being compared. Differences in capitalisation, cost allocation and outsourcing across DNSPs are less likely to distort the benchmarking analysis.

A further matter for consideration is our approach to assessing forecasts of maximum demand which are an important input into augmentation expenditure. We have also examined a number discrete expenditure types including debt and equity raising costs, self insurance, related party contracts and cost estimation risk factors, where we are interested in considering a standardised approach to assessment for all NSPs. We are interested in your views on whether any existing approaches to these expenditure types are appropriate and whether they should be specified in the Guidelines.

Question 8

Do stakeholders agree with our general approach of attempting to derive quantitative relationships between expenditures and drivers? Are there better, more cost effective alternatives to assessing disaggregated expenditures?

Question 9

Do stakeholders have any in-principle comments about the level of expenditure disaggregation given our expectation that lower levels of aggregation e.g. by asset type, are likely to be conducive to more robust benchmarking and other quantitative analysis?

Economic benchmarking techniques

Attachment A outlines four general methods to assess the overall efficiency of the firm, namely:

- Total Factor Productivity (TFP)
- Econometric modelling
- Data Envelopment Analysis (DEA)
- Stochastic Frontier Analysis (SFA)

These methods employ economic theory regarding the behaviour of firms in order to estimate relative efficiency and how this changes over time. The methods also provide a framework for decomposing the various types of efficiency affecting NSPs. Each method has its various advantages and disadvantages, data requirements, levels of sophistication and transparency.

We are proposing to develop these techniques and conduct higher level 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[18]
- 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.

[18] For example, small inefficiencies at an individual category level may compound into large overall inefficiency.

Question 10

Do stakeholders agree that economic benchmarking will be an important adjunct to more detailed expenditure assessments?

4.4 Expenditure assessment process

We consider there is merit to providing more guidance on how we will integrate our new assessment techniques and Guidelines into the new regulatory determination process. In contrast to our existing approach where all stakeholders are only made aware of the our views on the NSP's expenditure forecasts at the draft determination stage, we consider it would be more useful for stakeholders to have our initial views on forecast expenditure brought forward to the issues paper stage in the regulatory determination process.

At this earlier stage we would ideally be in a position to present the results from the application of our assessment techniques aside from detailed engineering review, such as trend analysis, expenditure benchmarks or modelling. This process would form our 'first pass' of the NSP's proposed expenditure. The first pass of expenditure assessment is detailed in Figure 1 below.

Figure 1 'First pass' review of expenditure in the new regulatory determination process

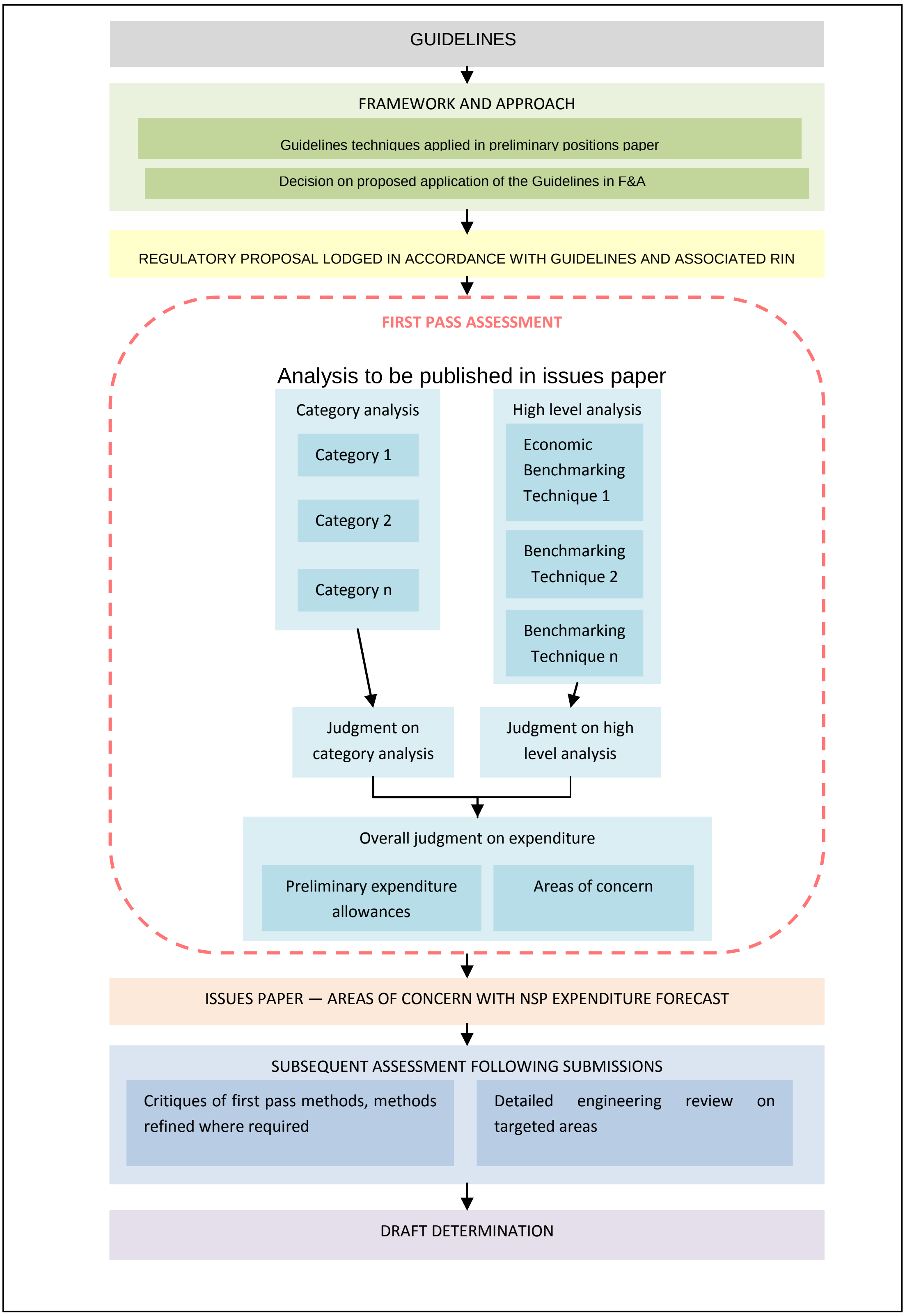

Figure 1 illustrates:

- At this stage we envisage that the Guidelines will outline a set of standardised expenditure assessment techniques. Under the NER, a decision on the application of the Guidelines to each

NSP occurs at the conclusion of the F&A consultation process. The details of further F&A consultation will depend on the final content of the Guidelines. As discussed in section 3.2 below, some assessment techniques we intend to implement will require the collection of standardised data over several years across all NSPs. This will need to be balanced against any calls to change or customise techniques during NSP specific determination processes.

- After the lodgement of the NSP's regulatory proposal, we could conduct our 'first pass' — a preliminary view of the proposed operating and capital expenditure that can be formed within the issues paper timelines (40 business days)[19] and used to highlight areas that warrant further investigation.
- Stakeholders would be provided the opportunity to make submissions on the application of techniques contained in the Guidelines as well as other data analysed with respect to the NSP's proposal.
- Subsequent to the first pass and the lodgement of submissions, we would have a better understanding of the areas that are contested by stakeholders. For some types of expenditure, we may need to address concerns about the application of some assessment techniques, and for others, a detailed review of matters of potential concern may be conducted.
- This detailed review may involve engineering review of proposed cost categories and/or review and refinement of the assessment techniques used in the first-pass. However, a well defined first-pass assessment methodology could streamline the assessment of opex and capex and facilitate a more targeted use of engineering consultants.
- The draft determination process would provide a further filtering of issues with the application of our assessment techniques.

Question 11

Do stakeholders agree that the first-pass process described above is a useful and appropriate application of expenditure assessment techniques?

4.5 Expenditure incentive schemes and their application

One of our objectives is to complement our existing set of assessment techniques to include a greater reliance on benchmarking and to formalising this in the Guidelines. This will enable us to compare the costs (both actual and forecast) of each NSP to assist us in forming a view about a NSP's expenditure proposal.

However, where we decide to adjust a NSP's forecast based on assessment techniques that involve benchmarking, we may also need to consider what expenditure incentives should apply to that NSP during the regulatory period.

For example, we currently apply an EBSS to operating expenditure. This scheme features a carryover mechanism whereby the benefit or loss of any under or over spending with respect to the expenditure allowance is retained for a fixed period of time. This mechanism is employed because where a base, step, trend technique is applied to assess forecast expenditure NSPs have the incentive to shift

19 NER, clauses 6.9.3(b) and 6A.11.3(b).

expenditure to the base year in order to inflate forecast expenditure. The EBSS counterbalances this incentive and provides a continuous incentive for NSPs to reduce expenditure and a constant sharing ratio of efficiency gains between consumers and the NSP.

However, as we progressively increase the use of benchmarking assessment techniques to form a view about proposed expenditure, the need to use a carryover mechanism to counteract the incentive for NSPs to shift operating expenditure to the base year will decrease. This is because we will be less reliant on the revealed costs of an individual NSP in assessing and making adjustments to its forecast expenditure.

An additional issue is whether once our benchmarks are established, we should retain the application of a revealed cost approach combined with the existing EBSS for NSPs that perform well compared to their peers, or whether benchmarking assessment techniques should be applied to assess the expenditure forecasts of all NSPs and the need to amend incentive arrangements to accommodate this.

There is a separate work stream on incentives that will consider these matters and we will coordinate the development of the expenditure assessment Guidelines and incentives.

Question 12

Do stakeholders have any views on the relationship between the assessment tools that we have identified, and our existing incentive schemes? Given the interrelationship between the two, and that our incentive schemes are to be revised over 2013, what processes should we follow to ensure there are appropriate incentives on NSPs to make efficiency gains, while at the same time implementing appropriate expenditure assessment techniques?

5 Implementation issues

5.1 The Guideline, benchmarking report and determinations

Our expenditure assessment approach, which we intend to standardise to a significant degree, will be the subject of various consultation processes and documents, affecting its implementation and development over time. In this context we note the following:

- Most, if not all, assessment techniques currently contemplated require data to be reported against particular definitions that will (ideally) not be subject to change for several years. This will require lead times in developing associated templates, and in collecting and ensuring compliance in reported data.
- Some techniques also require the same data to be reported by all NSPs for the purposes of comparison, regardless of whether they are subject to a current determination process.
- Data collected for benchmarking and other assessment purposes arising from the Guidelines are very likely to be used for the purposes of annual reporting on NSP performance, including the new requirement to publish benchmarking reports.
- Most techniques that are likely to form part of our first Guidelines will be untested, particularly with nationally consistent data. Even those that are relatively stable will inevitably require some refinement in the future. This could be at the time of the draft and final determinations, during F&A processes or in periodic revisions to the Guidelines.
- As with many aspects of our decisions, complications are likely to arise where a particular NSP appeals the use of a certain method or data source and a Tribunal ruling is not forthcoming until well into or after the completion of subsequent determination processes.
- Our experience and that of other regulators is that no single assessment technique is perfect and many require (at the request of the regulator or of regulated businesses) further data that cannot always be contemplated at the time the technique is defined conceptually.
- Some techniques may appear robust and agreed upon at an early stage, however, ultimately they may be abandoned or subject to revision if they cannot produce sufficiently reliable and accurate results.

Some of these observations underlie the Productivity Commission's draft findings regarding the robustness of benchmarking to date. We and previous state regulators have been constrained in developing data sets with sufficient numbers of consistently defined observations to construct robust benchmarks in most areas of expenditure. While having a national regulatory framework has the potential to address these challenges, we face the practical reality of having to make determinations for NSPs on a staggered basis. The staggered timing of determinations tends to result in assessment methods being incrementally and frequently refined, rather than subject to considered and wholesale review, for example that undertaken by Ofgem as a precursor to its new RIIO (Revenue = Incentives, Innovation and Outputs) framework which is now being applied to a single set of aligned determinations. Our experience, in contrast, was to try and maintain consistency in data templates used by jurisdictional regulators which we based around trend analysis. This has perpetuated differences in how data are reported across NSPs and hence detracts from detailed benchmarking.

We seek stakeholder views on managing these issues under a new nationally consistent approach. Given the staggered timetable for our determinations, we may need to acknowledge a certain degree of inflexibility in assessment approaches for a period of time. While this may seem undesirable or impractical in the face of techniques that naturally evolve, it may be acceptable where certain techniques can only be properly tested and refined after several years of data have been collected. An alternative approach, including over the shorter term, would be to only make incremental additions to data templates or to seek further levels of disaggregation in categories, rather than to remove or change categories over time. The burden and lead times in consulting on and implementing RINs that collect the same information from all NSPs will also need to be considered.

For benchmarking techniques, we are also concerned that NSPs may seek to strategically present information only at the time of their individual revenue determinations, rather than continually engage with us on these matters. Again, NSPs may be more incentivised to engage in the development of approaches where they have certainty that these approaches will apply for the longer term. The annual publication of benchmarking results and scrutiny by other stakeholders, as well as comparisons made in draft and final determinations, is expected to provide some incentive for NSPs to continually engage in the collection and presentation of data.

We would also be concerned if, for example, NSPs were to present arguments or data in their favour only after viewing benchmarking that indicates they are inefficient. Less weight may be placed on this information during the revenue determination process, however we would still want to encourage NSPs that present information as new data or methods genuinely come to light. We may also develop new methods or discover new data sources ourselves at any time in the assessment process. A better solution may be to release benchmarking results only after stakeholders have exhausted the opportunity to present arguments and information from an "in-principle" perspective. Any legal restrictions on NSPs, stakeholders or us in presenting new arguments and information, for example in the case of nominating new capex/opex factors in the F&A, or generally after the draft decision stage[20], will also need to be considered in this context.

We are interested in stakeholder views on the potential overlap between methods employed by NSPs to generate their expenditure forecasts and techniques we may use to assess them. In this context there is a new requirement on NSPs to inform us of their expenditure forecasting methods at least 24 months prior to the end of the regulatory control period, which is unrelated to our assessment Guidelines.[21] Given this notification would occur approximately one month before we publish our final F&A paper, the Guidelines are highly unlikely to be affected (as a general guideline, and also in their detailed application). This obligation is, however, likely to give rise to further discussions between us and each NSP in the pre-determination phase, potentially allowing us to further prepare our assessment methods, brief technical consultants and identify matters that could be explored in issues papers and ultimately in determinations. For the purpose of receiving information with the NSP's regulatory proposal, we typically initiate consultation on RIN templates from the time the final F&A is published. RIN templates may therefore be expanded to also cover matters pertinent to the NSP's forecasting methods in addition to the information required in the Guidelines, as well as other requirements listed in the F&A. The scope of RIN templates may be influenced by the amount of information NSPs provide on their forecasting methods and the degree to which some matters have been anticipated in the Guidelines.

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20 For example, through the operation of section 16(1)(b) of the NEL.

21 The timing requirements quoted here do not reflect transitional arrangements arising from the recent NER amendments.

Question 13

Do stakeholders have any comments on how best to manage the interrelationships between the guidelines, F&A processes, determinations and annual benchmarking reports?

Question 14

How would it be best to maintain a degree of consistency in assessment techniques and associated data reporting, while at the same time allowing improvements in techniques?

Question 15

Are there any ways the expenditure assessment process, including in preparing NSP forecasts, could be improved by linking the Guidelines, the F&A process and the NSP's obligation to notify us of its forecasting methods?

5.2 Detailed timing and transitional issues

The first Guidelines will be published by 29 November 2013. The first time they will be applied, as contemplated in the NER, will be in the F&A for NSPs in NSW and for ActewAGL, Transend and Directlink. This F&A process will be finalised in February 2014. Assessment techniques involving benchmarking for this determination process (and all those in the future) will require the same data to be collected from all NSPs in the National Electricity Market (NEM).

Our first benchmarking report, outlining analysis pertaining to "a 12 month period", must be published by 30 September 2014. This report will almost certainly apply any benchmarking methods (and potentially all methods relevant to efficiency assessment) contained in the Guidelines where sufficient data exist. As with determination processes, this report will require consistent data to be collected and analysed at the same time from all NSPs in the NEM. The purpose of these reports is to provide stakeholders with some useful information on the relative efficiency of NSPs. The usefulness of these reports will depend upon the effort involved in collecting data and in testing any results with NSPs prior to publication.

Each regulatory determination process would also necessarily require the use of benchmarking information as well as information specific to the NSP under consideration.

There is a question, therefore, about whether benchmarking reports, or determination specific RINs, would be the vehicle through which we collect and analyse benchmarking data for multiple historic years. One option is to continue the current practice whereby annual reporting simply supplements methods employed in the determination process. Less effort would be given to data cleansing and analysis provided in the benchmarking information requests than would be applied in the determination process. Alternatively, each benchmarking report may produce the results of each technique by adding one year of historic data to its inputs, thus providing a readily available and up to date set of analysis to be used for determinations as they arise. These are matters that require further discussion.

Most NSPs in the NEM report data on an Australian financial year basis and generally take around 3 to 4 months to close accounts for the year, audit and report data to us. Based on existing performance reports (which would require relatively little data manipulation), it would take approximately 2 to 3 additional months for us to process and properly analyse expenditure data for the purposes of making meaningful benchmarking comparisons. Hence if we were to publish data pertaining to financial years, the earliest publication date for benchmarking reports would be around December of each year, with a potential separate report in approximately June for NSPs reporting on a calendar year basis (i.e. Victoria). The publication process may also take longer if we were to firstly release benchmarking reports in draft form to NSPs and seek feedback on any misreported or misrepresented data, as is the current practice with performance reports. As the NER require us to consider benchmarking reports in setting efficient capex and opex allowances,[22] it will be in the interests of all parties to ensure the reports are as accurate as possible.

In order to reduce regulatory burden, and naturally following completion of consultation on the Guidelines, we are likely to issue RINs to NSPs in early 2014 for the purposes of the NSW/ACT process, with data submitted by the NSPs in line with regulatory proposals in May. It seems logical to use this same data for the purposes of the annual benchmarking report. Notices issued in early 2014 would cover data for the 2012-13 financial year and the 2012 calendar year. A full analysis of this data would be published around the time of our draft decisions for NSW/ACT, expected around November 2014. To comply with the NER's timing obligation, preliminary benchmarking analysis could be published in the annual benchmarking report by 30 September.

Beyond this first round of decisions and reports, however, coordinating the collection and reporting benchmarking information becomes problematic under the current determination timeframes. Figure 2 below illustrates the next cycle of determinations. The table assumes that second and subsequent benchmarking reports are published by 30 November each year. The last row of the table indicates we will be publishing benchmarking analysis (not including as part of issues papers under the 'first pass' suggested in section 4.4) up to four times a year.

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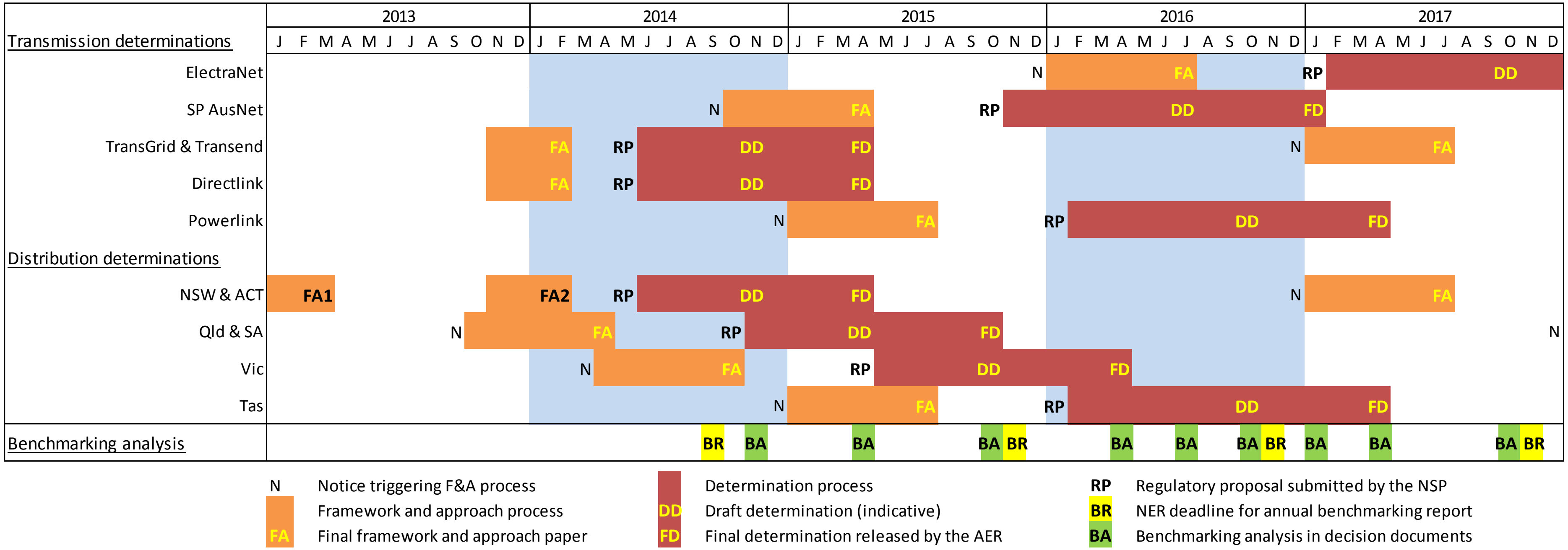
22 NER, clauses 6.5.6(e)(4), 6.5.7(e)(4), 6A.6.6(e)(4), and 6A.6.7(e)(4).

Figure 2 Timing of next round of electricity determination processes and benchmarking reports



In late 2014 we will publish draft decisions for several NSPs at the same time as receiving commentary or new information in response to our first benchmarking report. This may give rise to further data requests from all other NSPs included in the benchmarking analysis. New information will also arrive in the form of data templates and proposals from DNSPs in QLD and SA as well as from SP AusNet (transmission). At the same time, matters arising in the context of the Victorian F&A process may also influence our data requirements from all NSPs. Any new data would need to be collected and factored into our analysis for the final decision in NSW/ACT and the draft decision in QLD/SA in April 2015. This same information would likely be used in the benchmarking report for 2015, however a RIN to populate this report would need to be consulted on and issued by early 2015, that is, at the same time we are preparing draft and final determinations for all the aforementioned NSPs.

We have previously dealt with overlapping processes and arguments on the same issues, notably on the rate of return. Benchmarking has the additional and significant complication of potentially requiring the periodic issue of RIN templates (which need to be identical to ensure the robustness of analysis) as well as reports outside the regulatory determination process.

A solution over the longer term may be to align regulatory control periods across NSPs. This would have the significant advantage of focusing the sector's effort in a logical sequence, namely on the application of the Guidelines in a global F&A process, undertaking benchmarking analysis through the aligned determination process, and then assessing ongoing performance over the regulatory period. It would allow for the proper testing of methods in a single review process, and adequate time for reflection and refinement of techniques, rather than making frequent and incremental changes in constantly overlapping development, determination and review processes. Even if a full alignment were to occur at some point, we would still need an approach that allows us to develop and establish suitable techniques in the short term.

As highlighted above, the mix of calendar and financial year reporting across NSPs is likely to detract from the making of robust comparisons of expenditure and potentially add some administrative burden. We would be interested in views as to the significance of this issue and whether it could present an opportunity for some NSPs to discount any benchmarking results.

We would be interested in hearing views on how much effort should be devoted to annual benchmarking reports when it is perhaps more material in terms of expenditure and price outcomes to focus on the full range of expenditure assessment techniques during the price control/review process itself. In this context, the AEMC's expectations on the annual benchmarking report are noted:

> The intention of a benchmarking assessment is not to normalise for every possible difference in networks. Rather, benchmarking provides a high level overview taking into account certain exogenous factors. It is then used as a comparative tool to inform assessments about the relative overall efficiency of proposed expenditure.[23]

Our benchmarking reports will likely cover existing performance reporting, given a proper assessment of efficiency requires consideration of the outputs delivered by NSPs as well as expenditures. A combined report would also better serve the purpose of informing stakeholders of key performance indicators of NSPs over time. The reports would be an input or starting point for further analysis rather than contain this analysis in its entirety.

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23 AEMC, *Rule determination: Rule change: Economic regulation of network service providers, and price and revenue regulation of gas services,* 29 November 2012, Sydney, pp. 107–108.

As foreshadowed by the Productivity Commission, we are likely to face some problems in terms of a limited number of observations to calibrate techniques and to produce robust results. There are also likely to be some "teething" issues in terms of reporting and assessing compliance with new data templates as well as the progressive testing of results. For this reason some methods may not be relied upon in the near term, with the need for continued reliance on existing techniques. Throughout consultation it will be important for us to manage stakeholder expectations on what techniques will be feasible or robust, which in turn will largely be dependent upon NSPs' ability to comply with new data templates, including potential backcasting. The continuation of some existing techniques in our new Guidelines, notably the predictive repex model and the "base, step, trend" approach to setting opex forecasts, may reduce the need for transitional arrangements, however we are also interested in examining any interim solutions where new methods are introduced.

We are mindful of existing data being reported in templates born from previous determinations, and the work undertaken by us and NSPs in recently issuing RIN templates for this purpose. Wherever possible and appropriate, the methods employed in the Guidelines will aim to minimise duplication of reporting and to build on existing reporting categories. As outlined in attachment B on category based analysis, we expect that (to some degree) the reporting we propose will align with existing categories, noting that detailed, nationally consistent definitions will be different to what NSPs currently report. The data required to populate techniques examined in attachment A should also be generally available as they relate to inputs and outputs of the businesses, however again some will not be currently captured or will require some changes to definitions currently used. Wholesale re-categorisation of expenditures and templates would only be considered where there was a high degree of certainty of the expected benefits of doing so, and where these are sufficient to outweigh the resource burden and time taken for NSPs to comply.

We are also mindful of having already commenced consultation on expenditure reporting and assessment methods with the NSW DNSPs, including with a view to making comparisons with Victorian DNSPs.

Question 16

Keeping in mind the preference to use up to date and nationally consistent data in all benchmarking analysis, what would be the best time to issue RIN templates? Would these need to be for all NSPs? How frequently should we do this?

Question 17

Should we try and limit the collection and analysis of benchmarking data to annual benchmarking reports? Alternatively, should we focus our effort on benchmarking analysis at each draft and final decision stage, with less attention to annual benchmarking reports?

Question 18

Are there alternative, more flexible means to gather data for benchmarking purposes in annual reports and in determinations, such as requests outside the NEL provisions?

Question 19

Should we be considering the alignment of regulatory years and of regulatory control periods for transmission and distribution NSPs to overcome some of these challenges? If so, should regulatory years reflect the Australian financial year? How would the alignment of regulatory control periods be best achieved?

6 Next steps

As noted in our recent consultation announcement[24], we will be engaging closely with the sector in the development of a series of guidelines over the next year. In most instances this will commence with a guideline specific stakeholder forum and the forming of one or several working groups.

We expect that the initial forum on expenditure assessment will collate stakeholder views on the scope and timing of issues to be considered, based around the suggestions in this issues paper. We expect the details of further consultation will be affected by the availability of stakeholders with particular expertise, the complexity of particular issues to be considered and having to coordinate the timing of other guideline consultations. Table 1 lists the timeframes anticipated for the working group stage of consultation, leading into the prescribed steps and timing of consultation under the NER procedures for transmission and distribution.

Table 1 Timeline for developing the expenditure assessment Guidelines

Date	Topic	Description
December 2012	Issues paper published	Explain issues and preliminary thoughts on approach to the expenditure assessment Guidelines and benchmarking reports. Invitation for written submissions and to register for working group meetings
Late January 2013	First stakeholder roundtable	Meeting with all registered stakeholders. Opportunity to discuss AER's general approach, any specific issues and working group tasks, sequencing and logistics.
Feb to June	Working group meetings	Timing and scope to be determined between stakeholders.
15 Mar	Submission on issues paper due	Formal response to issues paper as well as on anything discussed during working meetings to this date.
June-July	Stakeholder consultation	AER considers submissions, develops positions. Further bilateral meetings.
9 August	Draft Guidelines published	Set out AER's draft techniques, as well as position on annual benchmarking reports and information reporting instruments.
August	Stakeholder consultation	Further discussions with stakeholders (may continue with working group format).
Mid September	Submissions on draft Guidelines due	Formal response by stakeholders.
October	Stakeholder consultation	Clarify with stakeholders remaining substantive issues. Indication of AER likely final decision.
29 November	Publish final Guidelines	Publication of methodologies and likely data requirements in relation to expenditure assessment. Process and timing for data collection also specified.

Our current expectation is that most work on establishing the Guidelines will be around standardising driver or category based analysis as well as introducing new, more technical and aggregated assessments of productivity/efficiency including TFP. Some techniques, namely our repex model, sample project reviews and real cost escalators, have been employed in recent determinations and so

24 Available at: http://www.aer.gov.au/node/18824

are expected to be subject to relatively less controversy. However, this will need to be canvassed in the working groups.

Attachment A: Economic benchmarking techniques

This attachment details our proposed approach to consulting on the development of economic benchmarking techniques and supporting data requirements to be included in the expenditure forecast assessment guidelines (the Guidelines). In this attachment we also request feedback from stakeholders on some of specific issues relating to economic benchmarking.

Box 4 Economic benchmarking

We define economic benchmarking to be benchmarking that applies economic theory to measure efficiency or change in efficiency. Economic benchmarking techniques assess the efficiency of distribution network service providers (DNSPs) by comparing their performance with their past performance or the performance of other DNSPs. Economic theory often analyses the firm and its behaviour by modelling its use of inputs – in particular capital and labour – in producing its outputs. Economic benchmarking uses this framework to measure the efficiency of the firm in its use of inputs (defined by the factors of production) to produce outputs (industry specific).

Economic benchmarking of costs considers relevant factors including a firm's outputs, inputs and environmental variables that may influence its costs. This distinguishes it from the other benchmarking techniques we use such as partial productivity indicators and replacement and augmentation modelling. These benchmarking techniques examine the efficiency of undertaking specific activities and do not consider the efficiency of a firm as a whole.

Earlier this year we, jointly with the ACCC, released a report on benchmarking operating expenditure and capital expenditure in energy networks (the benchmarking report).[25] The purpose of the report was to review the different benchmarking techniques that may be applied to a cost assessment of energy networks in regulatory determinations. We consider that the economic benchmarking techniques identified in the benchmarking report are an appropriate starting point for consultation on the regulatory application of economic benchmarking. Readers are referred to that report for a more detailed discussion of these techniques.

We do not propose to specify a single economic benchmarking technique in the Guidelines. Instead we consider that a holistic approach considering all available economic benchmarking techniques is more appropriate. This will enable us to consider the available data when selecting a technique, and provide the flexibility for us to use more data intensive techniques over time. The holistic approach will also allow for the application of multiple economic benchmarking techniques where appropriate. Also, the holistic approach will allow the AER to consider submissions on its economic benchmarking reports when selecting economic benchmarking techniques.[26]

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25 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012. Available at: http://www.accc.gov.au/content/index.phtml/itemId/1054590 .

26 Under clause 6.27 of the national electricity rules the AER is required to publish annually benchmarking reports for DNSPs

At this stage we consider that it is pertinent to consult on the inputs, outputs and environmental variables for economic benchmarking. This is because we consider that the inputs, outputs and environmental variables should be the same regardless of economic benchmarking technique applied. Section 5 considers inputs, outputs and environmental variables.

We are seeking to work with stakeholders to develop a preferred specification of inputs, outputs and environmental variables for DNSPs. In addition to the preferred specification, we would like to collect a broader data that includes other inputs, outputs and environmental variables that have been used in the literature or are otherwise relevant. While the preferred specification would be our starting point, we would like to collect a data set that provides us with a degree of flexibility to test the robustness of these models.

It is important to note at the outset that we are very aware of the work the Australian Energy Market Commission (AEMC) has already conducted in relation to the use of Total Factor Productivity (TFP) for the determination of prices and revenues and its accompanying consideration of the rule change proposed by the then Victorian Energy Minister. However, this work program is looking at the use of economic benchmarking techniques to assist us in assessing forecast expenditure rather than directly setting prices. We are also of the view that other economic benchmarking techniques should be considered, such as data envelopment analysis (DEA), econometric models (EM) and stochastic frontier analysis (SFA). These techniques have somewhat differing data requirements to TFP.

This is considered further in the section on our proposed holistic approach below.

1 Holistic approach to selecting economic benchmarking techniques

We are proposing to apply a holistic approach to select economic benchmarking techniques for the upcoming distribution determinations, rather than specifying a single technique in the Guidelines.

A key reason for the holistic approach is that it allows us to select and tailor economic benchmarking techniques based on the available data. We consider that the data we have collected in the past (for distribution resets, annual reporting and other functions) may not be suitable for economic benchmarking techniques. This view is supported by the AEMC. In its review into the use of TFP for the determination of prices and revenues the AEMC concluded that there is currently insufficient data for TFP and the initial focus should be data collection.[27] Consistency of data between businesses is a major issue and a legacy of the different reporting requirements under the previous state-based regulatory regimes. This will be the focus of ongoing consultation.

We have considered the alternative approach of choosing a preferred economic benchmarking technique, then consulting on this technique (the preferred technique approach). Potentially we could choose a single technique based on the theoretical strengths and weaknesses of each technique and experience from past benchmarking studies to be specified in the Guidelines.

However, we consider the holistic approach is more appropriate for a variety of reasons.

The holistic approach allows for the use of multiple techniques. The NER requires us to have regard to benchmark expenditure in deciding whether a DNSP's forecast expenditure is efficient and prudent.[28] It is up to us to utilise the techniques we consider are appropriate for this purpose, and we are not constrained to choose a single technique to determine the benchmark expenditure.

As the benchmarking report described in detail, each of the alternative economic benchmarking techniques has advantages and disadvantages in relation to several important factors including:

- data requirements, including sample size
- the need to specify functional forms (for example, production or cost functions)
- whether statistical or other techniques can test the veracity of the model
- identification of optimal behaviour.[29]

By using multiple economic benchmarking techniques, we could use the results from other techniques as a sensitivity test on each other and any preferred or primary technique(s). Multiple techniques may enable us to 'offset' the advantages of one technique with the disadvantages of another technique. For instance, the Finnish regulator, Energy Market Authority (EMA), was concerned about a number of weaknesses with DEA. The EMA commissioned a study comparing the results from DEA and SFA.

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27 AEMC, *Review into the use of total factor productivity for the determination of prices and revenues*, 30 June 2011, p. ii.
28 NER, clauses 6.5.6(e)(4) and 6.5.7(e)(4).
29 Table 7.1 of the benchmarking report summarises these factors for the four economic benchmarking techniques. See ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012, pp. 139–140.

The authors considered the two techniques are complementary such that the weaknesses of one are the strength of the other and suggested averaging the scores from DEA and SFA.[30]

The holistic approach does not imply that we will use every technique in distribution resets. For example, the SFA technique has many desirable properties including the identification of an efficient frontier and the ability to separate statistical noise from relative efficiency. On the other hand, it is very data-intensive. The benchmarking report provided examples of regulators that did not utilise SFA because of the relatively small sample sizes available.[31] While we may have a preference for SFA given its desirable properties, a potentially small data set may compromise any conclusions to be drawn from SFA analysis. The benchmarking report noted the sample size in Australia is small, though we may include comparable businesses in other countries.[32] On the other hand, we may be able to use SFA if we can expand the sample size using panel data.[33] We consider the holistic approach will help answer such questions.

The holistic approach provides flexibility for future distribution determinations (and other obligations that may require benchmarking). Setting out a preferred technique in the Guidelines creates an expectation that the technique be 'locked in' for future resets, even though we may have decided on a preferred technique based on data limitations at the time.

We are required to benchmark the efficiency of DNSPs in our annual benchmarking report. This report will be a focal point in consultation on the development of economic benchmarking and may incorporate a number of differing benchmarking techniques. The holistic approach will allow for us to take into account comments on the benchmarking report when selecting economic benchmarking techniques.

Though we consider it appropriate to allow a holistic approach to selecting economic benchmarking techniques in the Guidelines, we consider that the application of the holistic approach should be undertaken in accordance with the principles for the selection of assessment techniques. This will provide DNSPs with some certainty regarding our likely application of economic benchmarking in determinations.

It is intended that the Guidelines will outline how we will select any particular or combination of economic benchmarking techniques in future distribution determinations from the suite of available techniques. This would set out how we would select economic benchmarking techniques based on the availability of data.

Question 20

We are interested in your views on the holistic approach to the selection and establishing reporting requirements for economic benchmarking techniques.

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30 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012, pp. 91–92.
31 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012, p. 103.
32 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012, p. 104.
33 Panel data are data on an economic variable that include both multiple economic units and multiple time periods, thus displaying both cross sectional variation and time series variation.

2 Economic benchmarking techniques

There are many approaches to benchmarking including process techniques, programming techniques and ratio analysis.[34] However, only a subset of benchmarking techniques can be used to conduct economic benchmarking. The ACCC-AER benchmarking report focused on four economic benchmarking techniques commonly used to compare efficiency.[35] The four techniques all measure productive efficiency but have a number of different characteristics;

- SFA, DEA and EM all involve the estimation of an underlying cost or production technology of the industry.
- TFP index measures productivity changes, and requires just two observations and does not involve direct estimation of an underlying cost or production technology of the industry.
- EM and SFA require the estimation of a specific functional form that is sufficiently flexible to capture the structure of the underlying production process.
- EM reveals information about average industry cost structures, with the cost function estimated on the basis of the sample average and as such the cost structure of the industry average rather than the frontier businesses.
- DEA is a relatively simple technique using input and output quantities to compute a production frontier that provides a comparison of efficiency. It is however sensitive to outliners and errors in the measurement of the data.
- SFA separates out the inefficiency of businesses from “noise” in the data, estimates a frontier and provide insights into the significance of key cost drives and the role of technology over time.

Table 2 summarises the alternative economic benchmarking methods.

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34 AER, *Draft decision: Victorian electricity distribution network service providers: Distribution determination 2011–2015 Appendices*, June 2010, p. 54.

35 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012.

Table 2 Summary of alternative Economic benchmarking techniques

Characteristics	TFP index	EM	SFA	DEA
Type	Non-parametric	Parametric	Parametric	Non-parametric
Presence of random error	No	Yes (one composite error term)	Yes	No
Presence of inefficiency	No	Yes (one composite error term)	Yes	Yes
Presence of optimal behaviour	Yes	Yes, cost function	Yes, cost frontier	Yes, frontier firm(s)
Statistical testing allowed	No	Yes	Yes	Possible
Measurement	Productivity changes	A benchmark cost function	A benchmark cost frontier	A set of all the feasible input-output combinations
Information requirements to measure cost efficiency [a, b]	Quantities and prices of inputs and outputs [c]	Volume of outputs, prices of inputs, and costs	Volume of outputs, prices of inputs, and costs	Price and volume of inputs, or costs and volume of outputs
Number of inputs	Multiple	Multiple	Multiple	Multiple
Number of outputs	Multiple	Multiple	Multiple	Multiple
Sample size requirement	A minimum of two observations (at least two DNSPs or two time periods)	As large a dataset as possible	A large number of data points (more than the equivalent econometric model).	As large a dataset as possible (some rules of thumb recommended in the literature)
Dataset requirements	Cross-sectional Time-series Panel	Cross-sectional Time-series Panel	Cross-sectional Panel	Cross-sectional Panel

a. These can be considered as standard or minimum information requirements for each economic benchmarking technique. More sophisticated applications of each technique may employ additional types of information. In addition, environmental variables may be required to adjust business performance for external factors that are beyond management control.

b. Other measures of efficiency and productivity may also be computed. The data requirements are specific to the measurement.

c. TFP index is used to measure productivity change.

Table 2 briefly summarises the data requirements for different economic benchmarking techniques. Each of the economic benchmarking techniques may have more sophisticated model specifications and hence require more data. However, a summary of the minimum data requirements may be as follows:

- (index-numbered) TFP requires price and quantity information for inputs and outputs, for at least two or more businesses or time periods;
- EM and SFA (using a cost function) require data in relation to costs, output quantities, input prices and business environmental conditions for a group of comparable businesses in the same industry. Input quantities and cost share data may also be required; and
- DEA relies on data in relation to the quantity of outputs and the quantity of inputs required to produce that set of outputs (the 'input-output combinations') for a group of comparable businesses in the same industry.

3 Economic efficiency

We must consider expenditure that would be incurred by an efficient DNSP over the regulatory control period.[36] To do this, we must consider what efficiency is and how it can be measured. There are different components of economic efficiency, however we consider that productive efficiency is the most relevant to the assessment of the reasonableness of the proposed costs. The economic benchmarking techniques can be applied to measure productive efficiency where inputs are measured in terms of their costs or input prices are available. Hilmer considered the components of economic efficiency in the inquiry into the National Competition Policy. Box 5 outlines of the components economic efficiency as set out in the Hilmer Report.

Box 5 Economic efficiency[37]

Three components of economic efficiency were set out by Hilmer – 'technical or productive efficiency', 'allocative efficiency' and 'dynamic efficiency' – and these are encapsulated in the Competition Principles Agreement.

- Technical or productive efficiency is achieved where individual firms produce the goods and services that they offer to consumers at least cost.
- Allocative efficiency is achieved where resources used to produce a set of goods or services are allocated to their highest valued uses (i.e., those that provide the greatest benefit relative to costs).
- Dynamic efficiency reflects the need for industries to make timely changes to technology and products in response to changes in consumer tastes and in productive opportunities.

We consider that economic benchmarking techniques will primarily assist us in forming a view on the productive efficiency of DNSPs. In the academic literature the terms technical and productive efficiency have differing definitions to that in Table 3. Productivity can be defined as the ratio of aggregate output to aggregate input. Where a firm has one output and one input productivity can be measured a simple ratio. However, where a firm has multiple inputs and multiple outputs, weights are required to construct and output index and an input index. This allows for the calculation TFP which is equal to the ratio of the output index to the input index.[38] These weights are usually based on price information.

In the literature, productivity efficiency is considered to have three main components, namely technical efficiency, scale efficiency and input/output mix allocative efficiency. Table 3 outlines the components of productive efficiency.

36 NER, clauses 6.5.6(e)(4) and 6.5.7(e)(4)

37 Independent Inquiry into National Competition Policy (F Hilmer, Chair), *National Competition Policy*, Australian Government Publishing Service, Canberra, 1993.

38 T Coelli, A Estache, S Perelman, and L Trujillo, *A primer on efficiency measurement for utilities and transport regulators*, World Bank Publications, 2003, pp. 10-11.

Table 3 Decomposition of productive efficiency

Efficiency measure	Description
Technical efficiency	Technical efficiency is a firm's ability to achieve maximum output given its set of inputs.
Input mix allocative efficiency	Input mix allocative efficiency is a firm's ability to select the correct mix of input quantities so as to ensure that the input price ratios equal the ratios of the corresponding marginal products, that is, the additional output obtained from an additional unit of input.
Cost efficiency	Cost efficiency is a firm's ability to produce a given level of output at minimum cost given the input prices it faces. Cost efficiency is achieved when both technical efficiency and input mix allocative efficiency are achieved.
Output mix allocative efficiency	Output mix efficiency is a firm's ability to select the combination of output quantities in a way that ensures that the ratio of output prices equals the ratio of marginal costs, that is, the additional cost corresponding to the production of an additional unit of product.
Scale efficiency	Scale efficiency is a measure of the degree to which a firm is optimising the size of its operations. A firm can be too small or too large, resulting in lower productivity associated with not operating at the technically optimal scale of operation.
Technical change	Technical change is a change in the amount of inputs required to produce an output or a combination of outputs. Productivity change over time can be decomposed into technical change, scale efficiency change, input/output mix efficiency change and technical efficiency change.

Source: Source: T Coelli, , A Estache, S Perelman, and L Trujillo, A primer on efficiency measurement for utilities and transport regulators, World Bank Publications, 2003, pp. 11-12.

3.1 Efficiency and productivity measurement

The empirical challenge of economic benchmarking is to determine what represents a business or industry's best-practice frontier or technological constraint.[39] A considerable amount of cross-sectional data from a group of comparable firms (i.e., adopting the same technology) is needed before an estimation of the frontier or constraint, and subsequently measurement of efficiencies relative of individual firms, can be made. For the measurement of technical efficiency, only output and input quantity information is required to estimate the production function/frontier. For the measurement of input/output mix allocative efficiency, relevant input/output price information is also required.

Cost efficiency, can be directly measured by estimating a cost function representing the optimal behaviour (i.e., cost-minimisation) under a parametric approach (e.g., EM and SFA) or using cost measures as inputs under DEA. If efficiency levels change over time, it contributes to productivity changes. Productivity changes are also an important measure of a firm's dynamic performance.

Using DEA and SFA, it is possible to measure relative efficiency of individual firms. For example, DEA, as a non-parametric technique, constructs a 'piece-wise linear convex production/cost boundary' from the data points.[40] In contrast, SFA estimates a model assuming a functional form of

[39] The term 'technological constraint' refers to the technological possibilities of transforming the set of inputs into the set of outputs.

[40] Since only a limited number of efficient firms can be identified to form the best practice frontier, the resultant isoquant (technology) is a piece-wise linear convex instead of being smooth.

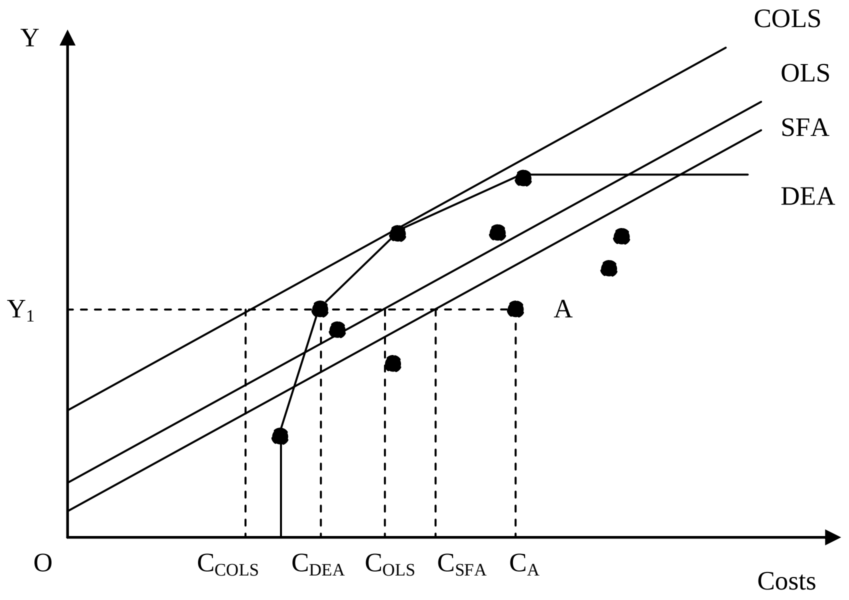
the production/cost frontier and the efficiency distribution. Under both SFA and DEA, the relative efficiency of individual data points is measured against the estimated frontier.

Similar to the SFA, the econometric method can empirically estimate a specified production/cost function. Under Ordinary Least Squares (OLS), the line-of-best-fit is the estimated production/cost line. Under Corrected Ordinary Least Squares (COLS), the line-of-best-fit is shifted in parallel to obtain the frontier. The relative efficiency of individual data points is measured against the estimated line (which represents the frontier).

Figure 3 below illustrates how alternative benchmarking methods measure cost efficiency for a group of observations representing comparable firms under a simple input-oriented one-output cost model. Cost efficiency is measured as the ratio of minimum costs possible relative to observed costs, holding the technology, input prices, output quantities, and environmental variables constant. As shown in the diagram, the cost efficiency of firm A producing output Y_1 at cost C_A is measured relative to the frontier/technology estimated under each benchmarking method:

- under DEA, an efficient firm can produce Y_1 at cost C_{DEA}. So cost efficiency of firm A is OC_{DEA}/OC_A.
- Under SFA, an efficient firm can produce Y_1 at cost C_{SFA}.[41] So cost efficiency of firm A is OC_{SFA}/OC_A.
- Under OLS, an efficient firm can produce Y_1 at cost C_{OLS}. So cost efficiency of firm A is OC_{OLS}/OC_A.
- Under COLS, an efficient firm can produce Y_1 at cost C_{COLS}. So cost efficiency of firm A is OC_{COLS}/OC_A.

Figure 3 Benchmarking Methods



[41] Note that the position of the SFA differs with respect to the data points considered due to the presence of the error term.

Source: extracted and readapted from Productivity Commission, *Draft report: Electricity network regulatory framework*: *Volume 1*, October 2012, p. 148.

Similar analysis can be conducted to measure technical efficiency, which requires input and output quantity information to construct the production function or best input-output combinations.

Expanded applications

A number of extensions can be made to the standard application of benchmarking methods. For example, one extension is to apply the Malmquist index[42] to panel data (i.e., cross-sectional and time-series data) to estimate technical change, technical efficiency change and productivity change over time.[43] By allowing the production frontier to shift over time due to technical change, a Malmquist productivity index is derived to measure productivity change between two periods. Both DEA and SFA can be used to estimate the technologies/frontiers for the computation of the Malmquist productivity index and its decomposition into sources. Despite its common use in the productivity literature, the Malmquist productivity index and its decomposition have been subject to considerable debate in recent literature. For example, Grifell-Tatjé and Lovell[44] found that the Malmquist productivity index can be a biased measure of productivity change in the presence of non-constant returns-to-scale technology.

There are alternative measures of TFP and its components. For example, the Färe-Primont TFP index,[45] has gained popularity in recent years.[46] Its computation also involves the estimation of the underlying technology, and it can be decomposed into four components: technical efficiency change, technological change, scale efficiency change and mix efficiency change (which captures change in economies of scope in a multi-output and multi-input model).[47]

There are also other classes of TFP indices that have been developed primarily under the index-number-based approach. Both the Tornquist index and the Fisher Ideal Index have been commonly used for TFP analysis as they possess desirable statistical properties, as well as economic-theoretic properties.[48] For example, the Tornquist index is found to be consistent with an underlying production technology of a translog functional form.[49] In order to calculate these indices, price (or revenue-share or cost-share) information is required as weights to derive the weighted-sum of output/input change. However, the index-number-based TFP method does not allow for a decomposition of productivity changes into alternative sources. Implicitly the method assumes full technical efficiency, constant returns-to-scale, neutral technological change and a behavioural objective such as cost minimisation.

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42 Originated by D Caves, L Christensen and W Diewert, 'The economic theory of index numbers and the measurement of input, output and productivity', *Econometrica*, 50, 1982, pp. 1393-1414.

43 The term "Malmquist" was named after Sten Malmquist's (1953) work on constructing a quantity index by comparing two quantity vectors to an arbitrary indifference curve using radial scaling. Coelli *et al.* (2005) devotes one chapter on the computation of the Malmquist TFP index using DEA and SFA.

44 E Grifell-Tatjé and CAK Lovell, 'A note on the Malmquist productivity index', *Economics letters*, 47 (2), 1995, pp. 169-175.

45 Developed by Färe, R and D Primont, *Multi-output production and duality: Theory and applications*, Boston: Kluwer Academic Publishers, 1995.

46 O'Donnell, C, *DPIN 3.0: A program for decomposing productivity index numbers*, 20 September 2011; Available at: http://www.uq.edu.au/economics/cepa/dpin.php [accessed on 23 October 2012].

47 For further information about mix efficiency change, see TJ Coelli, DSP Rao, CJ O'Donnell, and GE Battese, *An introduction to efficiency and productivity analysis*, 2nd Edition, NY: Springer, 2005; O'Donnell, C, 'An aggregate quantity-price framework for measuring and decomposing productivity and profitability change' *Centre for Efficiency and Productivity Analysis working papers WP07/2008*, University of Queensland, revised 2 February 2009; Available at: http://www.uq.edu.au/economics/cepa/docs/WP/WP072008.pdf [accessed on 23 October 2012].

48 For further information about TFP indexes, see Coelli *et al.* (2005) and O'Donnell (2009).

49 Diewert, WE, 'Exact and superlative index numbers', *Journal of Econometrics*, 4, 1976, pp. 115-145.

Question 21

Have we identified all the relevant economic benchmarking techniques and, if not, are there other economic benchmarking techniques that should be considered?

4 Relating productivity measurement to the AER's task

The NER requires us to have regard to benchmark expenditure in deciding whether a DNSP's forecast expenditure is efficient and prudent.[50] Economic benchmarking may allow us to decompose relative efficiency into components that DNSPs can control and components that they are unable to control. Better understanding the components of relative efficiency is necessary to assess a DNSP's productivity and efficiency performance.

Cost differences between DNSP's may be due to factors that are outside that DNSP's control. For instance, a DNSP may appear less efficient than another DNSP simply because they are not producing at the same or similar scale of operation. However, DNSPs may not have much control over the demand for their services, so it may not be realistic to expect that a DNSP can achieve the same efficiencies of scale.

As reviewed in the benchmarking report,[51] economic benchmarking techniques have been employed widely by energy regulators, however regulatory applications differ in terms of the choice of the method(s) and the use of benchmarking results.[52] In some instances, economic benchmarking techniques have been used directly to determine the appropriate price change for a DNSP.

Under the NER, we are required to have regard to benchmarking when evaluating the reasonableness of proposed expenditure. In regulatory determinations, we have generally used a revealed cost approach to reviewing the forecast of operating expenditure, working on the basis that opex is largely recurrent. Typically the actual opex incurred in the second last year of the previous regulatory control period (i.e., the 'base year') is reviewed to derive base-year efficient costs, which is then escalated for three changes, namely scale escalation, input-cost escalation (accounting for partial factor productivity change), and allowance for 'step changes' in regulatory requirements or external operating environment. Partial performance indicators have been commonly used to inform the comparative performance of a network service provider to other comparable businesses. The results are mainly considered for the assessment of base-year efficient cost.

With relevant cross-sectional data for the most recent year the relative technical or cost efficiency of individual DNSPs can be measured against the estimated productivity frontier. For the DNSP considered, the efficiency estimates show the extent of input quantity reduction or cost reduction that a benchmark DNSP may be able to achieve. This is useful for assessing whether the actual cost incurred by a DNSP in a base year is efficient.

It may be necessary to make a distinction between short-run and long-run cost assessment in applying economic benchmarking techniques.[53] The short-run cost assessment (which may focus on opex) assumes that capital stock is fixed and thus modelled as a fixed input. It is generally assumed

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[50] NER, clauses 6.5.6(e)(4) and 6.5.7(e)(4).

[51] ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012.

[52] See the summary in ACCC/AER, *Regulatory practices in other countries: Benchmarking opex and capex in energy networks*, May 2012, pp. 4-5.

[53] A distinction between efficiency improvements that can be made immediately and those that can only be achieved incrementally over time in a number of studies. These include the work of Ofgem which has been reviewed in the review we released jointly with the ACCC on regulatory practices in other countries: AER/ACCC, *Regulatory Practices in Other Countries: Benchmarking opex and capex in energy networks*, May 2012. Further Coelli and Lawrence consider the relative TFP improvements that differing firms can achieve in Chapter 8 of T Coelli, and D Lawrence, *Performance measurement and regulation of network utilities*, Edward Elgar Publishing, 2006.

that the estimated inefficiency in terms of variable inputs (i.e., opex) can be removed in the short run (e.g., within one or two years). The long-run cost assessment (which covers both opex and capex or total cost) assumes all inputs are variable in the long term and thus the inefficiency cannot be removed immediately but is removable gradually. A path to removing the inefficiency (e.g., at a target 10 per cent per annum) needs to be set out ex ante to provide businesses incentives to out-perform and thus converge to the industry frontier. While long-run cost assessment may be preferred as it avoids perverse incentives for businesses to substitute capex for opex, short-run cost assessment may also be used to identify sources of the short-run inefficiency and to assess the appropriateness of investment decisions made by a business that is found to be relatively efficient in the short run but relatively inefficient in the long run.

Furthermore, with panel data, not only efficiency performance at a point in time, but also productivity change over time and its decomposition into sources, can be estimated. The estimated trend in technological change by the industry-frontier businesses or the industry average can also be particularly useful for informing the trend productivity change that is relevant for adjusting for input cost escalation.

At this initial stage of implementing economic benchmarking, it is likely that there will be data availability and consistency issues. Where limited confidence can be had in the data quality and model specifications, we will take this into account when interpreting results from applying economic benchmarking techniques. Of particular concern will be the interpretation of the efficient frontier. Where there are data issues the likelihood that the revealed benchmarking efficient frontier reflects the actual relative efficiency frontier will be lessened. Hence, some leniency might be required when interpreting the relative efficiency of firms with reference to the efficient frontier.

Question 22

We are interested in your views on how economic benchmarking techniques should be applied in our decision making process regarding expenditure. Specifically, we are interested in your views on:

- using these techniques to assist us to form a view on the efficiency of base expenditure and expenditure forecasts
- measurement of the likely pace at which productivity improvements may be made over a regulatory control period.

5 Inputs, outputs and environmental variables

In order to apply economic benchmarking techniques it is necessary to identify the inputs, outputs and environmental variables relevant to DNSPs. This is because all economic benchmarking techniques aim to measure the efficiency of DNSPs – which is their ability to convert inputs into outputs. Hence, regardless of the technique used, the same set of inputs and outputs can be modelled. In measuring and comparing efficiency, it is also necessary to account for environmental variables that may affect a DNSP's ability to convert inputs into outputs. Regardless of economic benchmarking technique these environmental variables are likely to be common.

It is important to explain our view of the difference between environmental variables and outputs upfront. There can be confusion between outputs and environmental variables because both are explanatory variables of DNSP costs. We consider that outputs reflect services provided to customers whereas environmental variables do not. Also, the treatment of outputs and environmental variables may differ in the modelling.

It is necessary to develop a framework for selecting inputs, outputs and environmental variables for economic benchmarking as there is no consensus in the literature on which are relevant and how they should be measured. The use of variables commonly used in benchmarking studies may not be relevant to the AER's task or not reflect stakeholders' views on inputs, outputs, and environmental variables. We note that variables are not necessarily appropriate for economic benchmarking distribution resets simply because they are that are commonly used. Researchers may have chosen particular variables to answer specific questions, or alternatively may have chosen certain variables due to data availability.

The combination of inputs, outputs and environmental variables selected is important because the results of economic benchmarking are sensitive to the inputs and outputs selected.[54] DNSPs in Australia vary significantly in terms of size and operating environment.[55] Where these differences are not appropriately accommodated benchmarking results may be inaccurate and skewed.

An alternative approach to accounting for all variables in economic benchmarking modelling might be to split DNSPs into sub groups. These sub groups might be separated by network characteristics (such as rural or urban areas) or by jurisdiction. This may be done in two ways; comparing groups of DNSPs or comparing differing parts of networks separately. Whether DNSPs should be grouped and compared separately was considered by the AEMC in its review into the use of TFP.[56] The AEMC did not propose a grouping of DNSPs for the purpose of TFP. Instead the AEMC considered that the formation of relevant industry groupings of service providers will be a matter for the AER to determine.[57]

While we are seeking to discuss with industry the appropriate inputs, outputs and environmental variables for use in economic benchmarking techniques, it is likely that we will collect a broader set of data than just the preferred specification determined through this process.

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54 Economic Insights, *Energy network total factor productivity sensitivity analysis report prepared for Australian Energy Market Commission*, 9 June 2009. p. 24.

55 For instance, Ergon Energy's network region is over six times the size of Victoria – which contains five separately regulated distribution networks. Source: Ergon Energy: *Submission to the AEMC's review into the use of total factor productivity for the determination of prices and revenues*, Feb 2009, p. 2.

56 AEMC, *Review into the use of total factor productivity for the determination of prices and revenues: framework and issues paper*, 12 December 2008, p. 14.

57 AEMC, *Final report:* Review into the use of total factor productivity for the determination of prices and revenues, 30 June 2011, pp. 22-23.

The following sections set out criteria and identify issues related to the identification and selection of inputs, outputs and environmental variables. The identification of inputs, outputs and environmental variables will be a focal point for the first phase of consultation on economic benchmarking techniques.

> **Question 23**
>
> Should the AER separate DNSPs into groups for the purposes of economic benchmarking? If so, how should the groupings be determined?

5.1 Inputs

Inputs, or factors of production, are the resources a DNSP utilises to deliver distribution services (outputs) to its customers.[58] Unlike outputs, there is broad agreement in previous benchmarking studies on DNSP inputs. As with many industries, the main types of resources DNSPs use to provide outputs are labour, capital, materials and other inputs.[59]

This section considers the appropriate input variables we require for economic benchmarking of DNSPs. Section 5.1.2 shows there is broad agreement in previous studies on the input variables for economic benchmarking.

However, previous studies have disagreed on precisely how to measure these inputs, particularly capital inputs. We therefore consider the appropriate measure of capital inputs in detail in section 5.1.4. A key consideration is whether physical or value measures best represent capital input quantities. We also consider the price measures that can be used to weight capital input quantities.

Economic benchmarking assesses a DNSP's relative efficiency in terms of the inputs it utilises to produce outputs for a period of time (generally one year). On the other hand, capital inputs contribute to providing DNSP outputs over many years. When specifying capital input measures for economic benchmarking, we must ensure they reflect the annual contribution of capital to providing DNSP outputs.

5.1.1 Criteria for selecting input measures

Table 4 sets out the criteria we consider relevant for input measures for the economic benchmarking techniques.

As the introduction to this section 5.1 outlined, there is broad agreement in previous benchmarking studies on what constitutes a DNSP's inputs. The main issue is precisely how to measure the annual contribution of capital inputs to the delivery of outputs. Hence, the criteria's objective is to aid us in choosing the appropriate measure of capital inputs.

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58 We use outputs and distribution services interchangeably in this section.

59 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, p. 142.

Table 4 Criteria for selecting input measures

Criteria	Justification
Reflective of production function	Inputs should reflect all of the factors and resources a DNSP utilises to produce outputs modelled. Inputs, and the sub-components of inputs, should be mutually exclusive and collectively exhaustive. There should be no double-counting or omission of factors of production. Any costs shared between a DNSP and other related businesses (such as staff shared between the electricity and gas distributors under one company) should be allocated to reflect its contribution to the production of the DNSP's outputs.
Consistency with NEL and NER	The NEL and NER provide a framework for reviewing DNSP expenditure. Within this framework we must accept regulatory proposals where they reflect the efficient costs of delivering outputs. The input variables for economic benchmarking should therefore enable us to measure and assess the relative productive efficiency of DNSPs in the NEM.

Question 24

Are our criteria for selecting inputs appropriate? Are there any additional criteria that should be added?

5.1.2 Input measures in previous economic benchmarking studies

We consider past studies provide a useful starting point when defining input variables for economic benchmarking. The benchmarking report contains further details on these studies.[60]

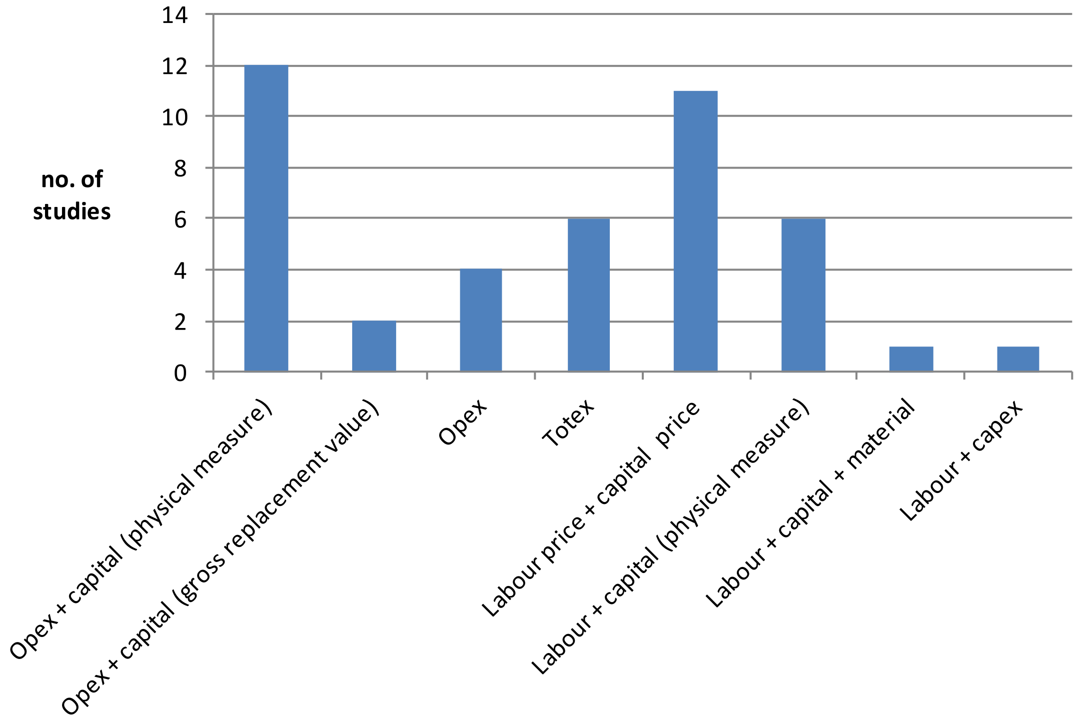
Frequently used input variables include labour, capital, opex, and line length. However the *combination* of input variables is important because economic benchmarking investigates efficiency in terms of the total inputs a DNSP utilises to produce outputs. Figure 4 shows previous benchmarking studies tended to use one of the following combinations of inputs:

- opex plus some measure of capital
- labour plus some measure of capital.[61]

60 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012.

61 We understand the choice of input variables may depend on what the researcher was modelling. For example, research that used opex and physical measures of capital modelled the production function, while those using labour and capital prices modelled the cost function.

Figure 4 Common input measures identified



Source: ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no. 6*, May 2012, tables 3.1, 4.1, 5.1 and 6.1.

Figure 4 shows that the most common input combination is opex and a physical measure of capital with 12 applications. The combination of a labour price and a capital price is the second most common with 11 observations. After this the combination of labour and a physical measure of capital and total expenditure by itself are the third most common with six applications each.

Commonly used variables do not necessarily imply they are appropriate for economic benchmarking. Researchers may have chosen those variables to answer specific questions. Alternatively, researchers may have used certain variables because of limited data availability.[62] Nevertheless, the consistent use of capital in past studies indicates researchers view it as an important input for the provision of distribution services. As Figure 4 indicates, there are several ways to measure a DNSP's capital inputs, including:

- Value measures—this is the monetary value of a DNSP's assets. Past studies have used two types of value measures:
  - Value measures of the capital stock—this is the monetary value of all of a DNSP's assets.
  - Capex—this is a DNSP's annual capital outlay for discrete sections of the network, usually for a specific asset, or group of assets.[63]

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62 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, pp. 142–143.

63 For example, see T Jamasb, and M Pollitt, 'International benchmarking and regulation: An application to European electricity distribution utilities', *Working Paper, No. 0115*, Revised June 2002, p. 13; C Growitsch, T Jamasb and M Pollitt, 'Quality of service, efficiency, and scale in network industries: An analysis of European electricity distribution', *IWH-Discussion Papers No. 3, July 2005*, p. 14.

- Physical measures—typical measures include kilometres of line and transformer capacity.

Section 5.1.4 sets out our consideration of the issues with measuring input variables, including these measures of capital inputs.

5.1.3 Input variables for economic benchmarking

We consider that DNSPs require two fundamental types of inputs in order to provide distribution services:

- their assets (the assets variable); and
- the activities they undertake to operate and maintain their assets and their business more generally (the operate and maintain variable)

We consider these two input variables are broadly consistent with the input variables used in previous benchmarking studies (see section 5.1.2). On the other hand, there is considerable debate in the literature on how to measure capital inputs for economic benchmarking. Section 5.1.4 sets out our consideration of this debate.

We consider obtaining price and quantity measures for the operate and maintain variable are less problematic than they are for the assets variable. Section 5.1.4 therefore focuses on issues relating to measuring the assets variable. Physical quantity of labour input is generally measured at the aggregate level; for example, the number of full-time-equivalent (FTE) staff or total hours worked. Labour quantity can also be measured as the labour cost (derived from opex data) deflated by an appropriate labour price index, which may reflect many inter-business differences, such as skill composition and wage rates. Depending on how labour quantity is measured, the labour price can be measured either directly using a suitable labour price index or indirectly as the total labour cost divided by the labour quantity measure.[64] Apart from labour, the operate and maintain variable may need to incorporate prices and quantities for 'materials' and 'other'. The constant-dollar value measure is generally used for measuring these variables.[65] Similar to labour, the prices and quantities for materials and other can be derived using appropriate price indices.

We consider that a DNSP's assets (in particular, those assets that make up its network) are a primary input for the provision of distribution services. The definitions in the NER recognise that DNSPs are asset management businesses.[66] In order to provide distribution services, a DNSP relies on the assets that comprise a distribution network.

We understand DNSPs are directly involved in building assets in their network. This involves expenditure on labour, materials and other inputs. This differs from industries where firms rent their capital inputs, where the rental price captures labour, material and other costs. We consider it appropriate to use the term "assets" rather than the more general term, "capital", used in previous

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64 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, pp. 146–147.

65 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, p. 147.

66 The NER defines a DNSP as "a person who engages in the activity of owning, controlling, or operating a distribution system." Further, DNSPs provide distribution services, which the NER defines as "a service provided by means of, or in connection with, a distribution system." In turn, the NER defines a distribution system as "[a] distribution network, together with the connection assets associated with the distribution network, which is connected to another transmission or distribution system..."
Chapter 10 of the NER defines a distribution network as "a network which is not a transmission network" where a network is the "apparatus, equipment, plant and buildings used to convey, and control the conveyance of, electricity to customers (whether wholesale or retail) excluding any connection assets..."

benchmarking studies (see section 5.1.2). This avoids confusion between the building of network assets (and the capital, labour and materials such building activity represents), and the use of those network assets to provide a DNSP's outputs. Similarly, using the operate and maintain variable removes any ambiguity regarding the nature of labour, materials and other expenditures/inputs.

Question 25

Are the assets and operate and maintain variables appropriate for economic benchmarking?

Question 26

What indices can we use to derive price and quantity information for the operate and maintain variable for economic benchmarking?

5.1.4 Measurement issues

In the following sections, we consider several issues with how inputs should be measured.

The sunk investment problem

Many distribution assets, particularly network assets, contribute to the provision of distribution services over many years. On the other hand, economic benchmarking assesses a DNSP's relative efficiency for comparatively short and discrete time periods, such as one year, or one regulatory control period.[67]

It is inappropriate to allocate an asset's entire cost to the year(s) in which the expenditure took place because it would not necessarily reflect the annual contribution that asset makes to providing outputs.[68] Hence, we consider it is not appropriate to use capex as the measure of capital inputs for economic benchmarking.[69]

A challenge in economic benchmarking is to measure the annual contribution of long-lived assets to providing outputs. Here, the concepts of capital services and the capital service profile are useful.

Capital services

The benchmarking report noted the proper measure of capital input is the flow of capital services during a period.[70] Capital services are the services DNSP assets provide that enable DNSPs to deliver outputs. Transformers convert electricity into the appropriate voltages, cables conduct electricity from zone substations to distribution substations then to consumers, circuit breakers protect DNSP equipment from damage, and so on.

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67 In our distribution resets under the NER, regulatory control periods generally cover five years.

68 T Coelli, H Crespo, A Paszukiewicz, S Perelman, M Plagnet, and E Romano, 'Incorporating quality of service in a benchmarking model: An application to French electricity distribution operators', Draft: June 2008, pp. 4–5. Available at: http://www.gis-larsen.org/Pdf/Plagnet.pdf [accessed 14 December 2012].

69 This does not prevent us from using capex in other types of benchmarking, such as the repex and augex models. In addition, capex can be used to update capital stock values under the perpetual inventory method.

70 ACCC/AER, *Benchmarking opex and capex in energy networks, Working paper no.6*, May 2012, p. 145.

A proxy for the flow of capital services is the measure of capital stock, which is assumed to be in proportion to the flow of capital services, regardless of the age of assets.[71] In deriving the annual contribution of assets to the production of outputs, a key consideration is the assumed capital service profile of assets, which describes the level of capital services an asset provides over time. As the next subsections discuss, this has implications for the appropriate quantity measure for the assets variable.

Capital service profile

Assets may provide capital services at different rates over their lives. Some studies assume DNSP assets provide capital services in accordance with the 'one-hoss shay' assumption. This assumption applies to assets that do not exhibit deteriorating performance during its life (or exhibits minimal deterioration). The typical analogy is a light bulb, which does not noticeably decrease in brightness as it ages. Rather, a light bulb exhibits more or less the same level of illumination until it extinguishes at the end of its life.

Alternatively, some studies assumed DNSP assets exhibit deteriorating performance over time. A common asset deterioration profile is the declining balance or geometric profile, where asset performance deteriorates by a constant rate every year. Other asset deterioration profiles include linear deterioration and hyperbolic deterioration.[72]

There is considerable debate in the literature whether DNSP assets exhibit one-hoss shay properties or whether their performance deteriorates over time. Pacific Economics Group (PEG), for example, stated the one-hoss shay depreciation pattern is not consistent with experience in energy network industries. PEG stated even though distribution assets tend to be long-lived, they involved extensive maintenance programs which point to physical decay over time.[73]

On the other hand, Economic Insights stated one-hoss shay is the most appropriate proxy for the capital service profile of DNSP assets, providing the following example:

> Suppose a DNSP 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 advocated by PEG...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.[74]

We understand DNSP assets are not likely to display the one-hoss shay property perfectly: there is likely to be some deterioration in the performance of a DNSP asset over time because age, weather and other factors cause wear and tear. In addition, many assets have a failure rate profile that resembles the bathtub curve (figure 5). DNSP assets may experience installation wear-in issues (the initial declining portion of the bathtub curve).[75] The risk of failure and, therefore, operational and maintenance costs will then be relatively constant for most of a DNSP asset's life. The risk of failure then rises more rapidly near the end of its life in the upward sloping portion of the bathtub curve. This may reduce the capital services the asset provides towards the end of its life. More maintenance work

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[71] ACCC/AER, *Benchmarking opex and capex in energy networks: Benchmarking paper*, May 2012, p. 145; OECD, *Measuring capital*, Second edition, 2009, p. 26.

[72] OECD, *Measuring capital*, Second edition, 2009, pp. 92–93.

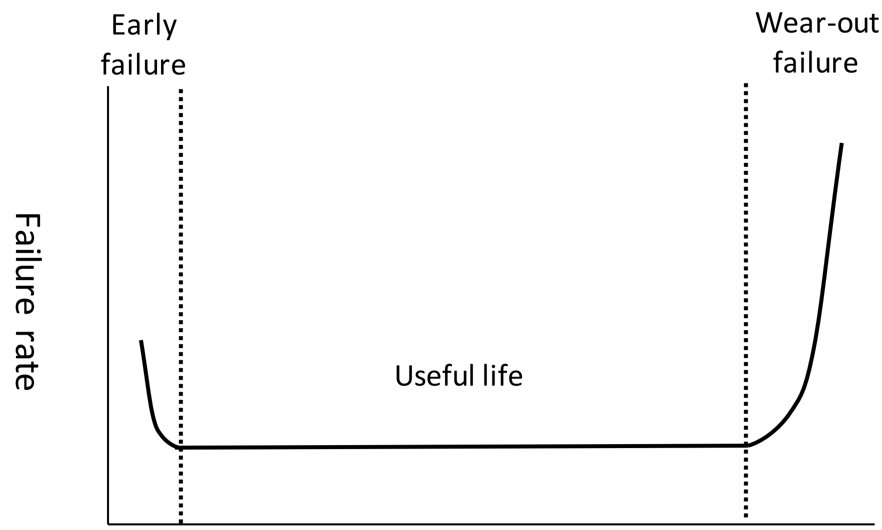
[73] PEG, *Defining, measuring and evaluating the performance of Ontario electricity networks: A concept paper*, April 2011, pp. 101-103.

[74] Economic Insights, *Electricity distribution industry productivity analysis: 1996–2008*: *Report prepared for the Commerce Commission*, 1 September 2009, pp. 63–64.

[75] Initial failures are normally replaced under warranty, hence we ignore this portion of the bathtub curve in this discussion.

may mean an asset is offline for longer periods. Economic benchmarking can account for such costs through the use of asset age profiles in deriving the annual contribution of capital, where asset age is a reasonable proxy for asset condition.[76] In addition to asset age, we consider other variables capture some of the effects of asset condition on cost efficiency. For example, the use of climate as an environmental variable may capture some of the effects of climate on asset condition. Likewise for peak demand.

Figure 5 The bathtub curve



Source: AER analysis.

Figure 5 illustrates the bathtub curve. This shows the failure rate of assets, which is moderate once they are initially installed, low for the majority of their life and then increases significantly when the assets life passes the end of its useful life.

We consider the one-hoss shay model of depreciation is a reasonable approximation of the capital service profile of a single DNSP asset.[77] There is support in the literature for using the one hoss shay assumption for electricity distribution networks.[78] The capital services profile would be constant for the majority of its life, then decline towards the end of its life.

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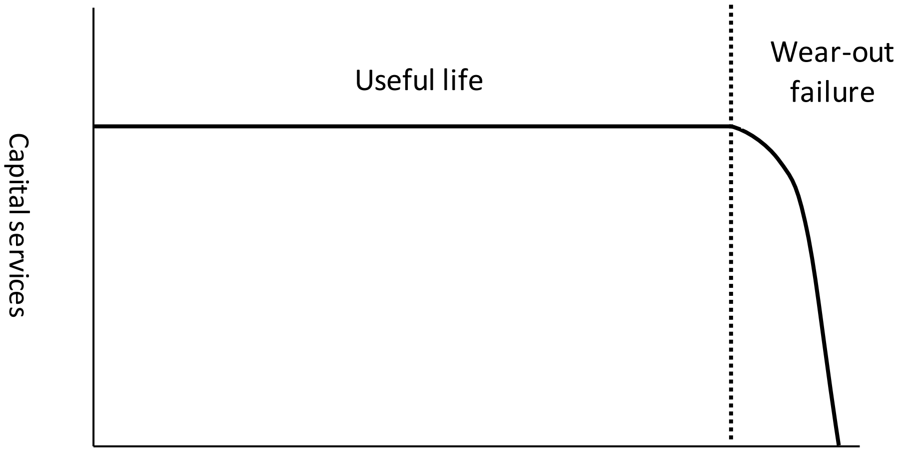
[76] The bathtub curve potentially complicates the analysis from economic benchmarking because an older asset does not necessarily require more maintenance than a younger asset. Consider two EDBS that are identical except one has a young network (say 10 years old) and the other has mid aged network (say 25 years old). The cost pressures are probably very similar as neither has reached a point where maintenance, reliability or the need to replace assets are significantly different (they are both on the flat section of the bathtub curve). However, if there is a third identical EDB that is much older (say 55 years old), this business is more likely to have entered the steep upward slope in the bathtub curve for many of its assets and so these are more likely to affect maintenance costs, reliability and replacement costs. It may therefore be necessary to separate age profiles into those on the flat section of the bathtub curve and those on the upward sloping section.

[77] For a more detailed exposition on the appropriateness of the one-hoss shay assumption for EDBs, see Economic Insights, *Total factor productivity index specification issues*, 7 December 2009, pp. 54–57.

[78] D Lawrence and E Diewert, 'Regulating electricity networks: The ABC of setting X in New Zealand', in T Coelli and D Lawrence (eds.), *Performance measurement and regulation of network utilities*, Edward Elgar Publishing, Cheltenham, 2006, pp. 207-237; J Makholm and M Quinn, *Price cap plans for electricity distribution companies using TFP analysis*, NERA working paper, 21 October 1997, p. 15;

Figure 6 Capital services profile accounting for the bathtub curve



Source: AER analysis

Figure 6 above depicts the capital services profile of a DNSP asset, accounting for the probability of failure depicted by the bathtub curve. This illustrates that the capital service profile is constant for the life of the asset, but then decreases significantly once the asset reaches the end of its useful life.

While the one-hoss shay assumption may apply to individual assets, it may not apply to a population of assets. PEG stated different assets:

> ....are retired at different dates: some may last only a year or two, others ten to fifteen years. When the experience of the short-lived assets is averaged against the experience of the long-lived assets, and the average cohort experience is graphed, it will look nearly geometric if the 1000 assets have a retirement distribution of the sort used by the Bureau of Economic Analysis (i.e., one of the Winfrey distributions). Thus, the average asset (in the sense of an asset that embodies the experience of 1/1000 each of 1000 assets in the group) is not one hoss shay, but something that is much closer to the geometric pattern.[79]

Economic Insights stated this 'portfolio effect' only applies if there is a large number of firms with a wide spread of asset ages. Economic Insights noted the 'bunched' nature of previous network rollouts in New Zealand and the impending 'wall of wire' as assets of similar age requires replacement. The portfolio effect would not apply in such a case.[80] PEG stated Economic Insights did not provide empirical evidence to support this claim (in the case of New Zealand), and proposed the AER can undertake an empirical investigation to test the existence of the portfolio effect in the NEM.[81]

Question 27

Is the one-hoss shay assumption appropriate for the measurement of capital services provided by individual distribution system assets?

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79 PEG, *Submission to Australian Energy Market Commission: Preliminary findings report*, April 2010, p. 24. The OECD also described a case where the capital service profile of individual assets deteriorates linearly, though the cohort of assets has a deterioration profile that has a convex shape. OECD, *Measuring capital*, Second edition, 2009, p. 41.

80 Economic Insights, *Total factor productivity index specification issues*, 7 December 2009, pp. 56–57.

81 PEG, *Submission to Australian Energy Market Commission: Preliminary findings report*, April 2010, pp. 26–27.

Question 28

Does the 'portfolio effect' apply to populations of distribution assets? Assuming the one-hoss shay assumption is appropriate for individual assets, does the portfolio effect negate the one-hoss shay assumption when using populations of assets in economic benchmarking?

Question 29

If the one-hoss shay assumption does not appropriately describe the deterioration profile of DNSP assets, which deterioration profile is most appropriate?

Physical vs. value measures to derive the quantity of assets

The economic benchmarking techniques require input information in terms of price and/or quantity (see Table 2). There is debate in the literature whether the quantity of assets (capital inputs) is best derived using physical or value measures. The central consideration in this debate hinges on the capital service profile, particularly the validity of the one-hoss shay assumption.

Economic Insights stated the most appropriate proxy for the quantity of capital inputs for one-hoss shay situations is the physical quantity of the principal assets.[82] Examples of physical measures include route kilometres for overhead and underground lines, possibly disaggregated by capacity. Transformer capacity is a candidate measure to quantify transformers. While poles can be quantified using number of poles of a particular type (wood poles, concrete poles, and so on).

The following example illustrates the intuition for using physical measures to derive quantity of assets, assuming one-hoss shay. Suppose a farmer uses only one capital input: a tractor with a life of 50 years. Assuming one-hoss shay, the tractor will work the same area of land every year for 50 years. In an economic benchmarking study, we can use the quantity of one tractor for any given year because the tractor provides the same level of service over its life. If the farmer buys another unit of the same tractor in year 5, the capital input quantity would be two tractors from that point on.

If the one-hoss shay assumption is not reasonable, physical measures are not an appropriate measure of capital input quantities. Physical measures indicate the same level of capital services over the benchmarking period, when in fact it is declining, adding bias to an economic benchmarking study. Similarly, we cannot simply add the two tractors together in the example above because they differ in the amount of capital services they provide in any given year.[83]

PEG stated two conditions must be satisfied for physical measures to be applicable for benchmarking:

- there must be empirical evidence that every capital good measured by physical units exhibits one-hoss shay deterioration, and

82 Economic Insights, *Total factor productivity index specification issues*, 7 December 2009, p. 16.
83 PEG, *Defining, measuring and evaluating the performance of Ontario electricity networks: A concept paper*, April 2011, p. 102.

- there must be no evidence of a 'portfolio effect'.[84]

PEG expressed doubt whether both of these conditions are satisfied (see previous section). PEG therefore advocated using deflated monetary values of capital expenditures (and not physical measures), as the most appropriate measure for capital input quantities.[85] The researcher or regulator can use an appropriate price index to derive the quantity measure.

We previously outlined our reasons for considering the one-hoss shay assumption to be reasonable for individual DNSPs assets. Hence we consider that PEG's first condition is satisfied. However, it is not clear whether the portfolio effect is relevant for DNSPs in the NEM and will be the subject of research for economic benchmarking work.

We note that satisfying the two conditions from PEG does not preclude using value measures to derive the quantity of capital inputs. Researchers have used the gross replacement value of DNSP network assets to measure capital stock under the one-hoss shay assumption.[86] Such value measures can then be deflated using a price index. Economic Insights stated this indirect method of deriving asset quantities is second best if physical measures are available. This is because price indexes will never accurately reflect the prices paid by a firm or an industry.[87] However, we may wish to use value measures to derive asset quantities for sensitivity testing and/or if issues arise with physical quantity data.

A sub-issue with collecting value measures of the capital stock is choosing the appropriate prices to use to value assets. Assets can be valued either at historical prices (the prices at which the DNSPs acquired the assets), or the prices of a reference period.[88] Either type of prices has pros and cons for use in economic benchmarking. For example, historical prices may introduce bias as newer assets will be weighted more heavily if prices have been rising over time.[89] This can be mitigated if an appropriate index is available to represent historical prices in real terms. On the other hand, we may wish to compare actual spend on DNSP assets to indicate relative cost efficiency. Using prices from a reference period would not necessarily reflect this.

Question 30

Should we measure asset quantities using physical or value based methods?

Question 31

Assuming the one-hoss shay assumption is appropriate for individual distribution assets, would the existence of the portfolio effect render the use of physical measures of capital quantities inappropriate for economic benchmarking?

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84 PEG, *Submission to Australian Energy Market Commission: Preliminary findings report*, April 2010, p. 26.
85 PEG, *Submission to Productivity Commission: Electricity network regulation issues paper*, May 2012, p. 8.
86 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, p. 146.
87 Economic Insights, *Total factor productivity index specification issues*, 7 December 2009, p. 53.
88 OECD, *Measuring capital*, Second edition, 2009, p. 39.
89 OECD, *Measuring capital*, Second edition, 2009, p. 39.

Question 32

How should we derive the value of a DNSP's capital stock for the purpose of determining quantity of assets?

Question 33

What index should be used to inflate historical asset prices into real terms?

RAB depreciation as a practical measure of capital inputs

In the discussion above we consider the one-hoss shay assumption to be reasonable for individual assets. If the portfolio effect is not applicable to DNSPs in the NEM, physical measures may be used to calculate the quantity of capital. As mentioned previously, however, this does not preclude the use of value measures of capital for economic benchmarking purposes. The annual contribution of a single asset can be derived by dividing the cost incurred by the DNSP by number of years the asset is in service (similar to straight line depreciation). To this end, depreciation of the regulatory asset base (RAB) in real terms may be a practical measure of the annual contribution of assets to the provision of outputs. We, and the NEM DNSPs, already have a history of calculating RAB depreciation in distribution determinations under the NER.

The RAB is a measure of all the assets a DNSP has in place to provide distribution services. RAB depreciation is the annual depreciation applied to the RAB as part of the calculation of allowed revenue. In distribution determinations under the NER, we use the straight line method to obtain annual RAB depreciation having regard to the asset age profile proposed by DNSPs. Hence the annual RAB depreciation value is a reasonable measure of the annual contribution of capital to providing outputs under the one-hoss shay assumption.

RAB depreciation can be directly extracted from the RAB roll forward models, so it is much less data intensive than obtaining value measures of capital (using either historical prices or the prices of a reference year). However, RAB depreciation may be problematic. We have observed that asset lives used to calculate RAB depreciation differ across states and also differ from asset lives used in the repex model. Where these differences are justified we consider that RAB depreciation would be an appropriate basis for the measurement of capital services. However, if these differences reflect significant differences in opinion regarding the expected lives of assets then RAB depreciation may not be an appropriate measure of capital services as consistent asset lives should be applied. Where inconsistent asset lives aren't applied, the measurement of capital services for identical networks would differ and hence so would the benchmarking results.

Question 34

Is RAB depreciation an appropriate measure of the annual contribution of capital to the provision of outputs?

Prices of inputs

Another issue is how the prices of inputs should be measured. Differences in input prices may contribute to difference in costs and price information may help to identify differences in input mix allocative efficiency. Economic benchmarking may also require price information when using physical measures of capital to weight the amount of capital services they provide to derive an aggregate measure of inputs. Asset prices may also be used to weigh the effect of capital additions to the capital stock when updating capital quantity indices using the perpetual inventory method.[90]

Further, differences in prices may explain why DNSPs use different combinations of inputs. Where the prices of inputs materially differ across jurisdictions then it may be appropriate to deflate input prices to derive a constant price measure of inputs.

Measuring the prices of inputs may be a challenge. The prices used will ultimately depend on the measures of inputs used. Further, shadow prices may need to be estimated where actual prices cannot be measured. Lastly, where capital is used as an input, it is necessary to determine the appropriate price of capital.

The benchmarking report noted capital input price can be measured either directly (i.e., annual user cost of capital that takes account of depreciation, opportunity costs and capital gains) and indirectly (i.e., realised residual between total revenue and operating and maintenance costs).[91] An example of capital input prices used in past research is the ratio of capital expenses (depreciation plus interest) to the total installed capacity of the utility's transformers in kVA.[92] Similarly, another paper calculated capital price as the ratio of residual capital costs to the capital stock. Residual capital cost is the total distribution cost minus labour cost. The capital stock is approximated by the total installed transformer capacity measured in kVA.[93] A third paper formulated a capital price index that incorporated depreciation (assuming geometric decay of capital inputs), the difference between opportunity cost and capital gains, and the real rate of return on capital.[94]

Should we not factor the prices of inputs into consideration, we would still be able to measure productive efficiency, however we would not be able to decompose it into its different elements. Ultimately, this would reduce the explanatory power of our economic benchmarking and may lead to a less sophisticated interpretation of its results.

Question 35

What prices should be used to weigh assets and the activities involved in operating and maintaining those assets?

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90 PEG, *Defining, measuring and evaluating the performance of Ontario electricity networks: A concept paper*, April 2011, pp. 45–46.

91 ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012, p. 146.

92 Farsi, M, M Filippini and W Greene, 'Application of panel data models in benchmarking analysis of the electricity distribution sector', *Annals of Public and Cooperative Economics*, 77, 3, 2006, p. 277.

93 Filippini, M, N Hrovatin and J Zoric, *Efficiency and regulation of the Slovenian electricity distribution companies*, CEPE working paper no. 14, April 2002, p. 8.

94 Lowry, M, L Getachew and D Hovde, 'Econometric benchmarking of cost performance: The case of US power distributors', *The Energy Journal*, 26, 3, 2005, p. 79.

Question 36

Do the prices of inputs materially differ across jurisdictions within Australia, or could the AER use the same prices as weights for inputs across jurisdictions?

5.2 Outputs

In this section, we consider the variables that should be used to model the outputs of DNSPs. The literature on benchmarking acknowledges that it is difficult to define the outputs of DNSPs.[95] Hence, we have developed criteria for determining the appropriate economic benchmarking outputs. We consider that there are multiple dimensions to the outputs of DNSPs. These may include both the quality and quantity of services provided by DNSPs. In economic benchmarking, we consider that it may be necessary to consider all the dimensions of outputs. Otherwise important aspects of outputs might be missed in benchmarking comparisons which may explain differences in relative efficiency.

Outputs are generally considered to be the total of the goods and services delivered by a business. The challenge is selecting the appropriate output variables that summate, at an aggregate level, the services provided by a firm to its customers. For instance, the output of a factory might be a number of cars. However, DNSPs provide services which are less tangible than the products produced by a factory. The literature on economic benchmarking does not appear to have settled on a specification of the services of DNSPs.

There are many aspects to the service provided by DNSPs. For instance, DNSPs will have many different types of customers within their networks, whose specific requirements for access to electricity will differ. In measuring these different aspects of distribution services, it may be necessary to weight them by their importance. To do this, studies will often use a price-weighted output quantity index to measure aggregate outputs. Where prices are not directly observable or may not be reflective of importance, relative shares of cost elasticities to outputs may be used in their stead.[96]

5.2.1 Criteria for selecting output variables

Our criteria for selecting output variables for DNSPs, and reasons for selecting these criteria, are presented in Table 5.

Our approach to using criteria to select output variables is similar to the approach applied by Norwegian regulator to select output variables. This was described as follows:

> The selection of output variables was one of the most challenging issues when the new regulation model was developed prior to its introduction in 2007. The regulator formulated three criteria that should be met if an output variable was to be included in the model. First, the variable should have a solid 'theoretical and practical' foundation. Second, it should have a statistically significant effect on company costs, evaluated based on regression tests. Third, the variable should be statistically significant in the so-called 'Banker test', (see Banker, 1993), such that the efficiency estimates obtained using models with or without the variable had to be significantly different. Hence, although a large number of candidate variables were

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95 Toru Hattori, Tooraj Jamasb and Michael G Pollitt, *A comparison of UK and Japanese electricity distribution performance 1985-1998: lessons for incentive regulation*, 2003, p. 4.
A Omrani, S Azadeh, F Ghaderi and S. Aabdollahzadeh, 'A consistent approach for performance measurement of electricity distribution companies', *International Journal of Energy Sector Management*, 4, 3, 2010, pp. 401-402.

96 Economic Insights, *Energy Network Total Factor Productivity Sensitivity Analysis: Report prepared for Australian Energy Market Commission*, 9 June 2009, p. 5.

considered initially, the final set of variables shown in Table 1 was determined mainly based on statistical tests.[97]

Our criteria differ from those of the Norwegian regulator in a few ways. Table 5 outlines the reasons for the selection of our criteria.

Table 5 Criteria for selecting output variables

Criteria	Justification
The output aligns with the NEL and NER objectives	The NEL and NER provide a framework within which the review of DNSP expenditure must be conducted. Within this framework we must accept regulatory proposals where they reasonably reflect the efficient costs of delivering certain outputs. In order to be of use in our review of regulatory proposals, the outputs in economic benchmarking should reflect the outputs that we must ensure that DNSPs are supported financially to deliver. The expenditure objectives specify the required deliverables of expenditure forecasts. Economic benchmarking outputs should align with the deliverables in the expenditure objectives to assist us in reviewing whether forecasts of expenditure to meet those deliverables reflect efficient costs. The expenditure objectives are to achieve the following: - meet or manage the expected demand for standard control services over that period; - comply with all applicable regulatory obligations or requirements associated with the provision of standard control services; - maintain the quality, reliability and security of supply of standard control services; - maintain the reliability, safety and security of the distribution system through the supply of standard control services.[98]
The output reflects services provided to customers	We consider that in defining outputs it is necessary to distinguish between the goods or services that a firm provides from the activities that it undertakes. The outputs of should be the same regardless of the activities that a firm undertakes. For instance, the output of a factory is the number of cars produced regardless of the technology, capital or labour utilised to produce the cars. Outputs should reflect the services that are provided to customers. Otherwise the use of economic benchmarking may incentivise activities are not actually valued by customers. For instance, the connection of a customer to a network would be a service. However, the replacement of a substation would not represent a service because it is not directly provided to a customer. If replacing a substation was considered an output, then DNSPs might prioritize replacing substations in order to appear efficient over activities that will more directly deliver services for customers. Further, it may make DNSP's that had prioritised replacing substations in the past over other activities appear unjustifiably more efficient.
The output is significant	There are many output variables for DNSPs. For the purposes of economic benchmarking, the variables must be significant either in terms of their impact on customers or on the costs of DNSPs. For instance, responding to customer inquiries might be considered an output. However, because responding to customer inquiries may not have a significant effect on the costs of DNSPs it may not be considered necessary for economic benchmarking purposes.

97 VL Miguéis, AS Camanho, E Bjørnda,l, M Bjørndal, 'Productivity change and innovation in Norwegian electricity distribution companies'.,*Journal of the Operational Research Society*, 63, 2012, pp. 983–984.

98 NER, clauses 6.5.6(a) and 6.5.7(a)

Question 37

Are our criteria for selecting outputs appropriate? Are there any additional criteria that should be considered?

5.2.2 Output variables

Economic benchmarking comparisons between DNSPs have used differing output variables. Typically, economic benchmarking studies have used combinations of outputs to reflect the multiple dimensions to the outputs of DNSPs. The combination of variables used for this purpose varies across studies. In preparing the benchmarking report, we engaged WIK Consult to review the cost benchmarking practices in some European countries.[99] The WIK Consult report revealed that the benchmarking outputs varied quite significantly across European countries. Generally the literature has modelled electricity distribution in the following dimensions:

- Energy delivered – commonly modelled by electricity distributed. Sometimes this is disaggregated into customer type, tariff class, or peak/non-peak deliveries
- Customer numbers – commonly measured by the number of customers and sometimes disaggregated by customer type
- Network size – which is commonly modelled as network length or service area
- System capacity – commonly modelled as the peak capacity that network line/transformer can manage
- Peak demand – which measures the capacity that network assets were actually required to manage. This is either measured as coincident peak demand (the maximum demand on the network at any given time) or non-coincident peak demand (the sum of the individual maximum demand on network assets)

Often the selection of economic benchmarking technique will align with the researcher / regulator's conceptualisation of DNSPs services. Generally, these conceptualisations consider from an economic perspective the services that DNSPs provide and hence their outputs. There have been a number of differing conceptualisations of the services provided by DNSPs, such as the following from CREG, Growitsch et al and Economic Insights:

CREG provided the following description of energy networks (not just DNSPs) in its report on the development of distribution system operators for the Belgium government:

> In the liberalized market, the final client buys his energy from a supplier in an open competition. To exercise the purchase the client turns to a system operator and requests a seamless and uninterrupted transportation and distribution of the energy from the supplier to the connection point. This creates three service dimensions for the distribution task; transportation work, capacity provision and customer service.[100]

Growitsch et al have a different conceptualization of distribution services, which justifies their choice of customer numbers and energy delivered as outputs:

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99 WIK-Consult, *Final report: Cost benchmarking in energy regulation in European countries*, 14 December 2011.
100 CREG, *Development of benchmarking models for distribution system operators in Belgium*, November 2011, p. 32.

> Electricity distribution utilities operate in a regulated environment and provide a required amount of energy to a given number of customers as a joint service. The two elements of this service, electricity delivered and number of customers supplied, can be treated separately, as they (i) drive different costs, and (ii) interact with each other technically. Therefore, we use two output variables in the cost-only and the cost-quality models. These variables have been identified based on the "separate marketability of components" property suggested by Neuberg (1977), that is total number of customers and number of energy units supplied measured in Gigawatt-hours (GWh). The two output variables also reflect the structure of a two-part tariff, i.e. a fixed charge per customer as well as a variable part dependent on consumed energy.[101]

Finally, Economic Insights uses the analogy of a road network to describe distribution services:

> Like all network infrastructure industries, a major part of DBs' output is providing the capacity to supply the product. In this sense, there is an analogy between an energy distribution system and a road network. The DB has the responsibility of providing the 'road' and keeping it in good condition but has little, if any, control over the amount of 'traffic' that goes down the road. Other outputs the DB provides are directly related to its number of connections ('local access roads') as well as call centre operations responding to queries, connection requests, etc.[102]

Figure 7 presents the differing combinations of output variables identified in the benchmarking report.

[101] C Growitsch, T Jamasb and M Pollitt, 'Quality of service, efficiency, and scale in network industries: An analysis of European electricity distribution', *IWH-Discussion Papers No. 3, July 2005*, p. 15

[102] Economic Insights, *Total factor productivity index specification issues: Report prepared for Australian Energy Market Commission*, 7 December 2009, p. 3.

Figure 7 Output variables used in previous economic benchmarking studies

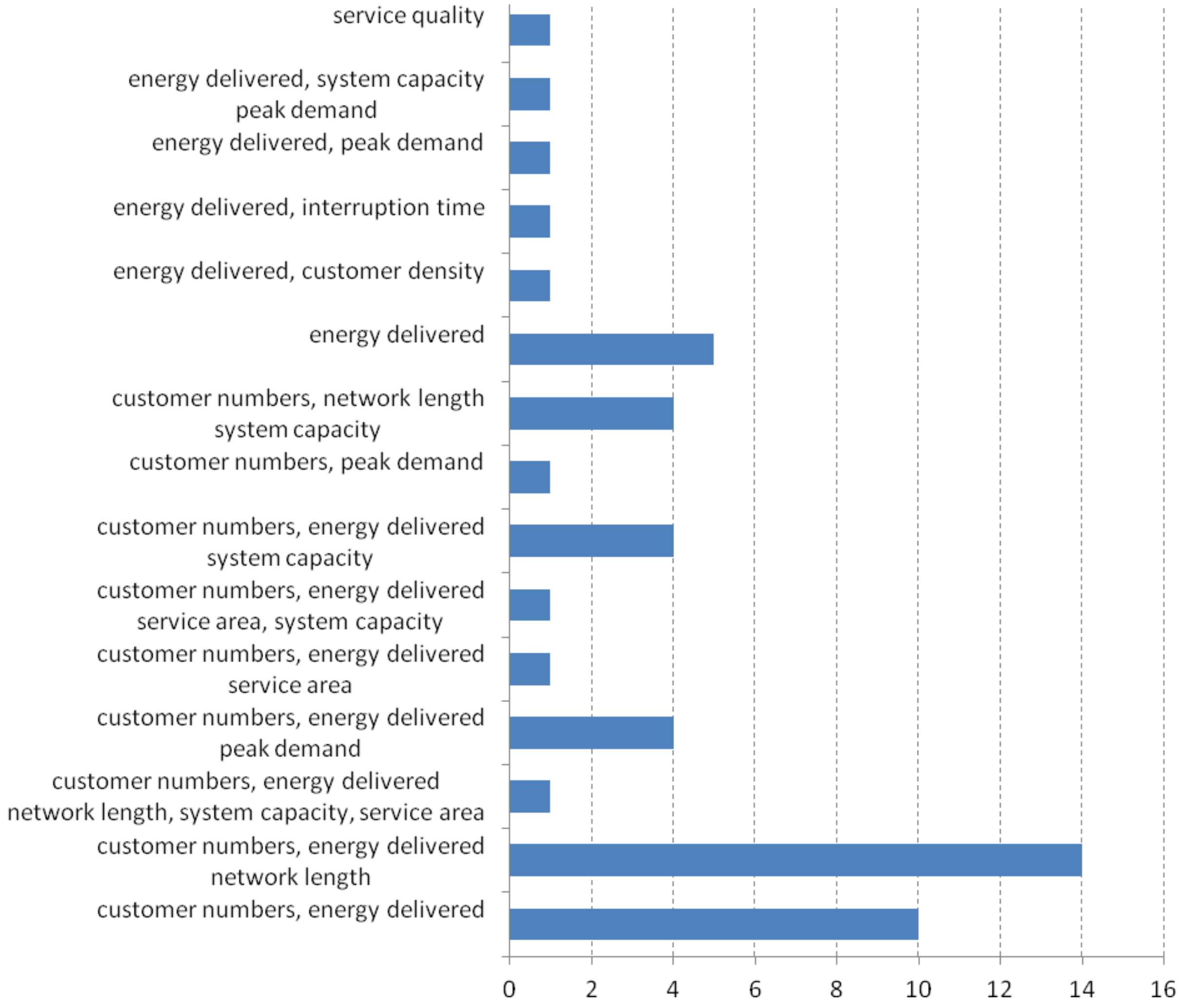

Figure 7 shows that the most common combination of outputs is customer numbers, energy delivered and peak demand with 14 occurrences. The second most common combination is customer numbers and energy delivered with 10 occurrences. After that, energy delivered by itself is the third most common with five occurrences.

The reasons why these various output variables have been used is considered in the following sections. Further, the expenditure objectives specifically make a reference to a number of factors that might be considered outputs. These are also considered below.

Energy delivered

The most common output variable previously used to benchmark DNSPs is energy delivered. This reflects the electricity put into or drawn out of an electricity network over the course of a year. Energy delivered is measured in terms of Watt hours (Wh) of energy. DNSPs collect and maintain reliable data on the energy delivered in their networks for the purposes of calculating electricity charges and distribution losses. It should be noted that the AEMC's proposed required data set for TFP included the measurement of energy delivered.[103] The AEMC did not provide explicit justification for the use of energy delivered but noted that most TFP studies have used outputs covering energy delivered, customer numbers and measures of peak demand or system capacity. The AEMC cautioned the use of erratic variables, such as system demand as proxies of demand based charges and contracted reserved capacity charges, as these variables may lead to potential inaccuracies and biases in the measures of TFP growth rates.[104]

Energy delivered may not be an ideal output variable for DNSPs because it may not significantly affect the costs of providing distribution services. Ralph Turvey suggests that DNSPs act passively in distributing energy along their lines and cables and through its switchgear and transformers. Turvey notes that the amount distributed is not decided by the DNSP. In the short-run a load alteration will not affect the size of the network and will and only trivially affect operating and maintenance costs.[105]

However energy delivered has been commonly used in benchmarking studies. One study used energy delivered as an output stating that:

> Although a distribution network operator cannot normally determine the amount of electricity distributed, it has to ensure that all its network assets have the capacity to deliver this energy to its customers. Hence, the total amount of energy supplied may be viewed as a proxy for the load capacity of the network.[106]

A recent study of Finnish distribution networks supported this perspective noting that in their data set peak demand correlated almost perfectly with energy delivered.[107] The correlation between energy delivered and peak demand may not hold in Australia. This is because there is evidence that, in recent years, growth in peak demand on Australian networks has not been in step with the growth in average demand on those networks.[108]

Another recent study has used energy delivered as an output variable simply because it has been commonly used in other studies.[109] Further, other recent studies include energy delivered as an output because it represents one of the marketable goods of the joint service of electricity.[110][111] Though energy delivered is a marketable good of the service of electricity it may not hold that it represents a service provided by DNSPs. Since energy distribution is a natural monopoly, there can be significant departures from cost reflective pricing across outputs.[112] Also, energy delivered may represent a throughput, not an output.[113] This is because DNSPs do not generate electricity. Rather they provide a network which distributes it. Energy delivered can fluctuate from day to day or year to year whilst DNSPs provide customers with the same network services.

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103 AEMC, *Review into the use of total factor productivity for the determination of prices and revenues*, 30 June 2011, p. 80.

104 AEMC, *Review into the use of total factor productivity for the determination of prices and revenues*, 30 June 2011, p. 68.

105 R Turvey, 'On network efficiency comparisons: electricity distribution', *Utilities Policy*, Vol.14 (2), 2006, p. 105.

106 T Coelli, A Gautier, S Perelman and R Saplacan-Pop (2010), *Estimating the cost of improving quality in electricity distribution: A parametric distance function approach*, a paper presented at Lunch Seminar in Energy, Environmental and Resource Economics Spring 2011, Swiss Federal Institute of Technology Zurich, p. 7.

107 T Kuosmanen, 'Cost efficiency analysis of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model', April 2011, p.10

108 AEMC, *Draft report: Power of choice - giving consumers options in the way they use electricity*, 6 September 2012

109 A Omrani, S Azadeh, F Ghaderi and S. Aabdollahzadeh, 'A consistent approach for performance measurement of electricity distribution companies', International Journal of Energy Sector Management, 4, 3, 2010, pp. 399-416.

110 Growitsch, C, Jamasb, T and Wetzel, W, *Efficiency effects of quality of service and environmental factors: Experience from Norwegian electricity distribution*, August 2010, p.9.

111 Growitsch, C., Jamasb, T., Pollit, M., 'Quality of service, efficiency and scale in network industries: an analysis of European electricity distribution', *Applied Economics*, 41(20), 2009, pp. 2555-2570.

112 Economic Insights, *Total factor productivity index specification issues: Report prepared for Australian Energy Market Commission*, 7 December 2009, p.3.

113 Turvey, R, 'On network efficiency comparisons: Electricity distribution', *Utilities Policy*, 14, 2006, pp. 103-113.

It might be argued that we must account for energy delivered when considering a DNSP's ability to meet or manage expected demand under the capex and opex criteria. However, there is a contrary perspective that energy networks are engineered to manage peak demand not energy delivered. Energy delivered does not necessarily reflect peak demand.

Network capacity

Network capacity is a measure of the total peak demand that a DNSP can manage. There are a number of measures of network capacity, including embedded transformer capacity, and capacity by line length. Network capacity is normally measured in terms of Kilo Volt-Ampere (kVa) capacity.

We consider that network capacity may be a key characteristic of DNSP assets as it is the peak demand that DNSP assets are engineered to manage. Should actual demand exceed network capacity then network assets may be damaged or fail. Increasing network capacity is a significant cost driver. Further, network capacity may significantly affect the costs and reliability of distribution services for customers.

A common view in the literature is that network capacity should be regarded as an output. Ralph Turvey contends that:

> The throughput of a network of pipes and wires, as already pointed out, is not determined by the enterprise and should not be regarded as an output. From the point of view of a long -run analysis, then, what the enterprise provides is not gas, electricity, water or messages; it is the capacity to convey them. It follows that, to compare efficiencies, it is necessary to compare differences in capacities with different costs.[114]

However, network capacity may not reflect a service provided to customers. Changes in network capacity may not directly improve customer experience and may have no effect at all on customer experience. Instead network capacity might be considered a characteristic of electricity networks and an input to the provision of distribution services. From this viewpoint, the use of network capacity as an output would be inappropriate. This is because it is possible to install network capacity without having a commensurate improvement in customer experience. Thus, DNSPs could appear unjustly more efficient because they have additional network capacity when this capacity does not improve the customer experience.

Network capacity might be said to align with the expenditure objectives because it is required to meet and manage the demand for energy services. To ensure continuous supply to customers, a level of network capacity is required to manage demand.[115] However, network capacity may not be an appropriate measure of this as there are other ways that a network may meet and manage demand, including demand management, and the use of embedded generation. Businesses engaging in demand management would appear to be inefficient should network capacity be used as an output variable, as it would increase costs, but would not add to network capacity. Further, using network capacity as an output might make businesses that have invested in excessive network capacity appear unjustifiably more efficient.

Additionally, network capacity may align with the expenditure objectives as it is required to maintain security of supply. However, this may not be appropriate because network capacity may only capture one aspect of network security. To maintain security of supply, it is necessary to undertake other activities such as vegetation management and ageing asset replacement. Using network capacity as

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114 Turvey, R, 'On network efficiency comparisons: Electricity distribution', *Utilities Policy*, 14, 2006, pp. 103-113.
115 Benchmark Economics, *Aurora Energy, a comparative analysis: Aurora Energy's network cost structure*, May 2011, p. 33.

an output without factoring the other variables relevant to security may disincentivise investment in other, perhaps more efficient, expenditure to ensure network security. Security of supply measures is considered later in this section.

Peak demand

Peak demand measures the maximum demand on an energy network during a year. This can be measured both in terms of coincident and non-coincident load. Coincident peak demand measures the peak demand on a network at a given point in time. Non-coincident peak demand measures the sum of the peak demand on individual assets over the course of a year. Peak demand is typically measured in terms of Mega Watts (MW).

The peak demand on a network can significantly affect network expenditure. In our distribution determination for Victorian DNSPs, it was expected that expenditure to reinforce the network to cope with peak demand will be 24 per cent of capital expenditure for Victorian DNSPs in the current period.[116]

The use of peak demand as an output would appear to align with expenditure objectives. It seems intuitive that the peak demand actually managed would reflect a DNSP's ability meet or manage expected demand for standard control services.[117]

However peak demand may not be an appropriate output variable for a DNSP because the management of peak demand might be considered a means towards maintaining reliable electricity supply. Under this perspective, because maintaining reliable electricity supply is the overall goal of meeting peak demand, the reliability of supply of electricity may be a more appropriate output variable.

There is an alternative view that peak demand should be considered an output because there is a notional contract between customers and DNSP's that DNSP's should meet customer demand for electricity. Indeed, this may be a contractual obligation for some networks. As CREG notes in its development of benchmarking models for Belgium distribution system operators:

> the demand from the client for electricity connection cannot be refused under the Universal Service Obligation and the client is not contractually requested to remain connected, or to guarantee and specific load profile.[118]

From this perspective, one dimension of the service provided by DNSPs is in ensuring that their networks have sufficient capacity to meet demand at all times. This view would appear to hinge on customer preferences. Customer preference may not hold that a DNSP should meet their load at all times if that will lead to higher network tariffs. If customers were provided with pricing signals indicating the costs of supplying electricity, they may prefer to reduce their peak demand to reduce network costs. Further, customers might be willing to participate in demand management initiatives to reduce their peak demand and their network tariffs.

Another justification for the use of peak demand as an output variable is that it is more important to maintain supply at times of peak demand because the value to customers of access to electricity at these times might be greater. From this perspective it is the welfare effects of network outages at

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116 AER, *Final decision: Victorian electricity distribution network service providers: Distribution determination 2011–2015*, October 2010, pp. 441–443.

117 NER, clauses 6.5.6(a) and 6.5.7(a)

118 CREG, *Development of benchmarking models for distribution system operators in Belgium*, November 2011, p. 32.

times of peak demand that justifies expenditure to meet and manage peak demand. Again, this view would appear to hinge on customer preferences. In this instance, what perhaps should be measured are the negative effects of outages at times of peak demand. The value to customers of access to electricity at any given point in time might be measured in terms of the load on the network at that time because the load reflects the demand for electricity. Hence, the load lost in an outage could reflect the detriment caused by that outage.[119] From this perspective, the output of a DNSP might be minimizing the negative effects of network outages as opposed to managing peak demand per se.

Because peak demand might be outside of the control of DNSPs and a factor that significantly affects the costs of providing distribution services, it may be considered an environmental variable. Consideration of peak demand as an environmental variable is set out in section 5.3.3.

Size of service area

In some economic benchmarking studies, network length and service area have been used as a output variable for a DNSP. Size of service area can be measured in terms of network line length (measured in km) or service area (measured in km^2).

Farsi, M and M Filippini justified the use of network size as an output as it is a characteristic that takes resources to manage.[120] We agree that the size of service area is a significant driver of costs. All other things being equal, a network with longer line length or a larger service area would be more costly to manage. However, size of service area might better be considered an environmental variable as opposed to an output. This is because it does not reflect a service provided to customers. Customers might not be concerned by the size of their networks. Further, size of service area does not appear to align with the expenditure objectives to which we must have regard.

Network density, which takes into account the size of service area, might be considered an environmental variable. This is considered in section 5.3.3.

Electricity quality and safety

Quality and safety are explicitly mentioned in the expenditure objectives.[121] Because of this, there may be a view that they should be considered as an output.

Network safety and electricity quality is important to customers and may have a significant impact on the costs of DNSPs. Electricity networks are made up of dangerous assets that can electrocute and cause fires. Variation in electricity quality of supply, such as voltage spikes, may affect the performance of or damage the electrical equipment of customers. Electricity quality of supply relates to aspects of service such as voltage, frequency variation, voltage waveform and interference. Drops in electricity quality of supply can damage electrical appliances.

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119 Lost load is an important consideration when measuring reliability performance. This is because an outage with the same duration affecting the same number of customers could have a different impact depending on the demand for electricity at the time. A network outage in the middle of the night will probably have less of a detrimental effect than an outage in the same location at noon.

120 Farsi, M and M Filippini, *A benchmarking analysis of electricity distribution utilities in Switzerland*, Centre for Energy Policy and Economics (CEPE) working paper no. 43, June 2005, p. 9.

121 It should be noted that in this context electricity quality of supply specifically references the quality of electricity delivery to customers. Quality of electricity supply relates to aspects of service such as voltage, frequency variation, voltage waveform and interference. This is should be distinguished from overall quality of electricity network services which may also include the reliability of supply measured in terms of the frequency of interruptions to supply.

There are many measures of network electricity quality and safety. Individually, these measures may not have a significant effect on network costs. However, taken together it they may be significant.

We have not identified studies that have used electricity quality and safety as an output dimension for the purposes of economic benchmarking. This may reflect the fact that reliable, consistent data on electricity quality and safety is not available or that electricity quality and safety is not considered a material output for the purposes of economic benchmarking.

Security of supply

Security of supply measures the overall security of a distribution network, taking into account the probability that network assets will fail or be overloaded. A good example of measures of security of supply is the British regulator Ofgem's secondary deliverables, presented in Table 6.

Table 6 Ofgem's security of supply measures[122]

measure	Description
Load Index (LI)	The LI reflects the utilisation of network assets. The LI will be used to measure the used capacity of network assets (i.e. substations). The LI will be a ranking from 1 to 5 where LI1 categorizes assets with significant spare capacity and LI5 captures assets that are fully utilised and require augmentation
Health Index (HI)	The HI reflects the risk of failure of network assets. The HI of network asses is also ranked from 1 to 5 where 1 represents new assets that have a low risk of failure and 5 represents assets with a high risk of failure at the end of their serviceable lives
Fault rates	Fault rates will be used as a secondary measure for asset replacement expenditure, for specific asset classes where the DNSP does not presently have HI capability, or it is not economic to collect a full set of HI data.

Because the NEO and expenditure objectives both mention security of supply it may be argued that measures of security of supply should be used as outputs. Further, investment in security of supply is a significant driver of network costs.

Security of supply measures might be considered inputs because they concern the nature of assets used to deliver outputs, as opposed to service provided to customers. Hence, using security of supply measures as outputs might create incentives that do not align with the delivery of services. For instance, the use of a load index as an output measure could incentivise businesses to install extra network capacity when it isn't required in order to appear efficient. Alternatively, the load index might make DNSPs that have invested heavily in network capacity appear relatively efficient.

Further, the ultimate goal of investing in security of supply might be considered to be ensuring reliable supply. Security of supply measures may represent inputs required to ensure reliability of supply in the future. As such, actual reliability of supply for a given level of inputs may be a preferential measure for measuring actual security of supply outcomes in economic benchmarking.

[122] Ofgem, *Electricity distribution price control review: Final proposals*, 7 December 2009, p. 2.

Customer numbers

Customer numbers are the number of customers connected to a DNSP's network. These are commonly measured in terms of metered supply points or billable customers in a DNSP's network. Customer's can be further broken down into different types to distinguish different customer types by their difficulty to serve. This has included differentiation by voltage, network area type (such as CBD, urban, rural), and by customer class (such as residential and commercial). The disaggregation of customers by customer type may be necessary to adequately account for differences in the drivers of costs across DNSPs.

Customer numbers are a common measure of outputs of DNSPs that we have identified used in benchmarking studies. Various justifications for the use of customers are provided in these benchmarking studies. These include:

- A large part of distribution activities (relating to metering services, customer connections, customer calls, etc.) are directly correlated to the number of customers[123]
- Network firms have a legal obligation to connect all customers within their designated area, and the firms have to maintain the power lines in operation even if they are only used seasonally, which can be relatively costly.[124]

We must consider expenditure that would be incurred by an efficient DNSP over the regulatory control period.[125] The number of customers is a measure of the demand for distribution services. The use of customer numbers as an output measure may provide an indication of a DNSP's efficiency in meeting and managing demand for network services.

Further the connection of new customers is a significant driver of costs. As such, customer numbers would probably be significant enough to be used as a network output.

Question 38

If customer numbers are used as an output for economic benchmarking, should these customer numbers be separated into different classes? If so what are the relevant customer classes for the purpose of economic benchmarking?

Reliability

Reliability in electricity networks is commonly measured in terms of the number, duration and effect of interruptions to electricity supply. Measures of reliability include: number of customer interruptions, total duration of customer interruptions, and estimated load lost due to network customer interruptions. It may be important to include reliability as an output dimension because it has a direct impact on customers and it may explain variations in costs across networks. A number of studies note

123 T Coelli, A Gautier, S Perelman and R Saplacan-Pop (2010), *Estimating the cost of improving quality in electricity distribution: A parametric distance function approach*, a paper presented at Lunch Seminar in Energy, Environmental and Resource Economics Spring 2011, Swiss Federal Institute of Technology Zurich, p. 7.

124 T Kuosmanen, '*Cost efficiency analysis of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model*', April 2011, p.10

125 NER, clauses 6.5.6(e)(4) and 6.5.7(e)(4)

that reliability is a dimension of the services provided by DNSPs.[126] The expenditure objectives specify we must allow DNSPs efficient expenditure to maintain the quality, reliability and security of supply of distribution services and the distribution system.[127] Measures of reliability will directly relate to this objective and so potentially should be considered as outputs for economic benchmarking.

The way reliability has been incorporated into benchmarking has often depended on the purpose of the study. Interestingly, despite reliability intuitively being a dimension of the output provided by DNSPs, a number of studies have used reliability as an input. In one study the logic for with including the reliability as an input variable is that the operators can substitute between regular inputs (labour, capital etc.) and the inconvenience faced by the customers (interruptions). A rational DNSP will look at the "price of interruptions" (e.g., the penalty imposed by the regulator) and compare it with the price of other inputs (e.g., labour) before deciding upon the optimal (cost minimising) mix of inputs to use.[128]

The use of reliability as an input in studies may reflect the nature of reliability measures themselves. Reliability measures concern the frequency and duration of outages. Reductions in the frequency or duration of outages reflect an improvement in reliability. Hence, a decrease in the value of indexes that measure the frequency and duration of outages will reflect an improvement in reliability. This may be an issue because outputs in TFP studies may need to be measured in such a way that an increase in the measured quantity of an output represents more of the output.[129]

Question 39

Have we identified all the relevant outputs? Which combination of outputs should we use in economic benchmarking?

Question 40

Despite multiple studies using volume of energy delivered as an output, we are not convinced that this is appropriate. What are stakeholder's views on the use of energy delivered as an output?

Question 41

It would appear that much network expenditure is ultimately intended to maintain the reliable supply of electricity. This might include the management of peak demand, network capacity and investment to ensure that networks are secure. Given this, is it appropriate to use measures of reliability as an output variable?

126 Economic Insights, *Total factor productivity index specification issues*, December 2009, p. 9; Growitsch, C, T Jamasb and M Pollitt, 'Quality of service, efficiency, and scale in network industries: An analysis of European electricity distribution', *Applied economics*, 41, 20, 2009, p. 17; Growitsch, C, Jamasb, T and Wetzel, W, *Efficiency effects of quality of service and environmental factors: Experience from Norwegian electricity distribution*, August 2010, p.9.

127 NER, clauses 6.5.6(a) and 6.5.7(a)

128 T Coelli, H Crespo, A Paszukiewicz, S Perelman, M Plagnet, and E Romano, 'Incorporating quality of service in a benchmarking model: An application to French electricity distribution operators', Draft: June 2008, p. 7. Available at: http://www.gis-larsen.org/Pdf/Plagnet.pdf [accessed 14 December 2012].

129 Economic Insights, *Total factor productivity index specification issues*, December 2009, p. 9.

5.3 Environmental variables

Box 6 Environmental variables

Environmental variables are factors that are exogenous to the control of DNSPs that affect their ability to convert inputs into outputs.

Environmental variables outside of a DNSP's control can affect their ability to convert inputs into outputs. Environmental variables should be included to model factors that affect a DNSP’s cost and are outside the management control.

The selection of environmental variables is challenging because there are numerous environmental variables that may affect a DNSP's ability to convert inputs into outputs. Previous economic benchmarking studies have not applied consistent environmental variables. Further, there is overlap between inputs, outputs and environmental variables used in previous economic benchmarking studies. For instance, in the literature, network line length has been utilised as an input, an output and an environmental variable.

5.3.1 Criteria for selecting environmental variables

In order to select environmental variables for benchmarking, the following set of criteria is proposed. These criteria, and reasons for their selection, are outlined in Table 7.

Table 7 Criteria for selecting environmental variables

Criteria	Reasons for criteria
The variable must have a material impact	There are numerous factors that may influence a DNSP’s ability to convert inputs into outputs. Only those that have a material impact on costs should be selected.
The variable must be exogenous to the DNSP’s control	We consider that environmental variables are exogenous to a DNSP's control. Where variables are endogenous, investment incentives may not align with desired outcomes for customers. Further, the use of endogenous variables may mask inefficient investment or expenditure.
The variable must be a primary driver of DNSP costs	Many factors that could affect the performance might be correlated because they have the same driver. For instance, line length and customer density may be negatively correlated. Where there is correlation, the primary driver of costs should be selected. Higher line length might reflect a lower customer density, so perhaps customer density should be selected as the environmental variable because it may be considered to have a more direct influence on costs.

Question 42

Are our criteria for selecting environmental variables appropriate?

5.3.2 Environmental variables used in previous benchmarking studies

There have been numerous environmental variables used in previous economic benchmarking studies.[130] These include:

- Measures of load such as load factor, peak demand and system loading
- size of service area
- number of customers
- density measures such as customer density, consumption density and peak demand density
- various climate measures
- asset measures such as percentage of underground cables and asset age

Because the number of environmental variables used in the past has been significant, this section does not consider environmental variables individually. Rather four possible environmental variables that we consider important are discussed.

5.3.3 Possible environmental variables

We have identified a number of primary environmental variables that we consider may be used in economic benchmarking. We consider that the environmental variables selected reflect the most significant environmental variables which can be compared across businesses.

Climate

Climate may be considered an environmental variable, as:

- In Australia, there is variation in climate, and climate can affect the costs and reliability of DNSPs.
- DNSPs have no control over the climatic conditions within their networks.
- Climate conditions are a primary driver of costs.

In any given year, climatic conditions can affect the reliability of networks. Should reliability be used as an output, it is important that annual climate conditions be taken into account as an environmental variable.

Terrain

Terrain may be considered an environmental variable, as:

- We consider that terrain may have a significant impact on network costs.
- DNSPs have no control over the terrain within which their networks are located.
- Terrain is a primary driver of network costs.

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[130] ACCC/AER, *Benchmarking opex and capex in energy networks: Working paper no.6*, May 2012.

Customers in hilly or mountainous terrain will be more costly to service. In such terrain, network assets may need to be specifically tailored to distribute electricity to customers. Further, networks located within forested terrain will have greater vegetation management costs. The management of corrosion caused by high air salinity in coastal areas may also affect network costs.

Peak demand

Peak demand may be considered an environmental variable, as:

- Peak demand can have a material impact on network costs.
- Peak demand may or may not be considered exogenous to the control of DNSPs.
- Peak demand is a primary driver of network costs.

Networks are engineered to manage peak load. Consequently networks with higher peak loads will have greater costs. Peak load may not be considered an environmental variable as it may not be exogenous to a DNSPs control. DNSPs may engage in demand management or set peak load pricing signals to manage demand. If peak load is not exogenous then it may be better to identify and model the exogenous drivers of peak load as opposed to peak load itself.

Network density

Network density is a measure of the demand for distribution services per unit of network size. Network density has been measured in terms of customer density (customers per kilometre of line) or load density (average peak energy demand per km of line).[131] Network density may be considered an environment variable, as:

- Network density has been shown to materially impact the costs of DNSPs.[132]
- We consider that network density is exogenous to the control of DNSPs. DNSPs cannot control the number of customers or the size of their network service area.
- We consider that network density is a primary driver of DNSP costs.

Question 43

Have we identified all the relevant environmental variables?

Question 44

Which combination of environmental variables should we use in economic benchmarking?

131 AER, *Draft distribution determination: Aurora Energy Pty Ltd 2012–13 to 2016–17*, November 2011, p. 322.
132 Benchmark Economics, *A comparative analysis: Aurora Energy's network structure*, May 2011, p. 34.

6 Questions on economic benchmarking techniques

Holistic approach

Question 20

We are interested in your views on the holistic approach to the selection and establishing reporting requirements for economic benchmarking techniques.

Efficiency and productivity measurement

Question 21

Have we identified all the relevant economic benchmarking techniques and, if not, are there other economic benchmarking techniques that should be considered?

Relating productivity to the AER's task

Question 22

We are interested in your views on how economic benchmarking techniques should be applied in our decision making process regarding expenditure. Specifically, we are interested in your views on:

- using these techniques to assist us to form a view on the efficiency of base expenditure and expenditure forecasts
- measurement of the likely pace at which productivity improvements may be made over a regulatory control period.

Inputs, outputs and environmental variables

Question 23

Should the AER separate DNSPs into groups for the purposes of economic benchmarking? If so, how should the groupings be determined?

Question 24

Are our criteria for selecting inputs appropriate? Are there any additional criteria that should be added?

Question 25

Are the assets and operate and maintain variables appropriate for economic benchmarking?

Question 26

What indices can we use to derive price and quantity information for the operate and maintain variable for economic benchmarking?

Question 27

Is the one-hoss shay assumption appropriate for the measurement of capital services provided by individual distribution system assets?

Question 28

Does the 'portfolio effect' apply to populations of distribution assets? Assuming the one-hoss shay assumption is appropriate for individual assets, does the portfolio effect negate the one-hoss shay assumption when using populations of assets in economic benchmarking?

Question 29

If the one-hoss shay assumption does not appropriately describe the deterioration profile of DNSP assets, which deterioration profile is most appropriate?

Question 30

Should we measure asset quantities using physical or value based methods?

Question 31

Assuming the one-hoss shay assumption is appropriate for individual distribution assets, would the existence of the portfolio effect render the use of physical measures of capital quantities inappropriate for economic benchmarking?

Question 32

How should we derive the value of a DNSP's capital stock for the purpose of determining quantity of assets?

Question 33

What index should be used to inflate historical asset prices into real terms?

Question 34

Is RAB depreciation an appropriate measure of the annual contribution of capital to the provision of outputs?

Question 35

What prices should be used to weigh assets and the activities involved in operating and maintaining those assets?

Question 36

Do the prices of inputs materially differ across jurisdictions within Australia, or could the AER use the same prices as weights for inputs across jurisdictions?

Question 37

Are our criteria for selecting outputs appropriate? Are there any additional criteria that should be considered?

Question 38

If customer numbers are used as an output for economic benchmarking, should these customer numbers be separated into different classes? If so what are the relevant customer classes for the purpose of economic benchmarking?

Question 39

Have we identified all the relevant outputs? Which combination of outputs should we use in economic benchmarking?

Question 40

Despite multiple studies using volume of energy delivered as an output, we are not convinced that this is appropriate. What are stakeholder's views on the use of energy delivered as an output?

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It would appear that much network expenditure is ultimately intended to maintain the reliable supply of electricity. This might include the management of peak demand, network capacity and investment to ensure that networks are secure. Given this, is it appropriate to use measures of reliability as an output variable?

Question 42

Are our criteria for selecting environmental variables appropriate?

Question 43

Have we identified all the relevant environmental variables?

Question 44

Which combination of environmental variables should we use in economic benchmarking?

Attachment B: Category analysis

This attachment outlines our initial position on how to best categorise NSP proposed expenditures in order to undertake assessments in accordance with the NEL objective, namely setting efficient expenditure allowances in the long-term interests of consumers.

Through the publication of a set of assessment guidelines for transmission and distribution, and through annual benchmarking reports, our intention is to develop a framework that builds on existing practices while providing for more robust assessments. Specifically, we are interested in developing a nationally consistent approach that incorporates benchmarking and similar quantitative assessment techniques, supplemented by the appropriate use of qualitative evidence and the transparent use of judgment.

With respect to category based assessments, and for the purposes of initiating consultation with stakeholders, our current thinking is to implement a framework that supports the optimal use of the expenditure assessment techniques identified in section 4 of this issues paper.

We propose to utilise benchmarking at the overall expenditure level as well as across many of the identified categories.[133] Categorisation will also assist in increasing the robustness of other assessment techniques including trend analysis and predictive modelling. In developing the expenditure categories we will seek classifications that:

- are transparent, replicable and are readily understandable
- are consistent across NSPs and over time
- support the comparison of NSP expenditures at an aggregated and disaggregated level
- where possible, allow us to draw relatively robust inferences about the relationships between expenditures and explanatory variables or "drivers"
- provide sufficient information for analysing the cost and volume dimensions of undertaking activities.

The remainder of this attachment outlines our current thinking on a category based assessment framework that contains these elements and is intended to be a starting point for consultation. We are also interested in whether these particular elements and the associated expenditure categories are appropriate or could be refined.

The categories and techniques we have suggested here have been developed with distribution network expenditures in mind. However we expect that this general approach, and some categories and techniques (particularly for opex), should be applicable to transmission businesses and we will explore this further during consultation.

The next section summarises our proposed categories and applicable techniques. Section 2 explains some of the categories in more detail. Section 3 explores various other issues around our expenditure assessment including uncontrollable factors (such as environmental variables and input costs) and in the use of benchmarks.

[133] Noting that lower level expenditure benchmarks may not be required where other techniques (e.g. modelling) are applied.

1 Summary of our initial position

Our general approach does not significantly depart from the concept underlying the expenditure reporting frameworks already applied to NSPs where expenditures are categorised according to a particular activity or driver. The current expenditure categories that are reported on in each jurisdiction contain many similar categories, however some areas are markedly different. Furthermore, even where similar categories exist, differences will exist between NSPs in what expenditures are reported against these categories as well as differences in how categories have been defined or understood in detail. We intend to harmonise these expenditure categories based on the objectives identified above. We anticipate that the costs and expected benefits of changes to reporting arrangements to facilitate particular assessment techniques will be an ongoing point of discussion over the next year.

Our approach will seek to identify categories that allow us to set efficient expenditures based on comparisons between NSPs and the relationship between drivers and expenditures. In combination with this, we would use predictive modelling, trend analysis, engineering and project based assessments to form an overall picture of the efficiency of each NSP's expenditure proposal.

The results from these techniques will be used as a basis for assessing and challenging NSPs' views of efficient forecasts under the NER framework. They are not intended to be a stand-alone, mechanistic way of setting expenditures, particularly given that each method has shortcomings and will be populated with imperfect or incomplete data. However where a NSP's proposal differs significantly from benchmarking, modelling, engineering review etc, they will be required to provide evidence of why this is the case for the purposes of further discussion with us and potential refinement of our techniques. Where such justifications are lacking, and where our techniques are considered to be sufficiently robust and supported by other evidence, we are likely to place more reliance on our own assessment techniques in forming a view on what is an efficient expenditure allowance.

We expect to work closely with NSPs over the coming months to establish a robust conceptual framework for analysis. We recognise that for some techniques to generate reasonable results will require the collection of a certain quantity and quality of input data. It may therefore take several years of reporting against new information templates and refinements before some techniques produce dependable results. The actual application of this overall approach and data requirements would therefore vary based on the different histories of each NSP.

Table 8 summarises the assessment methodology approach we would like to consult on, based on the techniques we currently have available. Table 9 identifies the broad expenditure categories and additional techniques we are proposing to enhance or develop.

Table 8 Proposed expenditure categories and techniques

Expenditure	Primary techniques	Secondary techniques
Capex		
Customer driven	Demand review, Engineering	Benchmarking, Governance review
System growth	Modelling, Project sampling	Engineering, Governance review
Replacement	Modelling	Benchmarking, Engineering
Changes in obligations	Engineering	Benchmarking
Other	Various[a]	
Opex		
Maintenance (proactive and reactive)	Trending	Engineering, Benchmarking
Vegetation management	Trending[b]	Engineering, Benchmarking
Emergency response	Trending[b]	Engineering, Benchmarking
Corporate overheads	Trending[b]	
Network overheads	Trending[b]	
Other	Various[a]	

[a] Technique depends on the specific expenditure type and supporting information
[b] Base step and trend model supported by benchmarking and engineering to assess efficient base year

Table 9 Areas for further development or enhancement

Expenditure	New, enhanced or amended techniques
Capex	
Customer driven	Disaggregation of this category to better support benchmarking and comparison with the augex model.
System growth	Further development of the augex model and the potential use of benchmarks where appropriate.
Replacement	Further development of the repex model including the use of benchmarks where appropriate.
Changes in obligations	Not possible to define an assessment approach as the driver and magnitude of future expenditures not known. Depending on the nature of the obligation and changes from recent history, benchmarks and comparisons with historical trends could be used.
Other	Potential disaggregation of this category to identify material sub-categories. For example: Information technology, fleet/vehicles, land and easement purchases, etc.
Opex	
Maintenance (proactive and reactive)	Potential disaggregation of this category into proactive and reactive maintenance. Potential to consider inspections and period maintenance separate to reactive and condition based maintenance. Explore potential for modelling of maintenance expenditures. Improved benchmarking and targeted unit rate benchmarking.
Vegetation management	Improved benchmarking. Identification of drivers of expenditure and potential benchmarks.
Emergency response	Improved benchmarking. Improved capture of outage information. Identification of drivers of expenditure and potential benchmarks.
Corporate overheads	Improved definitions and potential disaggregation of this category. Identification of material sub-categories. Improved use of trending.
Network overheads	Improved definitions and potential disaggregation of this category. Identification of material sub-categories. Improved use of trending.
Other	Potential disaggregation of this category to identify material sub-categories. For example: Information technology, fleet/vehicles, etc.

Within these general categories we also consider that there may be a need to report expenditures according to asset type, network density and voltage level in order to better:

- identify factors that cause expenditure levels to change over time
- ensure consistency across NSPs and over time
- identify uncontrollable factors that influence expenditure and that differ across NSPs.

In addition, we anticipate the need over the medium term to develop reporting templates that collect other supporting data which give better context to NSP proposals as well as to the stand alone results of assessment techniques. For example, through repeated analysis we may identify some information that explains why some NSPs will always appear high or low with respect to certain benchmarks and would seek to include this in standardised data templates.

The remainder of this attachment outlines our thinking in more detail, noting that we have been primarily focussing on DNSP expenditures. Overall we seek stakeholder comment on whether these categories are appropriate or could be refined, noting that they (and any sub-categorisations) would ultimately form part of data reporting templates and information instruments under the NEL. We also seek views on whether expenditures should be better aligned to various drivers and activities undertaken by DNSPs.

2 Expenditure categorisation

This section outlines the rationale for our initial position on expenditure categorisation, particularly as it relates to capital (asset) items. Section 2.1 examines expenditure drivers, followed by a discussion of assessment approaches that attempt to measure the influence of these drivers on individual expenditure categories in section 2.2. Following this, assessment approaches for overheads and indirect costs that may have many relevant drivers are also outlined. Finally, issues around different approaches to capitalisation between DNSPs are discussed.

2.1 Expenditure drivers

Network services which deliver electricity to customers across both transmission and distribution systems mainly comprise of activities to build, repair, replace, operate and augment network infrastructure. The need to undertake these activities can be delineated into eight general categories of expenditure driver:

- Customer requests — customer requests for new or additional load resulting in the construction or augmentation of infrastructure, often to facilitate a new or altered connection point, but may also include any other requests such as the relocation of assets for visual amenity.
- System growth — changes in the level of capacity required by consumers will impact on the infrastructure required to fulfil the DNSP’s obligations to provide safe and reliable network services. Note that we distinguish this driver from customer specific requests to augment the network mentioned above.
- Actions of third-parties — acts such as vandalism, traffic accidents, or requests for relocation, may impact on the condition of the network and may require preventative or reactive activities to maintain safe and reliable network services.
- Vegetation — interference with the network by vegetation may impact on the condition of the network and may require preventative or reactive activities to maintain safe and reliable network services.
- Weather events — storms and other extreme weather events may interfere with the condition and proper operation of the network and may require preventative or reactive activities to maintain safe and reliable network services.
- Wildlife interference — interference with the network by wildlife such as birds and possums may impact on the condition of the network and may require preventative or reactive activities to maintain safe and reliable network services.
- Asset condition — the failure of assets as well as the deterioration in their condition or performance may impact on the fulfilment of a DNSP's obligations. Again this may require preventative or reactive activities, including asset replacement and maintenance activities.
- Changes in obligations — changes to obligations may require service providers to augment their networks, change management systems or a variety of other activities to ensure compliance with the new obligations.

There are also a number of other activities undertaken by DNSPs that arise as an indirect result of these drivers or in simply existing as a commercial entity. While these indirect activities are common across NSPs, the amount of expenditure may vary between them and over time. Variations in these expenditures may arise because of other, less identifiable drivers, including the size and complexity of the network, environmental conditions and legal obligations. These activities are typically known as indirect or overhead costs, and we have separated them into "corporate" and "network overhead" categories for the purposes of our assessment.

We consider that the consistency of these expenditure drivers and residual activities across NSPs forms a suitable basis for identifying and separately assessing categories of expenditure.

Question 45

Do you agree with this list of expenditure drivers? Are there any others that should be added?

Question 46

To what extent do you think the expenditure drivers are correlated with each other? Given this level of correlation, should we examine the impact on expenditure of each one, or can this list be consolidated?

2.2 Details of driver based assessments

The following sections examine the different expenditure categories that may be the best match for each type of driver identified above. The expenditure categories in this section align to those outlined above in Table 8 and Table 9.

We have not addressed approaches to examining expenditures in the "other" categories as they are beyond the level of detail canvassed in this issues paper, and will need to be dealt with in further consultation. Similarly, we are well aware of complications in defining appropriate drivers and categories for some expenditure (e.g. customer requests for the uprating of circuits) as well as instances of where expenditures are the result of multiple drivers (e.g. works triggered by a replacement need that are scoped opportunistically to address an expected capacity constraint on the same asset as this would be more efficient). It may be appropriate to consider expenditures according to a "primary" driver, however these and other definitional issues will need to be worked through with stakeholders in consultation.

For the purposes of consultation we are also interested in exploring the applicability of techniques to categories of alternative control service expenditures, as well as customer contributed works, as they may still be relevant in forming a view on the overall efficiency of NSP expenditure. The categories below are intended to include expenditure on these items where relevant.

2.2.1 Customer driven capex

This expenditure is driven by specific customer requests and typically represents a significant proportion of total capitalised expenditure. These consist of:

- new connections, which be broken down into the following components:
  - installation of connection point assets — similar to a fee-based service in nature as the required works are homogeneous within each type of connection point.

- extension of the shared network — similar to a quoted service as the scope of the works are specific to individual customers' needs, with the customers' needs relating mostly to length of new network required.
- alteration of the existing shared network — similar to a quoted services as the scope of the works are specific to individual customers' needs, with the customers' needs relating mostly to network capacity.

- fee-based services and quoted services.

The assessment of these categories is likely to involve a combination of benchmarking costs per customer and trend analysis, as well as the augex model for some subcategories of expenditure. The assessment of quoted services is likely to rely on engineering assessment.

Further details on the assessment of the three connection point subcategories, as well as fee based and quoted services, are outlined in turn below.

New connections: basic connection point works

This category should include costs of installing a meter and service at a new connection point, and exclude both the costs of extending the network to get to a connection point and the costs of upgrading existing network. The assessment approach could involve:

- volumes of new connection points to be assessed through demand forecast review
- base-and-trend approach to setting the average unit rate.

The connection point component of new connection expenditure will depend on the assets being installed. The most material variance in the cost of the assets to be installed may depend on the network segment in which the connection point is located, and whether or not the new connection is an overhead or underground connection. Hence this category could be disaggregated into different types of connection points (overhead or underground, connections to non-LV parts of the network, etc) and the assessment approach can be done separately for different types of connection points. Such disaggregation may be subject to the capability of DNSPs to report costs and volumes at these levels of disaggregation. We invite views on this position.

Note that for some DNSPs the basic connection and connection extension services are unregulated. Nonetheless, information should be collected to provide a more rounded picture for the standard control connection augmentation expenditures.

New connections: extension works

This category should include the costs of extending the network to get to a new connection point, and exclude both the costs of the new connection point and the costs of upgrading the existing network to facilitate the new connection.

Assessment of this category would require data on the kilometres of line length added to the network for the purposes of this driver only. This would allow a per kilometre unit cost to be derived. Data on kilometres added should also be broken down into network segments — e.g. subtransmission, short HV rural feeders, long HV rural feeders, HV urban feeders, HV CBD feeders, short LV rural feeders, long LV rural feeders, LV urban feeders, and LV CBD feeders. This would allow differentiation of the unit cost for each network segment.

This would facilitate revealed cost and benchmarking among DNSPs of the average per kilometre cost of extension for each network segment. A base year approach can be applied to the average unit cost. Forecast volume likely to be determined via long run historical average number of kilometres added per new connection, with number of new connections and average kilometres added per new connection determined via demand forecasting.

Recent resets have examined aggregate new connections costs, that is, the cost of the new connection point plus the cost of related network extension plus the cost of related network augmentation. The approach we suggest here provides greater accuracy in forecasting by providing greater disaggregation of cost types / types of network extended.

New connections: non-extension augmentation works

This category should include costs of upgrading the existing network to facilitate a new connection point, and exclude both the costs of the connection point and the costs of extending the network to get to the connection point.

Assessing this category would require data on MVa of capacity added to the network for the purposes of this driver only. This would allow the derivation of a per MVa unit cost. Data on MVa of added capacity should also be broken down by network segment to allow the unit cost of added capacity to be differentiated by network segment. This data is an input into the augex model (see Box 7).

The augex model could be used to benchmark the cost per MVa of added capacity for various network segments (subtransmission, HV, LV, etc). Long run historical average number of units of added capacity per new connection may be analysed and applied as a forecast volume trend.

The activities involved with the augmentation component of new connections expenditure and the activities involved with system growth-driven augmentations are similar with the two categories only differentiated by different events (customer connection request versus existing customer load growth). Therefore, distinguishing new connections augmentation expenditure by the following network segments may be an appropriate means of capturing the cost of different types of assets (which we also suggest as inputs to the augex model):

- subtransmission lines
- subtransmission substations
- zone substations
- high voltage lines (which may be single phase, multi-phase, or single wire earth return (SWER))
- distribution substations
- low voltage lines.

We will be releasing more details on the augex model to stakeholders in advance of working group meetings.

Box 7 The augex model

A major portion of most DNSP's capex is due to the need to augment the network (i.e. upgrade existing asset capacity or add new capacity) to account for changes in the customer demand for electricity.

We are developing a tool to aid in its assessment of augmentation capex – the augex model. The overall philosophy behind the model's functionality, in a regulatory context, is similar to the repex model we presently use to assess age-related replacement capex. In this regard, the augex and repex models provide a useful reference to assess regulatory proposals, allowing a common framework to be applied without the need to be overly intrusive in data collection and the detailed analysis of the asset management plans.

The augex model forecasts augmentation needs at an aggregate level using asset utilisation as the main asset state that drives this need - where asset utilisation is taken to mean the proportion of the assets capability being used during peak demand conditions. The model then uses idealised planning parameters to predict future augmentation needs given this asset utilisation.

In this way, the augex model takes account of the main internal drivers of augmentation capex that may differ between DNSPs, namely peak demand growth and its impact on asset utilisation. Similar to the repex model, the augex model can be used to determine intra- and inter-company benchmarks from actual historical augmentation levels. These in turn can be used to identify elements of a DNSP's augmentation capex forecast requiring more detailed review and inform the appropriate expenditure allowances.

Fee-based and quoted services

These services are all customer requested and typically involve an activity (e.g. asset alteration, relocation, removal or replacement) not otherwise undertaken except by customer request, or above standard activities.

Fee-based services are largely homogeneous in nature and therefore a fixed fee can be set in advance with reasonable certainty. Quoted services are those where the scope and nature of the service is specific to an individual customer's needs and varies from customer to customer.

Expenditure on quoted services need not be distinguished into sub-components. The forecasting error on the volume of different sub-components due to the relatively low sales volume for these services means that the additional modelling complexity may not be worthwhile. Expenditure on fee-based services also need not be distinguished into sub-components. The forecast sales volume for each service is considered to be the primary driver of expenditure differences over time – accounting for other potential cost drivers would create additional complexity that may not be worthwhile.

Hence the assessment of fee based services could require data on the costs and volumes for each service. Forecast volumes could be determined through forecasting sales volumes. Unit rates for these volumes could be assessed via base-and-trend model. Examining long-run historical trends i.e. ratio of percentage change in customer service costs to percentage change in customer numbers, may also provide useful information. Average unit cost for each fee-based service can be benchmarked to other DNSPs if definitions of services are reasonably comparable.

We expect this may not be the case for quoted services due to their disparate nature, however are interested in exploring this possibility and hence reducing the need for ad hoc, detailed analysis in this area.

Question 47

Do you think that the network segments outlined above provide a useful demarcation of the costs of customer-initiated network extension and/or augmentation? Do you think that there are significant cost differences in installing connection point assets and in network extensions between overhead and underground assets? What alternative asset type demarcations would be more appropriate?

Question 48

Do you agree with separating customer-requested expenditure by connection point assets, extensions, and augmentations? Do you think total expenditure for each service (excluding new connections services) is a sufficient degree of disaggregation? Should further sub-categories be identified?

Question 49

Do you agree with separating new customer connections expenditure by the connection point, extension, and augmentation components? Do you think that the number of new connections, length of network extensions added, and size of capacity added are useful measures of the volume of work and expenditure required for new connection services? Should these categories be disaggregated into more detailed categories reflecting the type of work undertaken by the NSP to account for factors that drive changes in new connections expenditure over time?

2.2.2 System growth capex

Customer load changes on the shared network trigger the need to build, upgrade or replace network assets. This is due to the increasing risk of the service provider not meeting the anticipated maximum demand at the desired measure of quality or reliability. Typically, the type of work done to address such issues is specific to the network needs at the time and in the location of the issue. These are costs related to changes in demand – either growth in demand, movement of demand around the network, or other changes that may cause power quality or reliability issues.

This category should include costs of upgrading the existing network, excluding upgrades that:

- are required to facilitate new connections, and
- occur incidentally from the application of current design standards and using modern engineering equivalent assets in replacement activities.

This category should also exclude upgrades that are not primarily directed at increasing network capacity, maintaining power quality, or allowing the network to better meet maximum demand (e.g. should exclude upgrades directed at improving power quality, such as harmonics).

Growth in maximum demand, with resultant constraints on network utilisation and available capacity, is the most significant driver for this expenditure. We consider it worthwhile to distinguish between expenditure that is directed at improving utilisation and network capacity from expenditure directed at other augmentations.[134] While the precise augmentation work undertaken by an NSP to address a capacity constraint will be specific to the individual project, insights can be gained from examining and comparing the scope of responses by NSPs at higher levels of aggregation. That is, it would be useful to see whether a NSP has been systematically upgrading its network to achieve substantially lower or higher levels of spare capacity than other NSPs. The impacts of demand fluctuations and the degree of forecasting error may also be reduced by examining NSPs' expenditures at higher levels of aggregation.

It is likely that the augex model will form the basis for other targeted assessments. For example, if the augex model indicates a DNSP is spending significantly more or less than it has historically, or with respect to other DNSPs, then we may seek justifications from the DNSP or undertake project or engineering based assessment.

Expenditure incurred in augmenting the network may involve material cost differences across various network segments. The types of assets required to distribute electricity at different voltage levels may display materially different costs, and work processes involved in building, repairing, or replacing these network segments may display material differences. For these reasons, and as with the case for customer driven works, breaking down system augmentation expenditure according to the following network segments may be useful:

- subtransmission lines
- subtransmission substations
- zone substations
- high voltage feeders (delineated by CBD, urban, rural short, and rural long)
- distribution substations
- low voltage feeders (delineated by CBD, urban, rural short, and rural long).

Within these categories, we propose to use the augex model to assess and benchmark:

- costs per MVa of added capacity, and
- ratios of capacity added to demand growth.

[134] Such as augmentations directed at addressing harmonics issues.

Question 50

Do you think the system growth expenditure driver category should be distinguished by expenditure directed at addressing different service standard issues, such as harmonics, voltage variance, ferro-resonance, and system fault levels? Would the benefits of distinguishing expenditure into these sub-categories for forecasting the timing and scope of changes in expenditure trends over time outweigh the added complexities from doing so?

Question 51

Do you think that the network segments outlined above provide a useful demarcation of the costs of general load driven network extension and/or augmentation? What alternative asset type demarcations would be more appropriate?

2.2.3 Deterioration in asset condition (replacement capex and maintenance opex)

In this category, we include all works to address the deterioration of an asset including where those works may be driven by reliability deterioration or an assessment of increasing risk. Expenditure driven by deteriorating asset condition could theoretically include expenditure on emergency rectification work as well as non-emergency rectification work, between which there can be significant cost differences. Expenditure on this driver category could therefore be distinguished between emergency and non-emergency activities.

Given the relatively long life of many network assets and the cost-benefit trade-off involved in the repair-replace decision, non-emergency expenditure should be distinguished between replacements and other maintenance activities.

Non-emergency maintenance activities can also be distinguished between routine and non-routine activities. Routine maintenance activities, predominantly directed at discovering information on asset condition, are by their nature often undertaken at intervals that can be predicted. However, non-routine maintenance activities are predominantly directed at managing asset condition. The timing of these activities is dependent upon asset condition and decisions around when to replace the asset, which may vary over time and across service providers. Expenditure could therefore be distinguished between routine and non-routine maintenance.

Activities and expenditure will differ depending on the asset to be inspected, repaired or replaced. Further, the asset life may differ, impacting on the anticipated asset condition deterioration issues and repair-replace trade-off decisions.

As per existing categorisations, we propose to examine this driver according to asset replacement activities (capex) and in delaying asset replacement (opex).

Replacement capex (repex)

In our most recent distribution determinations, we have developed and used a repex model to assess the reasonableness of these expenditures. Significant variations between the repex model and a NSP's submission provide a basis for more detailed investigation on particular asset categories or asset management approaches.

To reflect material differences in work processes and asset lives, and as a basis for populating the repex model, these expenditures could be distinguished by the following network asset groups:

- poles
- pole top structures
- overhead conductors
- underground cables
- services assets
- customer meter assets
- public lighting assets
- distribution transformers
- distribution switchgear
- distribution substation other assets
- zone transformers
- zone switchgear
- zone substation other assets
- other assets.

We will be releasing more details on the repex model to stakeholders in advance of working group meetings.

Box 8 The repex model

The repex model combines data on the existing age and historical rates of replacement across categories of different assets, and assumptions about the probability of failure (or replacement prior to failure), to forecast replacement volumes into the near future.

For a population of similar assets, it would be expected that the replacement life may vary across the population. This can be due to a range of factors, such as its operational history, its environmental condition, the quality of its design and installation. It would also be expected that a population of similar assets will have a range of lives. Asset age is used as a proxy for the many factors that drive individual asset replacements.

In developing our repex model, it was decided that the concept behind the model should have similar characteristics to those used by the UK regulator, Ofgem. For this form of model, the replacement life is defined as a probability distribution applicable for a particular population of assets. This probability distribution reflects the proportion of assets in a population that will be replaced at a given age.

The shape of the probability distribution should reflect the replacement characteristics across the population. Our repex model, similar to the Ofgem approach, assumes a normal distribution for the replacement life. The repex model also involves a calibration of assumptions with respect to recent replacement history.

From a regulatory point of view, this form of replacement modelling provides a useful reference to assess regulatory proposals as it allows for high level benchmarking of replacement needs. It is a common framework that can be applied without the need to rely entirely on intrusive data collection and detailed analysis of the asset management plans of particular NSPs. That said, no model of this kind can predict with certainty when an asset will fail or need to be replaced, let alone a collection of tens, hundreds or thousands of like assets.

In addition to forecasting volumes for an individual NSP, the model can facilitate the benchmarking of assumed replacement lives and the unit cost of replacement.

Question 52

Do you think the above asset types are sufficient in capturing the cost differences associated with activities to address deterioration in asset condition? What other asset types may be suitable?

Question 53

Do you think cost differences between emergency rectification activities and other activities to address deteriorating asset condition are sufficient to require separate categorisation?

Question 54

Do you think cost differences between non-emergency prevention activities and non-emergency rectification activities to address deteriorating asset condition are sufficient to require separate categorisation?

Question 55

Do you think cost differences between non-emergency replacement activities and non-emergency maintenance activities are sufficient to require separate categorisation?

Routine maintenance (opex)

These costs are for activities that are conducted on a pre-determined schedule, and should include asset inspections as well as other generic maintenance activities (battery replacements, alarm tests, take oil samples, etc).

The cost of these activities for each asset category would be largely determined by:

- the number of assets in the category to be routinely maintained; and
- the routine maintenance interval (half-yearly, five-yearly, etc).

A deterministic maintenance model (see Box 9) could be used to assess and benchmark these costs. A base-and-trend model could also be used. As with all model outputs, any significant departures would be subjected to further detailed review. Unlike the repex and augex models, we have not developed any maintenance model or prototype and would need to develop this in conjunction with stakeholders.

Box 9 The routine maintenance model

A routine maintenance model would assess, for particular asset types, two aspects of routine maintenance:

- the routine maintenance interval; and
- the average unit cost of routine maintenance.

The average unit cost of routine maintenance is the average cost of maintaining one asset category over the whole regulatory control period. This is because routine maintenance cycles for some types of maintenance can be longer than 12 months, but seem rarely longer than five years, meaning that a five year period should capture at least one full maintenance cycle for each type of routine maintenance undertaken.

A historical average unit cost of routine maintenance for the particular asset category over a five year period can then be determined for each DNSP, which can then be benchmarked and compared to the proposed average unit cost.

It is assumed that a deterministic framework is appropriate for routine maintenance due to the nature of the activities – since they are directed at preventing more costly events from occurring, the maintenance must be undertaken at pre-defined intervals.

There may be multiple types of routine maintenance activities undertaken for a particular asset category, each with different maintenance intervals. NSPs may also economise by undertaking different routine maintenance types of an asset at the same time.

Differences in proposed routine maintenance intervals to revealed and benchmarked intervals can be queried and investigated via a detailed engineering review. Statistical analysis of correlation between routine maintenance interval, number of asset failures, and asset age may also be possible and may provide a means of reviewing differences in proposed routine maintenance intervals. Impact on the average unit rate of routine maintenance for an asset category from moving from the historical to the proposed intervals can also be determined.

Under a base-and-trend model, the efficient base year unit cost and maintenance cycle could be benchmarked amongst DNSPs. This could then be escalated for the regulatory control period in accordance with a scale factor, for example the number of assets expected to be in place each year, subject to controlling for environmental variables.

Non-routine maintenance (opex)

These costs cover works to prevent or rectify deterioration in asset condition where such deterioration is driven by the normal operation of the network rather than by emergency events. Similar to replacements, these costs are expected to be correlated with asset age, with non-routine maintenance requirements increasing as the age of the asset approaches the point where it becomes cost effective to undertake replacement or refurbishment.

Non-routine maintenance expenditure could be distinguished by the asset categories used in the repex model. In this way expenditure trends can be considered in light of data reflecting the risk associated with each asset category (as well as replacement/ maintenance trade-offs).

A base-and-trend model can then be used with asset ageing being a potential growth escalator. The base year amount and the growth escalation factor should be benchmarked amongst DNSPs.

Question 56

Do you think the approach to using benchmarking and trend assessment for routine and non-routine maintenance is reasonable? Are there any alternatives which might be more effective?

Question 57

Given the relative predictability of maintenance cycles and activities, do you consider it feasible to construct a deterministic maintenance model, such as that described above?

2.2.4 Changes to regulatory obligations

Activities undertaken in response to changes in regulatory obligations will depend on the nature of the regulatory obligation. The Regulator considers there are no discernible sub-categories of this expenditure driver category that will assist in forecasting changes movements in expenditure within this category over time, or in explaining differences in expenditure in this category across service providers.

Question 58

Do you think that expenditure directed at altering network infrastructure or management systems to ensure compliance with a changed regulatory obligation can be disaggregated in a way that improves accuracy in forecasting and efficiency assessments?

2.2.5 Actions of third parties and natural causes (vegetation management, emergency response opex)

Expenditure driven by actions of third parties and natural causes includes expenditure on works to prevent or rectify damage to the network caused by third parties, wildlife damage, vegetation growth, and extreme weather events such as storms. It can involve emergency rectification work and non-emergency rectification work. Expenditure may also be directed at prevention or rectification of damage. Given the significant differences between these types of costs, this driver category could therefore be distinguished between emergency and non-emergency activities. We also consider that driver of vegetation management is clearly different from the drivers of other third-party activities and should be separately categorised.

Emergency response (opex)

Emergency response activities include activities that are primarily directed at maintaining asset condition or distribution system functionality, and for which immediate rectification work is necessary, and that are primarily due to extreme weather events, vandalism, traffic accidents, or other direct or indirect physical interference by a non-related entity.

Such categorisation may better facilitate trend or benchmarking analysis with respect to:

- Reliability outcomes
- Volume of emergency management activities
- Environmental variables (e.g. networks operating in tropical or arid climates, or in sparsely populated regions)
- Network size and type (e.g. in proportion undergrounding).

Vegetation growth (opex)

Vegetation growth tends to occur at reasonably predictable rates. Vegetation driven activities that are primarily initiated by growth or anticipated growth in vegetation in proximity to network assets or access to network assets.

Such categorisation may better facilitate trend or benchmarking analysis with respect to:

- Volume of vegetation management activities
- Environmental variables (e.g. networks operating in tropical or arid climates, or in sparsely populated regions)
- Network size and type (e.g. in proportion undergrounding)

Question 59

Do you think cost differences between emergency rectification activities and other activities to address third-party actions are sufficient to require separate categorisation?

Question 60

Do you think expenditure on managing vegetation growth should be distinguished from expenditure on third-party stochastic events? Should expenditure on third-party stochastic events be distinguished into sub-categories?

Question 61

Do you think general measures of network size and type are sufficient measures for investigating differences in third party expenditure across service providers? What other measures may be useful?

2.3 Indirect activities and overheads

In addition to building, repairing, and replacing network infrastructure, service providers also incur expenditure on overheads used in planning and managing how these activities are undertaken. The Regulator considers services providers typically incur the following types of overheads:

- Corporate overheads, including:
  - CEO
  - Legal and secretariat
  - Human resources
  - Finance
  - IT
  - Fleet
  - Other
- Network overheads, including:
  - System planning
  - System operations
  - Standards and compliance
  - Procurement, logistics and stores
  - Training and OH&S
  - Capital governance
  - Records management
  - Quality and complaints
  - Communications
  - Works management
  - Customer service and billing
  - Marketing
  - IT
  - Fleet
  - Other.

Overheads represent a significant proportion of a service provider's total expenditure. For this reason, it may be appropriate to collect information on the amount of expenditure attributed to the above categories for the purposes of more detailed assessment. However, we would also be interested in views on whether overhead expenditure should be allocated to expenditure reported by driver, activity and asset as outlined in the previous sections — that is, to conduct driver based assessment and benchmarking on a fully distributed cost basis.

Due to the ubiquity of overheads, overheads could also be examined separately and benchmarked across firms in other industries. We expect that such benchmarking would need to control for scale variables, such as the size or value of the network with respect to corporate overheads, and the size of investment program or staff numbers in the case of network overheads.

Question 62

Do you think overheads should be separately reported, or included on a fully-distributed basis in the expenditure driver-activity-asset categories, or both?

Question 63

How do you think overhead expenditure should be distinguished and assessed? How would you define any overhead expenditure sub-categories?

3 Other issues in category based assessment

This section explores at a high level further issues not captured above, namely:

- real price escalation of inputs
- cost estimation risk factors
- debt and equity raising costs
- demand forecasts
- general uncontrollable cost factors
- cost allocation and capitalisation policies
- related party margins
- self insurance
- the development and use of benchmarks.

3.1 Real price escalation

Input prices—the wages paid on labour, the price a wooden distribution pole, the lease price of a motor vehicle, etc—continually fluctuate and drive changes in expenditure. The price of some inputs may rise faster than others, or may rise faster in one region than in another region. The future changes in input prices, and the relative differences across service providers, should be taken into account when forecasting expenditure and assessing efficiency. This has been reflected in the capex and opex criteria in the NER which explicitly refer to a realistic expectation of the cost inputs required in the provision of regulated services.

However, independently examining the amount spent on just one input used to address an expenditure driver may not provide very important insights in isolation from information on the amount spent on other inputs. That is, a higher level of expenditure by a service provider on one type of input may be a part of a deliberate management decision that involves a mix of inputs which result in a lower overall cost.

There is therefore a need to find a breakdown of expenditure by input type that is both:

- sufficiently detailed to forecast the impact on expenditure of changes in input prices with a reasonable degree of accuracy, and
- simple enough to reconcile and integrate with the additional breakdown of expenditure by expenditure driver, activity, and asset without adding unnecessary complexity.

It is not clear whether or not changes in input prices over the forecast period (typically five years) have a material influence on aggregate expenditure. To some extent, NSPs have the ability to re-organise inputs to achieve a new mix efficiency (see section 3.1 of attachment A) in response to changes in input prices. In addition, forecasting error around the expected technical efficiency improvements may outweigh the influence on expenditure of changes to input prices.

In the past, NSPs have proposed, and we have assessed, input price changes by examining the following input types:

- labour (insourced and outsourced)
- land (including several subcategories)
- exchange rates
- steel
- copper
- aluminium
- oil
- construction
- other.

We have also devoted considerable effort in recent determinations to examining the methods employed by NSPs to account for all of these factors, which have tended to be quite detailed and in some cases prone to material error.[135] We also note that a material amount of time and money has been devoted in engaging expert consultants in developing frameworks for the recognition of input price escalators and also in the forecasting of input prices. The impact of price escalation on total allowances is typically in the range of 3% to 5%.

We are interested in stakeholder views in the materiality and effectiveness of the assessment approach we have employed in the past, particularly in light of the expenditure impact of these factors, the uncertainty inherent in some inputs and whether firms should be able to manage the impact of some cost factors e.g. through hedge contracts, productivity dividends in wage negotiations and in the timing of input purchases. We are interested in views as to whether a standardised approach could be agreed upon between NSPs and other stakeholders, including the use of forecasts published independently of the regulatory process, as well as the joint engagement of experts to produce forecasts.

Where factors are particularly uncertain and unmanageable, we would also be interested in exploring appropriate risk sharing mechanisms between NSPs and consumers e.g. potential pass through or price control adjustments, or whether the existing ex ante approach is adequate.

Data on input prices and input volumes for various inputs may also be collected as part of the economic benchmarking techniques. We may be able to leverage any datasets used with the economic benchmarking techniques for assessing the influence of input price changes on the category analysis.

135 See for example, AER, *Draft decision New South Wales draft distribution determination 2009–10 to 2013–14*, 21 November 2008, 471–472.

Question 64

How material do you think are changes in input prices on overall expenditure levels? What forecasting and modelling approaches do you think can reliably account for the impact of input price changes on expenditure without introducing overly burdensome reporting requirements?

Question 65

What categorisation of different inputs do you think provides a sufficient understanding of both how input prices may change over time, as well as how input prices may vary across geographical locations?

3.2 Cost estimation risk factors

In past transmission determinations TNSPs have proposed using cost estimation risk factors in forecasting the cost of non-routine projects. Cost estimation risk factors increase the estimated cost of a non-routine project, and are based on the concept that initial cost estimates display a consistent bias to under-estimating the actual out-turn cost.

Optimism bias or strategic misrepresentation (in the context of intra-organisational competition for funding and project approval) may be a cause for consistent under-estimation of project costs. Conversely, the regulatory process may provide NSPs with incentives to over-forecast expenditure.

In the recently completed Powerlink transmission determination, Powerlink proposed using cost estimation risk factors to develop its forecast capex allowance. Powerlink engaged Evans & Peck to develop cost estimation risk factors, which were calculated by reference class forecasting techniques.[136]

In general, if previous capital expenditure is inefficient (that is outturn costs are overinflated) and the cost estimation risk factor estimate is based on outturn costs, this should not form a basis for future capital expenditure. The operation of incentive schemes may be able to provide some reassurance on the efficiency of historical outturn costs.

We are interested in stakeholder views on whether and how such risk factors could be incorporated into a standardised assessment approach for TNSP expenditures.

Question 66

Do you consider optimism bias and/or strategic misrepresentation to be a material issue in the cost estimation for non-routine projects? Do you consider downward biases in cost estimation to materially outweigh regulatory incentives to over-estimate expenditure? To what extent do you consider there to be a consistent downwards bias in initial project cost estimates?

136 Powerlink, *Revenue proposal: Appendix G: Capital program estimating risk analysis*, May 2011. Available at: www.aer.gov.au.

Question 67

What should be our approach to cost estimation risk factors and addressing potential asymmetric estimation risk? Would techniques such as reference class forecasting be beneficial? How would any techniques to address asymmetric cost estimation risk interact with potential incentive schemes (for either opex or capex)?

3.3 Debt and equity raising costs

Debt raising costs are incurred each time debt is rolled over, and may include underwriting fees, legal fees, company credit rating fees and other transaction costs. Equity raising costs are incurred in raising new equity capital, and may include legal fees, marketing costs and other transaction costs. These are upfront expenses, with little or no ongoing costs over the life of the equity. While the majority of the debt and/or equity a firm will raise is typically obtained at its inception, there may be points in the life of a firm—for example, during capital expansion—where it chooses additional external equity funding (instead of debt or internal funding) as a source of capital, and accordingly may incur equity raising costs.

We have an established approach to assessing debt and equity raising costs that has been applied consistently in many recent determinations.[137] We expect to continue with this approach and are interested in stakeholder views on incorporating this approach into the expenditure assessment Guidelines.

For debt raising costs, we set a benchmark bond size and number of bond issues required to roll-over the debt component of the regulatory asset base. Benchmark market bond rates are then used to price the volume of debt raising required. For equity raising costs, a cash flow analysis is used to forecast the funds required and expected earnings. The residual funds required after raising debt and retaining earnings is then calculated. A benchmark ratio is used to determine the proportion of funds that are raised from dividend reinvestment plans or from seasoned equity offerings. Benchmark rates are then used to cost the volume of dividend reinvestment and seasoned equity offerings required.

Question 68

Do you think our established approach to assessing debt and equity raising costs remains appropriate? What modifications or alternative techniques would you suggest?

3.4 Demand forecasts

Electricity demand[138] is the primary driver of growth related capital expenditure. Hence an important element of assessing the efficiency of expenditure forecasts is determining whether it has been based on an appropriate forecast of demand. Like input costs, this has been reflected in the capex and opex

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137 See: AER, *Final decision: Queensland distribution determination 2010–11 to 2014–15*, May 2010, pp. 197–202; AER, *Final decision: Victorian electricity distribution network service provider: Distribution determination 2011–2015: Appendices*, October 2010, pp. 474–506; AER, *Final distribution determination: Aurora Energy Pty Ltd*, 2012–13 to 2016–17*: Attachments*, April 2012, p. 78.

138 In this context we intend demand in terms of required capacity (e.g. MVa) and new connections.

criteria in the NER, where expenditure must reflect realistic expectation of the demand forecast required in the provision of regulated services.

Examples of how demand affects expenditure includes:

- increases in the general level of demand drive the need to augment the network
- increases in the general level of demand drive the need to investigate and implement demand management
- demand for new connections to the network drives expenditure on those connections
- the new assets associated with demand growth will contribute to increased maintenance and operating expenditures.

Forecasts of network demand are typically undertaken at the overall network level and also at various points within the network. System wide forecasts are useful in capturing macro effects such as overall population growth, temperature variation and economic activity, but do not identify individual network constraints which are the driver for augmentation expenditures. On a distribution network, NSPs typically forecast maximum demand for zone substations and for individual feeders then compare this with top down forecasts prepared through an independent process (e.g. as prepared by consultants such as NIEIR). Assessing forecast demand at the lower voltage levels of the network is important given its relationship to expenditures however may not be effective given the significant volume of works expected to be triggered by demand growth during each regulatory control period.

Reflecting on our past experience, we anticipate the following steps in assessing the reasonableness of forecasts of maximum demand:

- identify a suitably long time series of historical metered demand for the asset / segment
- adjustments to these data for historical seasonal temperature variations
- changes between historic and future rates of underlying or "organic" growth based on identified input drivers
- adjustments for known 'spot' changes to demand, either historical or forecast, which may be outside of the underlying growth trend
- adjustments to account for macro trends (such as economic growth, general energy policy and consumption trends) which may be done as a reconciliation of the spatial forecast to an independent forecast of system maximum demand that accounts for these macro trends
- comparisons of input assumptions (e.g. economic growth rates) as well as system wide demand forecasts published by independent sources such as state treasuries and AEMO
- the extent to which an NSP has well documented and transparent processes for each of the above steps, including the identification of a best practice approach in forecasting across NSPs.

For forecasts of new customer connections, we consider these are likely to be driven by population growth, economic growth, and other demographic factors such as land release data, housing approvals, household size and composition. We would therefore assess how the business has accounted for these, and any other, factors in developing its forecasts. The assessment of major industrial and commercial customers is also an essential input to determining future changes in demand.

In the past we have combined the assessment of maximum demand and customer number forecasts with energy consumption forecasts as the latter also use the same inputs and forecasting techniques. However energy consumption is a determinant in setting some price control mechanisms rather than for capex allowances. We will be seeking views on how energy sales forecasts would be assessed outside of the expenditure assessment guidelines while still attempting a standardised approach to assessment that is closely linked to demand and customer numbers.

Question 69

Do stakeholders have any in-principle views on how demand forecasts should be derived and assessed?

3.5 General uncontrollable cost factors

Expenditure incurred to build, repair, or replace network infrastructure, for any purpose, may display material differences due to a variety of uncontrollable factors. In undertaking any benchmarking analysis we will need to normalise or adjust expenditures for scale, density/ sparsity (e.g. travel time in rural versus urban areas) climatic conditions, load profiles and regional differences in materials and labour costs.

We note that in some jurisdictions, feeders have been categorised against the following regional categories in past reporting arrangements in an effort to capture customer density:

- CBD
- Urban
- Rural – long
- Rural – short.

In this context, we note that the NZCC recently undertook benchmarking of network and non-network opex according to various explanatory variables. It found that customer density (customers per km of network) did not provide any additional explanatory power to its modelling beyond the scale variables it had already examined (namely customer numbers and length of distribution lines) noting that density could potentially result in higher or lower costs.[139] A recent report by Benchmark Economics using data on Australian DNSPs found load density (MW per km) was a powerful explanatory variable in the case of total regulated revenues, however the relationships were somewhat weaker (although still statistically significant) for expenditures.[140] Over the coming months we would like to explore the impact of these factors on capex and opex more thoroughly.

Overall we are interested in examining the influence of a variety of uncontrollable factors where they can be demonstrated to have a material influence on expenditure. We are also mindful of doing so in a way that does not introduce overly onerous reporting and/or analytical frameworks, nor encourages

139 NZCC, *Resetting the 2010-15 default price-quality paths for 16 electricity distributors*, 30 November 2012, p. 93.
140 Benchmark Economics, *A comparative analysis: Aurora Energy's network cost structure*, May 2011, pp. 1, 73 and 79.

NSPs to provide evidence on all factors affecting their networks without consideration of their materiality or uncertainty in their measurement. In approaching these matters, we expect that any allowances for such factors in benchmarking must be:

- supported by evidence, with the onus on network businesses to demonstrate that these differences exist, including how they might impact on discrete parts of their networks
- capable of robust measurement over time and be ideally quantifiable from an independent source.

Question 70

Do you think that the network segments outlined above provide a useful demarcation of the expenditure incurred to address various expenditure drivers? Do you think that there are significant cost differences in building, repairing, or replacing network assets based on region in which the work is being done? What alternative asset type demarcations would be more appropriate?

3.6 Cost allocation and capitalisation policies

The different approaches to cost allocation used by NSPs may be a potentially major source of incomparability in benchmarks. For example, some NSPs fully allocate their costs to activities or drivers such that items like head office costs are reported against categories such as asset augmentation and replacement. As noted above, we are interested in exploring a method that is neutral to the allocation of indirect costs and which requires NSPs to allocate all costs to various drivers. This method relies on there being reasonable methods to do so in all cases (which could differ across NSPs), otherwise we may require methods to be standardised. In this way, reported expenditures would reflect the full cost of undertaking that particular activity or responding to a particular volume driver. The application of benchmarks would similarly reflect the efficient cost of undertaking that activity in its entirety.

We are also interested in exploring similar issues in dealing with different approaches to capitalisation (the policy of reporting certain costs as capex or opex and also whether a capex or opex solution is adopted) as well as different outsourcing approaches. These may be best accounted for by examining expenditure categories simultaneously rather than in isolation. However given the importance of benchmarking analysis we may consider mandating particular approaches to capitalisation and cost allocation across NSPs for the purposes of regulatory reporting, and seek views on alternative methods to overcome problems of incomparability in reporting. In examining capitalisation policies we are mindful of new requirements in the NER regarding the impact of changes in policies as they may affect the roll-forward of the regulatory asset base.[141]

Question 71

For the purposes of comparative analysis of various expenditure categories, do have any views on how to best control for difference in approaches to cost allocation, capitalisation and outsourcing?

[141] NER, clauses S6.2.2A and S6A.2.2A.

3.7 Related party contracts

Some NSPs outsource activities to third parties that are separate legal entities but are related to the NSP through common ownership. Expenditure forecasts may then be based on charges paid to related parties. These charges may include a margin above the direct costs incurred by the related party contractor. To ensure forecast expenditure allowances are set at efficient levels, we need to examine the efficiency of any margins paid to related parties.

In past determinations we have used a conceptual framework for assessing proposed expenditure that includes related party contracts. This framework has been subject to some debate through review of our determinations in the Australian Competition Tribunal. The framework adopted a two stage process for the assessment of related party contracts.[142]

The first stage acts as an initial 'filter stage' This filter stage is to determine which contracts it is reasonable to presume reflect efficient costs and costs that would be incurred by a prudent operator, and which contracts it is not reasonable to presume reflect these criteria. In undertaking this 'presumption threshold' assessment, we considered the two relevant questions are:

- Did the service provider have an incentive to agree to non-arm's length terms at the time the contract was negotiated (or at its most recent re-negotiation)?
- If yes, was a competitive open tender process conducted in a competitive market?

The second stage depends on the outcome of the first stage:

- Where a contract 'passes' the presumption threshold specified above, we considered it was reasonable to presume the contract price (including any associated margin above direct costs) reflects efficient costs and the costs that would be incurred by a prudent operator in the circumstances of the relevant services provider. This was to be the case regardless of whether the contract is with a related or non-related party.
- Where a contract does not meet the presumption threshold, we did not presume the contract price reflects efficient costs and so these contracts were reviewed with greater scrutiny. In these circumstances, we considered a logical approach was to adopt the contractor's actual costs—which in most circumstances will be the actual (direct and indirect) costs of a related party—as the 'starting point' and then examine whether there are legitimate reasons to justify a margin above these costs. These reasons may include:
    - the allowance required to meet the contractor's common costs
    - the required return on and return of physical and intangible assets employed by the contractor in the provision of the service
    - efficiencies on the part of the contractor over the life of the contract (for example, where the contract allows some part of these to be retained by the contractor)
    - the contractor's ability to provide the service at a lower cost than the purchaser could obtain elsewhere (for example, a return to the 'know how' of the contractor)

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142 See: AER, *Final decision: Victorian electricity distribution network service providers: Distribution determination 2011–2015,* October 2010, pp. 163–205.

- the allowance required to self-insure against the asymmetric risks faced by the contractor.

Ultimately, we considered that whether or not a margin is justified, and the magnitude of that margin where justified, required a case-by-case examination of the specific contract in the context of the issues discussed in this section. This applied to both contracts with related parties and to contracts with non-related parties where the contract does not meet the presumption threshold.

Outside of this conceptual framework, benchmarking of particular cost categories (as outlined in section 2) may provide assistance in assessing margins included in related party contracts. Costs of one NSP, which may be inclusive of related party margins, could be compared to the costs of another NSP, which may not include any related party margins.

We note the NER requirements regarding the treatment of capitalised related party margins when rolling forward the regulatory asset base.[143] As part of good regulatory practice and in providing certainty to stakeholders we would be inclined to assess margins on an ex ante and ex post basis using the same approach, subject to the different circumstances and NER requirements that apply to these different assessments. We are interested in stakeholders' views on this.

Question 72

Do you think our conceptual framework for the assessment of related party contracts is reasonable? What other techniques may be appropriate? Should we apply the same conceptual framework when assessing the efficiency of related party margins on an ex post basis?

3.8 Self insurance

In past determinations we have used the following conceptual framework for assessing proposed self insurance allowances. Under this framework, we consider NSP proposals for a self insurance allowance on a case-by-case basis. These proposals are assessed against the following criteria:[144]

- whether or not the event is already compensated for through any other aspect of the regulatory regime, including through:
    - other components of the opex forecast (for example, through recurrent expenditure that is incurred during the base year)
    - the capex forecast or roll-forward of the regulatory asset base (RAB) at the end of the regulatory control period
    - the weighted average cost of capital (WACC)
    - pass through events
- whether any remaining negative risks (not already compensated) are outweighed by upside risks (that is, risks are negatively asymmetric in aggregate).

143 NER, clauses S6.2.2A and S6A.2.2A.

144 AER, *Final decision: Victorian electricity distribution network service providers: Distribution determination 2011–2015: Appendices*, October 2010, pp. 457–459.

NSPs face the risks of particular events irrespective of whether the cost of the event is externally insured, self-insured or uninsured. Insuring an event, through either externally provided insurance or self-insurance, should not materially alter the long-term total cost of the event, but rather change the cost profile from a series of potentially large, sporadic costs to a series of smoothed, ongoing insurance premiums. However, capitalisation of expenditure and rolling capex into the regulatory asset base also acts as a smoothing mechanism. The regulatory framework also provides alternative risk management mechanisms, such as contingent projects and pass-through provisions.

Self-insurance is often sought to insure events (or a portion of costs of events) that cannot economically be externally insured. Such events are typically catastrophic events that occur only very rarely, and as such historical cost data is limited and it is difficult to accurately estimate the cost of the event.

Often self-insurance is sought as a 'step-change'; that is, the risk is not currently self-insured but the NSP proposed to self-insure the risk in the next regulatory period. As NSPs are free to spend their opex and capex allowances as they see fit, there is no need for an NSP to wait til the beginning of a new regulatory period to begin self-insuring a risk. Evidence of a historical self-insurance pattern may be useful in assessing a self-insurance proposal.

If a self-insurance allowance is provided, it may be necessary to isolate costs associated with rectifying a realised self-insured event from other costs in annual regulatory reporting. This may be necessary to avoid double-counting of the costs of addressing the risk when using historical cost data in the expenditure assessments of subsequent determinations.

Question 73

Do you think our conceptual framework for assessing self-insurance is appropriate? What other techniques may be appropriate?

3.9 Development and use of benchmarks

In most of the categories explained above we have suggested the use of "benchmarking" as a technique to assess efficiency of NSP forecasts. This section briefly lists the issues that will arise in developed and applying benchmarks which we will need to canvass with stakeholders.

In most cases in the preceding discussion we have anticipated the benchmarking of unit costs or expenditures expressed as a unit of "driver", however the following issues will be relevant to any comparative analysis where it is applied in the regulatory framework:

- general views around the robustness of the measures
- to what extent benchmarks will be used to set expenditures, form a basis for further discussion or information requests from individual NSPs, or be a general (as opposed to quantitative) factor we use in forming a view on the overall efficiency of expenditures
- whether data will be drawn from historic or forecast data, and over what time period e.g. an average of several years
- how benchmarks will be presented.

Regarding the derivation and use of benchmarks, in the past we have examined general ratios of expenditures to various scale or explanatory variables (such as opex per customer density) in order to draw general inferences about relative NSP performance.[145] In other instances, such ratios have been used to identify outliers, resulting in reductions to NSP proposals where justifications were not apparent.[146]

We note that other regulators, in particular Ofgem and the NZCC, have employed regression techniques to estimate coefficients that are essentially more sophisticated measures of the ratios mentioned above. These coefficients reflect an efficient, per unit "base" amount of expenditure which is multiplied by the scale variable which has been forecast by other means e.g. predictive models or trend assessment. The key benefit of using econometric techniques in this way is that alternative model specifications and explanatory variables can be tested and compared. With more sophisticated techniques we would be cautious, however, about being drawn into detailed argument and would seek to take a pragmatic stance (including with respect to all available evidence) rather than attempting to achieve high degrees of (spurious) precision.

In deriving these and other benchmarks for the purposes of setting expenditure, further considerations arise around whether the lowest or frontier benchmark performer is relied upon, or whether an average (or other measure) is used. The distance from the frontier may reflect a level of conservatism (i.e. acknowledgement of error in data or methods) as well as incentives (i.e. providing rewards for frontier performers).

Where benchmarking is performed at a disaggregated level, caution should also be exercised in examining particular items in isolation. As Ofgem has noted of its own bottom up regressions, benchmarking NSPs at or near the frontier on individual activities risks setting expenditures on an artificial or unrealistic benchmark efficient firm.[147] For example, outperformance of an opex activity such as maintenance could simply be offset by higher (but still efficient) expenditure on asset replacement expenditure. Outperformance of some benchmarks could also reflect poor quality in service outcomes or an NSP taking on excessively high risk.

The findings of DEA, SFA and/or TFP analysis may assist in the process of reconciling any offsetting results in disaggregated category analysis. These methods would likely be in the form of a percentage efficiency gap between the NSP and the efficient frontier, which could be examined in tandem with findings from category based analysis where results can be meaningfully aggregated. Where they cannot, judgment may be required when overlaying the results of the DEA, SFA and TFP onto the individual category analysis.

Question 74

Do stakeholders have any in principle views on how benchmarks should be derived and applied?

[145] AER, *Draft decision: ElectraNet transmission determination 2013–14 to 2017–18*, November 2012, pp.290–292.

[146] AER, *Draft decision: New South Wales draft distribution determination 2009–10 to 2013–14*, 21 November 2008, pp. 139, 452–454.

[147] Ofgem, *Strategy consultation for the RIIO-ED1 electricity distribution price control: Tools for cost assessment*, 28 September 2012, p. 21.

4 Category analysis questions

Expenditure categorisation

Question 45

Do you agree with this list of expenditure drivers? Are there any others that should be added?

Question 46

To what extent do you think the expenditure drivers are correlated with each other? Given this level of correlation, should we examine the impact on expenditure of each one, or can this list be consolidated?

Details of driver based assessments

Question 47

Do you think that the network segments outlined above provide a useful demarcation of the costs of customer-initiated network extension and/or augmentation? Do you think that there are significant cost differences in installing connection point assets and in network extensions between overhead and underground assets? What alternative asset type demarcations would be more appropriate?

Question 48

Do you agree with separating customer-requested expenditure by connection point assets, extensions, and augmentations? Do you think total expenditure for each service (excluding new connections services) is a sufficient degree of disaggregation? Should further sub-categories be identified?

Question 49

Do you agree with separating new customer connections expenditure by the connection point, extension, and augmentation components? Do you think that the number of new connections, length of network extensions added, and size of capacity added are useful measures of the volume of work and expenditure required for new connection services? Should these categories be disaggregated into more detailed categories reflecting the type of work undertaken by the NSP to account for factors that drive changes in new connections expenditure over time?

Question 50

Do you think the system growth expenditure driver category should be distinguished by expenditure directed at addressing different service standard issues, such as harmonics, voltage variance, ferro-resonance, and system fault levels? Would the benefits of distinguishing expenditure into these sub-categories for forecasting the timing and scope of changes in expenditure trends over time outweigh the added complexities from doing so?

Question 51

Do you think that the network segments outlined above provide a useful demarcation of the costs of general load driven network extension and/or augmentation? What alternative asset type demarcations would be more appropriate?

Question 52

Do you think the above asset types are sufficient in capturing the cost differences associated with activities to address deterioration in asset condition? What other asset types may be suitable?

Question 53

Do you think cost differences between emergency rectification activities and other activities to address deteriorating asset condition are sufficient to require separate categorisation?

Question 54

Do you think cost differences between non-emergency prevention activities and non-emergency rectification activities to address deteriorating asset condition are sufficient to require separate categorisation?

Question 55

Do you think cost differences between non-emergency replacement activities and non-emergency maintenance activities are sufficient to require separate categorisation?

Question 56

Do you think the approach to using benchmarking and trend assessment for routine and non-routine maintenance is reasonable? Are there any alternatives which might be more effective?

Question 57

Given the relative predictability of maintenance cycles and activities, do you consider it feasible to construct a deterministic maintenance model, such as that described above?

Question 58

Do you think that expenditure directed at altering network infrastructure or management systems to ensure compliance with a changed regulatory obligation can be disaggregated in a way that improves accuracy in forecasting and efficiency assessments?

Question 59

Do you think cost differences between emergency rectification activities and other activities to address third-party actions are sufficient to require separate categorisation?

Question 60

Do you think expenditure on managing vegetation growth should be distinguished from expenditure on third-party stochastic events? Should expenditure on third-party stochastic events be distinguished into sub-categories?

Question 61

Do you think general measures of network size and type are sufficient measures for investigating differences in third party expenditure across service providers? What other measures may be useful?

Question 62

Do you think overheads should be separately reported, or included on a fully-distributed basis in the expenditure driver-activity-asset categories, or both?

Question 63

How do you think overhead expenditure should be distinguished and assessed? How would you define any overhead expenditure sub-categories?

Other issues in category based assessment

Question 64

How material do you think are changes in input prices on overall expenditure levels? What forecasting and modelling approaches do you think can reliably account for the impact of input price changes on expenditure without introducing overly burdensome reporting requirements?

Question 65

What categorisation of different inputs do you think provides a sufficient understanding of both how input prices may change over time, as well as how input prices may vary across geographical locations?

Question 66

Do you consider optimism bias and/or strategic misrepresentation to be a material issue in the cost estimation for non-routine projects? Do you consider downward biases in cost estimation to materially outweigh regulatory incentives to over-estimate expenditure? To what extent do you consider there to be a consistent downwards bias in initial project cost estimates?

Question 67

What should be our approach to cost estimation risk factors and addressing potential asymmetric estimation risk? Would techniques such as reference class forecasting be beneficial? How would any techniques to address asymmetric cost estimation risk interact with potential incentive schemes (for either opex or capex)?

Question 68

Do you think our established approach to assessing debt and equity raising costs remains appropriate? What modifications or alternative techniques would you suggest?

Question 69

Do stakeholders have any in-principle views on how demand forecasts should be derived and assessed?

Question 70

Do you think that the network segments outlined above provide a useful demarcation of the expenditure incurred to address various expenditure drivers? Do you think that there are significant cost differences in building, repairing, or replacing network assets based on region in which the work is being done? What alternative asset type demarcations would be more appropriate?

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Question 73

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Question 74

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