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REGULATED INDUSTRIES COMMISSION

BENCHMARKING – ITS APPLICABILITY TO ASSESSING COSTS AND EFFICIENCY

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Responding to this Document

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1. INTRODUCTION

1.1 Background and Context

The Regulated Industries Commission (RIC) is a statutory body mandated, inter alia, to establish the principles and methodologies for determining rates. While there are a variety of price setting methodologies, the RIC Act emphasises the adoption of some form of RPI-X regulation. The critical issues under this form of regulation are the inclusion of efficiency/productivity requirements and the setting of the X-factor. There are different approaches to setting the latter. An increasingly favoured approach is through relative efficiency analysis and benchmarking.

The RIC intends to utilize benchmarking in conjunction with any other relevant information to reach a judgment on the extent to which service providers can improve their efficiency and what rate of efficiency improvements are achievable. Benchmarking also provides an indication of the levels of efficient operating, maintenance and capital expenditure.

Accordingly, this document examines the use of benchmarking in the RIC's determination of efficient levels of costs.

1.2 Structure of the document

The remainder of the document is structured as follows:

- **Section 2** – discusses the legal framework and the importance of benchmarking.
- **Section 3** – presents an overview of different benchmarking techniques and the use of these methods in economic regulation, including the use of benchmarking in the RIC's review of tariffs for T&TEC.
- **Section 4** – examines the performance indicators for evaluating efficient level of costs.
- **Section 5** – summarizes issues for consultation.

2. LEGAL FRAMEWORK AND IMPORTANCE OF BENCHMARKING

2.1 Legal Framework and Role of Benchmarking

The RIC Act provides broad guidelines for pricing and regulation of the service providers. The Act emphasizes the adoption of an incentive-based regulatory regime (alternatively referred to as performance based regulation or price cap or RPI-X regulation) that:

- Provides a fair and reasonable return on efficient investment;
- Ensures efficient operating and maintenance practices;
- Fosters efficient use of resources and existing network;
- Encourages efficient behaviour by the service providers and incentives to increase productivity; and
- Provides an equitable allocation of efficiency gains.

Benchmarking assists in the determination of a price or revenue cap. In particular, benchmarking aids in determining:

- The efficient level of operating, maintenance and capital expenditure required for setting the annual revenue requirement of service providers; and
- The value of X in the RPI-X constraint on revenue increases over the regulatory period.

The regulator must consider the scope for efficiency gains and base the regulatory regime and X-factor on realistic assessment of costs and the extent to which efficiency gains can be achieved over the regulatory period. Benchmarking is an important, although not the only, input into the evaluation of efficient costs.

2.2 Importance of Benchmarking

Benchmarking is a method of performance monitoring which allows the assessment of the potential efficiency improvements within entities. By comparing the operating efficiency with regional and international counterparts, it is possible to identify the scope for further efficiency improvements for a service provider. Benchmarking also allows for the measurement of improvement in the performance of the utility over time, thus providing an indication of the rate of previous productivity gains. This is useful for establishing the expected rate of productivity over the subsequent regulatory periods. The latter has made benchmarking an integral part of incentive regulation regimes.

Recent trends in **Efficiency and Productivity Measures for T&TEC during the period 1999-2003** are presented in **Tables 1 and 2**. The customer per employee ratio rose from 141 in 1999 to 149 in 2003, representing a 5.7% improvement. Labour productivity (calculated as real revenue per employee) improved by 4.7% over the period 1999 to 2003. The operational efficiency of T&TEC also improved over the same period as reflected in lower operating costs per MWh sales. However, the operational efficiency as reflected by lower operating cost per customer and circuit km declined over the same period. These partial productivity measures illustrate that T&TEC has achieved significant efficiency gains in some areas in recent years. However, partial productivity measures should not be viewed in isolation but as an additional source of information.

Table 1: Efficiency and Productivity Measures for T&TEC

Year	1999	2000	2001	2002	2003	% Change 99 - 03
Customers per Employee	141	145	149	145	149	5.7
Labour Productivity (Real revenue per full-time equivalent employee)	440,642	453,147	437,295	448,471	461,164	4.7
Real Operating Expenditure per MWh sold ($)	2,095	2,251	2,310	2,056	1,936	(7.6)
Real Operating Expenditure per Customer ($)	3,247	3,572	3,459	3,435	3,386	4.3
Real Operating Expenditure per Circuit Km ($)	93,347	102,855	104,929	105,777	107,378	15.0

Source: T&TEC. Further calculations by RIC staff

Table 2: Productivity Indicators 1999 – 2003 for T&TEC

Operating Performance						
Year	**1999**	**2000**	**2001**	**2002**	**2003**	**% Change 99 - 03**
No. of Employees	2,242	2,174	2,238	2,328	2,335	4.1
No. of Customers	315,482	316,017	332,920	337,902	348,022	10.3
Sales (GWh)	4,889	5,015	4,985	5,646	6,088	24.5
Nominal Opex $ ('000)	1,198,496	1,367,262	1,472,494	1,545,975	1,627,656	35.8
Real Opex $ ('000)	1,024,387	1,128,727	1,151,486	1,160,786	1,178,355	15.0
Revenue (excludes dividends from subsidiary) $ ('000)	1,155,830	1,193,332	1,251,495	1,390,488	1,487,403	28.7
Real Revenue $ ('000)	987,919	985,141	978,666	1,044,040	1,076,818	9.0
Circuit Km	12,311.34	12,311.34	12,311.34	12,311.34	12,311.34	0.0
Nominal Ave Electricity Price ($ / kWh)	0.1275	0.1275	0.1275	0.1275	0.1275	0.0
Real Ave Electricity Price ($ / KWh)	0.1090	0.1052	0.0997	0.0957	0.0923	(15.3)
Nominal Opex per customer ($)	3,799	4,327	4,423	4,575	4,677	23.1
Real Opex per customer ($)	3,247	3,572	3,459	3,435	3,386	4.3
Nominal Opex per Circuit Km ($ / Km)	109,213	124,592	134,181	140,877	148,320	35.8
Real Opex per Circuit Km ($ / Km)	93,347	102,855	104,929	105,777	107,378	15.0
Nominal Opex per MWh sales ($ / MWh)	2,451	2,726	2,954	2,738	2,674	9.1
Real Opex per MWh sales ($ / MWh)	2,095	2,251	2,310	2,056	1,936	(7.6)

Source: T&TEC. Further calculations by RIC staff

Note:

(1) Simple average of kWh energy charges for rates A, B, D1, D2, D3 and E.
(2) All operating expenditure includes maintenance costs.
(3) Revenue figures exclude dividends from subsidiary.
(4) All circuit kilometer figures are as at December 2004.

3. BENCHMARKING TECHNIQUES AND ECONOMIC REGULATION

3.1 What is Benchmarking?

Benchmarking consists of two elements:

- The "measurement" side of benchmarking (called the metrics or sometimes performance benchmarking). This aspect concentrates on measurement and comparison within organizations and within industry by the use of techniques such as performance indicators, modeling and outcome measures; and
- The "action" side of benchmarking (called the process). It deals with understanding current processes, comparing to "best in class" and changing the way things are done.

Performance benchmarking is important for identifying whether a company is efficient compared with others and is useful to compare the performance of a firm over time. Process benchmarking allows the company to identify ways to improve efficiency.

3.2 Use of Benchmarking in Economic Regulation

The comparative information provided by benchmarking can be used to provide incentives for performance by highlighting the performance of individual firms against other firms. Benchmarking can also provide managers with information on areas where they might be able to achieve improvements. The scope for efficiency improvements provided by comparative analysis may be particularly important for firms that do not have an explicit profit motive. These firms would be encouraged to improve efficiency and thereby avoid the publicity of being identified as having breached a regulatory threshold.

It is generally accepted that there are large asymmetries of information between regulators and the firms that they regulate. This asymmetry creates problems for the regulator in determining what assumptions to make in relation to the cost and demand conditions faced by firms. If prices were to be based solely on the firm's costs and costs projections there would be scope for 'gaming', since the firm would be aware of its impact on future prices. Benchmarking offers a potential solution to the problem. By setting prices, as far as possible, on the basis of information other than the firm's own costs, it reduces the scope for gaming and enhances the incentives to produce and invest.

The prospect of having to share efficiency gains with consumers may reduce a service provider's incentive to reduce costs. The disincentive effect is likely to be relatively large where the regulatory parameters depend on the service provider's own costs (i.e. a service provider that reduces its costs is then forced to reduce its prices). Benchmarking attempts to minimize the disincentives that arise from basing the regulatory parameters on the service provider's own costs by unlinking the regulated prices from the service provider's own costs.

Comparison with other companies is not necessarily restricted to cost or efficiency data. Regulators might also derive valuable information from the comparison of output prices and quality of service parameters.

International Experience

Most UK regulators have made extensive use of benchmarking between the companies that they regulate in order to estimate projected operating cost efficiency or efficiency in capital expenditure. In fact, a number of approaches have been utilized. A yardstick benchmarking approach was applied to a number of electricity utilities in the state of New York. Companies were rewarded if they kept their cost growth below their peers. The X-factors in RPI-X controls for power distributors in Norway were chosen using data envelope analysis (DEA) of their cost efficiency. The Dutch regulator used DEA analysis in a similar way to set X-factors for distributors. The use of benchmarking to inform the setting of price caps is thus well established.

3.3 Criticisms of Benchmarking

There is widespread agreement that benchmarking can be a useful tool to counter information asymmetries and that soundly based benchmarking studies can help identify the scope for efficiency improvements and explain differences in prices and service indicators. Nevertheless, the use of benchmarking as a regulatory tool has been subject to criticism. In fact, the experience of using cost comparisons in price reviews has been unsatisfactory. The diverse operating environments (market size, population density, system configuration, etc.) can often invalidate the results. Additionally, data quality issues can also limit its usefulness. There are therefore major constraints in using benchmarking in practice.

Critics have also argued that benchmarking may even provide adverse incentives, because the regulated firm may pay attention to those measures that are targeted at the expense of other measures. Further, they contend that benchmarking measures past efficiency and that the focus of regulation should be on providing incentives for future efficiency gains.

According to Shuttleworth[1] (1999) benchmarking *'presents a number of methodological difficulties which, if not overcome, would rule out its use for regulation, because the results are intrinsically biased against cost recovery by regulated companies.'* Shuttleworth essentially argues that:

- Benchmarking makes companies "guilty until proven innocent". Regardless of the method used to define an efficient cost frontier, some companies will have costs that surpass it. The use of benchmarking assumes implicitly that high costs are due to inefficiency. However, a company's costs may lie above the frontier due to any number of factors not captured in the analysis. The company must determine what those factors are, or else the regulator reserves the right to disallow costs because they would be deemed inefficient.
- The burden of proof is unduly onerous. If a company wishes to defend itself against the claim that it is inefficient, it must identify the special factors that account for its deviation from the frontier. To do so any individual company must find the factors that explain not only its deviation from the frontier, but deviations of other companies as well. This requires a detailed knowledge of other companies, and of factors that determine their costs. Testing a factor is not difficult, however, identifying the factor may be impossible.

Based on the above arguments, Shuttleworth maintains that the use of benchmarking will nearly always deny some regulated companies the chance to recover their costs, even if they are efficient. He also contends that any regulatory system that systematically prevents cost recovery is open to challenge. Further, he argues that any benchmarking technique used to set a target level of costs must also set the time by which the target is to be achieved. However, the implied

[1] Shuttleworth (1999), Regulatory Benchmarking, NERA, Brief No. 3. These concerns are also reiterated by Dr. Jeff Makholm in his paper "Benchmarking, Rate Cases and Regulatory Commitment", 1999. Shuttleworth uses the term benchmarking to refer to techniques such as DEA, and regression techniques including least squares and corrected least squares, stochastic frontier analysis etc. Total Factor Productivity is not included here.

rate of productivity growth required to reach the target provides another potentially subjective lever, allowing regulators to prevent cost recovery by cutting prices. These shortcomings are likely to provide poor incentives for firms to meet the needs of consumers in, at least, two ways:

- The price which benchmarking informs may itself provide poor incentives to invest appropriately and to supply efficiently; and
- If the benchmarking methodology is not robust (or is not viewed as robust over time) then the incentive properties of the regulatory framework may be limited.

These shortcomings can lead to setting of tariffs that are "**incorrect**". If tariffs turn out to be significantly above the firm's costs, then existing resources and outputs may not be optimal as demand is choked off. Alternatively, if the resulting tariff is below the firm's short run incremental costs then the firm will not be incentivised to meet demand, and if the price remains below average cost, the firm can eventually go bankrupt.

The RIC recognizes these qualifications and limitations and will use benchmarking with caution, and in conjunction with other relevant information to reach a judgment. The RIC strongly feels that any assessment of achievable gains must be based on some form of benchmarking otherwise it would have to rely entirely on information submitted by the regulated entity. This can lead to its own inefficient actions. The key issue is what, in practice, can benchmarking deliver by way of clear and robust information to support price setting and the extent to which this can credibly support regulation.

3.4 Benchmarking Methods

3.4.1 The Efficiency Frontier

The objective of benchmarking is to compare the efficiency[2] of carrying out a particular business activity or group of activities either at a point in time or over time.

[2] In economic theory efficiency is defined in terms of productive efficiency and allocative efficiency. Productive efficiency refers to the ability of the firm to produce the maximum level of output from a given set of inputs Allocative efficiency reflects the extent to which firm uses the inputs in optimal proportions to minimize the costs of outputs for a given set of input prices and a given technology. Allocative efficiency is maximized where resources are allocated such that the value in the use of the product at the margin is equal to the increment in the cost of supplying the product at the margin. These two measures can be combined into a measure of total economic efficiency. Sometimes a third measure of efficiency known as dynamic efficiency is also included which relates to processes of a technological and managerial nature.

The efficiency measure is defined relative to assessment of best practice at a particular point in time. This is referred to as the efficiency frontier. If a firm is operating on the frontier it is defined as efficient; if it is operating away from the frontier it is defined as inefficient, and the level of inefficiency is measured relative to the frontier (in the case of a cost frontier, inefficient firms are those operating above the frontier). The extent to which a firm is inefficient is reflected in an efficiency score.

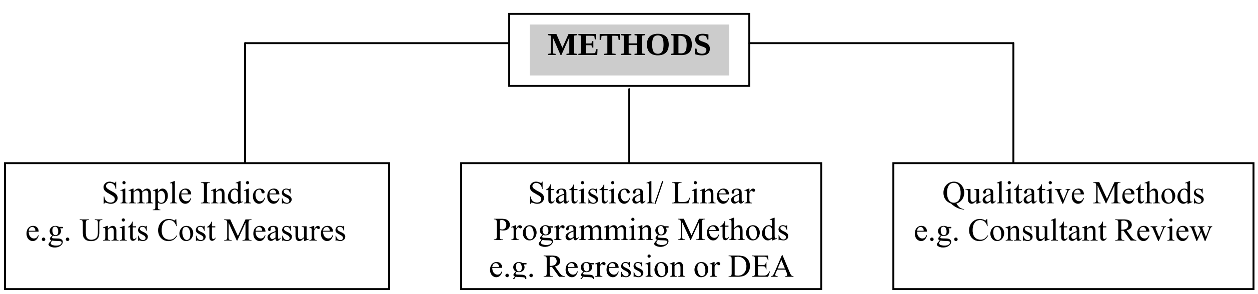
3.4.2 Benchmarking Techniques

There are a variety of approaches to the measurement of relative efficiency of firms in relation to an efficient frontier. Broadly these can be classified into three main types:

- Programming techniques;
- Econometric (parametric) techniques; and
- Process approaches.

Alternatively these methods can be categorized into three groups as shown below.

Figure 1 - Benchmarking Methods



3.4.2.1 Programming Techniques

Programming techniques relate outputs to inputs without recourse to econometric estimation. The efficiency frontier is calculated from the data. Data envelopment analysis (DEA) is the most widely used approach in this category. Index approaches to determining efficiency (partial and total factor productivity (TFP)) also calculate efficiency scores and are sometimes included in this category, but they do not result in the calculation of an efficiency frontier. Consequently, TFP is not considered by some as a benchmarking technique *per se*. Many analysts regard TFP as an alternative to benchmarking.

Data Envelopment Analysis (DEA)

Data envelopment analysis is a non-parametric method that uses linear programming[3] to determine (rather than estimate) the efficiency frontier of a sample. The approach works by solving individual linear programming problems for each firm or observation, in which the firm's inputs and outputs are assigned a set of weights in order to maximize the ratio of inputs and outputs (subject to the constraint that all efficiency scores are equal to or less than one). Under this approach, an efficient firm is one where no other firm – or linear combination of other firms – can produce more of all outputs using less of any input. This means that the efficiency frontier is constructed from an 'envelope' of these linear combinations of feasible input and output combinations.

The efficiency of each firm is calculated in terms of a score represented by θ, on a scale from 0-1, with the frontier firms receiving a score of 1. Efficiency scores are calculated for a firm by comparing it to a linear combination of sample firms that produce as much of each output with the minimum combination of inputs. The efficiency score, θ, measures how much the inputs need to be reduced to bring the firm onto the efficiency frontier. As the frontier comprises a series of linear segments, there are a number of possible values for this efficiency score: the efficiency score being the minimum of all possible values.

DEA has a number of advantages that have made it a popular methodology among some regulators. It has been used in published regulatory analyses for Norway, Australia (some regulators) and the Netherlands. The advantages and disadvantages of the DEA technique are highlighted in **Appendix I**.

Notwithstanding, regulators in Norway, Denmark, Colombia, the UK, and the Office of Utility Regulation (OUR) in Jamaica have used DEA. However, the actual approach used has varied extensively in terms of:

[3] Linear Programming – Finding the largest or smallest value taken on by a given function $ax_1+a_2x_2+\ldots+a_n+x_n$ (the objective function) given that x_1, $x_2 \ldots . x_n$ satisfy certain linear constraints. The constraints are inequalities of the form $b_1x_1 + b_2x_2 + \ldots . b_n>c$. Many applied problems, such as designing the cheapest animal feed that meets nutritional goals, can be formulated as linear programming problems.

- **The level of costs benchmarked** - e.g. regulators in Belgium, Colombia, Denmark, Northern Ireland and Norway have benchmarked total controllable costs, while the Dutch, Finnish and UK regulators have focused on operating expenditure.
- **The use of international comparators** - Most regulators have tended to limit themselves to domestic comparators. However, where domestic comparators are unavailable international samples have been used e.g. for electricity transmission in the UK and Netherlands and fixed line telecommunications regulation in the UK.
- **The input and output variables** used.
- **Reliance on other techniques** - In some cases, e.g. Netherlands, DEA was the primary means of benchmarking efficiency[4]. However, in other instances, e.g. New South Wales (electricity regulator) and Office of Telecommunications (Oftel) with respect to the regulation of British Telecoms, DEA has been used as just one of variety of techniques, none of which has been preferred over the others.
- **Translation into regulatory formula** – In certain instances the efficiency gap implied by the regulator is used to set company specific scores e.g. Netherlands electricity distribution. However, in the UK transmission sector and in New South Wales (Australia) the results of DEA analysis are just one of several factors used to determine the X factor or in the cases of Finland and Sweden, they do not explicitly drive the regulatory process at all.

Total and Partial Factor Productivity Indices

The rationale for the use of these methods is that the trend in industry unit costs can be decomposed into two factors:

- The trend in input prices; and
- The trend in the efficiency with which inputs are used.

In incentive regulation the X factor can be thought of as the productivity offset, thus it can be set using the expected changes in productivity. Productivity comparisons may be made based on

[4] In 2000, the Dutch energy regulator (Dte) undertook DEA to benchmark opex for its distribution companies, the analysis gave NUON an efficiency score of 65% and so Dte imposed an X factor of 8% per annum (real). NUON argued that the methodology used incorporated bias against large companies due to the use of coincidental demand as an output variable. It presented analysis based on three sets of data – one for each of entities that had merged to form NUON – and output variables that distinguished between network types. Dte accepted NUON revised data and using its own model gave NUON a revised efficiency score of 95% and an X factor of 2% per annum. The decision opened up challenges from several other companies.

partial productivity or total factor productivity measures. Both measures essentially construct ratios of measures of output to measures of input. Different indices use different methods to weight inputs and outputs, and it is this that gives the methods their different qualities.

Partial statistical measures – (Partial factor productivity (PFP) and Qualitative Measures).

Partial factor productivity (PFP) measures compare the ratio of a single input to a single output across firms and over time (e.g. labour productivity) and are less ambitious than full estimations of overall efficiency. Instead, they can act as indicators of performance in specific areas, such as unit costs in respect of particular services, or comparisons of costs in particular areas. The measures are easy to understand and compute and can be used to cross check scores for DEA and Corrected Ordinary Least Squares (COLS) for plausibility. However, the substitutability of some of the factors used in production means that the approach can be misleading and therefore cannot give an overall measure of the potential for cost improvement.

Qualitative comparisons e.g. average duration of each of interruption (CAIDI) which assess service quality are also important but need to be treated cautiously since good performance in one area can be obtained by sacrificing quality in another area.

Total factor productivity (TFP)

In a multi-input, multi-output environment, total factor productivity (TFP) indices provide a more comprehensive measure of performance. They can be used to compare firms at a specific date and also to compare a particular firm's performance over time. In order to compare TFP performance over time/or between firms, it is necessary to construct an index that relates changes (or differences) in outputs to changes (or differences) in inputs. The most common index used in the empirical literature is the Tornquist index, which measures the ratio of all outputs to all inputs, using revenue and cost shares as the output and input weights respectively[5].

Productivity measures may also be expressed in terms of unit costs. Trends in unit costs over time will be driven by changes in physical productivity, as well as movements in input prices.

[5] When revenue/ cost share data is unavailable, it is possible to estimate the weights from econometric cost functions.

Unit cost measures may be based on operating costs or total costs. TFP approaches have been used in the UK and North America to measure productivity movement in the utility sector.

3.4.2.2 Econometric Frontier Approaches

In contrast to programming techniques **econometric methods** require an assumption about the relationship between inputs and outputs, and also estimate the parameters of a function representing this. Econometric methods can be further categorized as deterministic or stochastic. The deterministic approaches assume that all the deviation from an estimated frontier is due to inefficiency. Under a stochastic approach, it is decomposed into inefficiency and measurement error.

Econometric methods estimate a cost (or production) frontier from the relevant data derived from other regulated companies or taken from international comparators. The estimated frontier is based on key drivers of costs, as selected by the modeler. Depending on the approach, any deviation from the frontier is then attributed to inefficiency (deterministic frontier approach); or to a combination of inefficiency and random error (stochastic frontier approach (SFA)).

Deterministic statistical approach

The most commonly used deterministic approach is corrected ordinary least squares (COLS), the standard regression technique, with the efficiency measures computed from the residuals. A functional form for the production/cost function is specified and this is estimated using ordinary least squares (OLS) analysis. The calculated line of best fit is then shifted to the efficient frontier by adding the absolute value of the largest negative estimated error to that of the other errors (for a cost function). This is therefore, a 'corrected' form of OLS known as corrected ordinary least squares. The correction reflects the assumption that the error terms must be greater than zero and ensures that the function passes through the most efficient unit and bounds the other units. The distance measures for the inefficient units are then calculated as the exponential of their corrected residuals. However, COLS does have implementation issues, including:

- The method makes no allowance for stochastic errors and relies heavily on the position of the single most efficient firm from the sample;
- Similar to DEA, COLS assumes that all deviations from the frontier are due to inefficiency;

- All firms are being compared to a frontier firm defined by one frontier firm. However, there may be no 'nearby' frontier firms.

However, the technique is simple to use and easy to understand and interpret and this has made it a popular choice among UK regulators.

Stochastic frontier analysis (SFA)

Stochastic frontier analysis (SFA) is similar to COLS, in that it requires specification of a production frontier based on input variables. The difference is that it does not assume that all errors are due to inefficiency, thus errors in parameters are incorporated into the model. A model of the form described under COLS is estimated with two error functions rather than one. The first one of these is assumed to have a one-sided distribution as under COLS. The second error term is assumed to have a symmetric distribution with a mean of zero. However, accounting for stochastic errors requires specification of a probability function for the distribution of errors and distribution of inefficiencies (e.g. half normal or gamma). As for the result of stochastic factors and their effect on the position of the most efficient firm, the estimated scores are higher than those estimated under COLS. The method however, requires large samples to yield robust results and due in part to the complexities of implementing, regulators have tended not to use this method.

3.4.2.3 Process Approaches

Process techniques attempt to assess efficiency using 'bottom-up' techniques. One such approach used by regulators relies on reviews of company practices and plans. It is also possible to use engineering data to calculate what costs should be for a particular company, based on its own individual characteristics. Another approach is to use surveys to canvas views on potential cost savings in specific areas.

Engineering economic analysis

Engineering economic analysis (EEA) can be used to calculate the optimal cost level for a particular firm by defining a 'model' firm and by building up the inputs and costs in a 'bottom-up' manner. Essentially, the engineering analysis leads to the creation of a production function.

Data for individual companies is then used in the production function to determine the overall appropriate cost level for the company. This method has at least two advantages:

- It does not rely on the actual efficiency of firms to determine efficiency
- It reduces the regulator's reliance on cost information provided by companies

However, the technique has distinct drawbacks:

- It relies heavily on judgments of engineering consultants both for the determination of the appropriate inputs, and also the appropriate costs of the inputs. This can be subjective.
- The approach is data intensive. Detailed information is required on the pattern of regional demand and other issues.

This approach has been used for electricity distribution in Chile, where a model firm was used to implement a form of yardstick regulation. This approach was also followed in Peru.

Process Benchmarking

Process Benchmarking involves assessing business processes and plans for individual companies by expert consultants, who determine the scope for performance improvement. This is done by examining individual functions, using experience and relevant external benchmarks of different business functions to estimate the extent that a company can reduce its costs. This is also a bottom up approach.

This approach is conceptually easy to understand, however, it relies heavily on the judgments made by consultants. Notwithstanding this, Ofgem, Ofwat and the rail regulator in the UK have used this method, either alone or in support of other quantitative techniques.

In short, there are some preferred methods and models that have emerged and are being utilized by different regulators. However, crosschecking with different approaches can help to detect possible data problems and to increase confidence in the results.

Benchmarking is an important regulatory tool for enabling comparison between firms engaged in similar activities. Benchmarking, if properly undertaken, can enable a regulator to establish the service provider's efficient level for its overall performance or for a given type of cost or activity. In turn, the comparative information enables judgments to be made on relative efficiency. The indicator used can be physical, operational or financial.

The RIC welcomes comments on:

- **the role of benchmarking as part of the process for determining cost efficiencies;**
- **different benchmarking techniques and their usefulness; and**
- **the limitations of benchmarking.**

3.5 RIC's Proposed Approach

Given the aforementioned assessment, what should be the RIC's approach to the determination of efficient costs of T&TEC? Before arriving at any conclusion, the under-mentioned factors must be borne in mind:

- Allowed revenue must offer a reasonable prospect for T&TEC to recover its efficient costs (including a reasonable rate of return), or else incentives for efficient expenditure and investment will be undermined;
- The high proportion of costs that are sunk or uncontrollable limits the scope for cost reduction. In the case of T&TEC, these costs amount to over 85 percent of operating expenditure;
- Even if T&TEC manages to improve its efficiency within a five-year regulatory period, it may not earn "excessive" profits, given the demand for investment and other improvements in performance;
- Estimating efficient costs purely on the basis of benchmarking would be challenging given the practical problems of finding good comparators as network companies differ in size, structure and other operating environment and factors; and
- The RIC has an obligation to ensure that costs that are demonstrably inefficient or unnecessary are not allowed but, at the same time, making an allowance for any additional costs arising out of new obligations.

In the first Price Review therefore, the RIC intends to adopt a cautious approach to the use of benchmarking in the determination of an efficient level of costs for T&TEC. This is not to say that there will be an all-or-nothing approach because benchmarking can be used to identify costs that are suitable for further investigation and can indicate where there is scope for efficiency improvements. Furthermore, it is common for regulators to employ a mix of techniques to ascertain efficient costs. As noted above, an assessment of efficient costs is critical to the establishment of two parameters in a revenue/price cap formula; the starting base price or revenue level for the price review period, and the X-factor.

Overall, the RIC will undertake benchmarking studies of expenditure but these studies will not be the sole determinant of efficient expenditure. Other analysis, such as cost drivers that underpin the expenditure forecasts and analysis of historical trends will also be utilized. More specifically, the following possible options will be utilized by the RIC to assess cost and efficiency:

- The historic performance of costs and cost outturns against budget on a disaggregated basis;
- Analyzing trends in input prices for key asset classes/activities to understand movements in costs and to make judgments about reasonable projections for future;
- Identifying a series of disaggregated key unit cost and productivity indicators and using these to benchmark regionally/internationally;
- Assessing aggregate and disaggregated partial productivity trends;
- Employing, where appropriate, "bottom up" assessment of major cost categories and of specific activities (e.g. of staff, materials, IT, etc.); and
- Employing Total Factor Productivity analysis (which will be discussed in detail in another technical paper) as a primary basis for setting the X-factor.

Comments are invited on the RIC's proposed approach in applying benchmarking techniques for the setting of price controls for T&TEC.

4. PERFORMANCE/PRODUCTIVITY INDICATORS FOR EVALUATING EFFICIENT LEVEL OF OPERATING EXPENDITURE

As discussed, comparative performance can be assessed using relevant quantitative techniques. Comparisons of simple indicators through to regression, data envelope and TFP analyses are several of the measures currently in use. An assessment of costs can also be based on the application of best practice from other regional and international jurisdictions. This analysis can then be used to assess future performance and identify potential expenditure reductions.

The RIC has attempted to source information from international utilities in order to perform its benchmarking studies. Based on data availability, a list of key performance indicators (KPIs) has been compiled in **Table 3**.

The indicators reflect both cost and reliability efficiencies. The cost indicators are computed using three scale versions i.e. customer numbers, network line length and GWh sold. Reliability indicators are measures of maintenance performance and highlight the trade off between system performance and operating effectiveness. System Losses provide a direct picture as to how effective the network is delivering energy to consumers and would signal the costs necessary for system operation and maintenance.

A preliminary comparison of T&TEC's KPIs with other utilities/countries is provided in **Appendix II.** This can be used to assess T&TEC's current position against those of the Caribbean and other developed countries. Care has to be taken on relying solely on these KPI's to determine efficiency and reasonableness of costs. The comparative exercise must take into account differences in the operating conditions[6] of T&TEC and other countries/utilities.

Comments are invited on whether the use of cost and reliability comparisons is an adequate measure to identify an efficient level of costs.

[6] These differences may include:

- size, in terms of area, the number of customers and network load;
- customer density;
- customer mix; and
- the condition of existing assets and network configuration.

Table 3 – Key Performance Indicators

Focus Area	Performance Indicator	Cost Driver affected	Units	Definition	Comments
Costs & Revenues	Operating costs per customer	Operating Costs	US$/customer	Annual operating costs / total number of customers	
Costs & Revenues	Unit operating costs per kWh	Operating Costs	US$/KWh	Annual operating costs / authorised consumption	
Costs & Revenues	Unit operating costs per km	Operating Costs	US$/km	Annual operating costs / km line length	
Labour Productivity	Customers per employee	Labour Costs		Number of customers/ number of employees	
Labour Productivity	Sales per employee (economic)	Labour Costs	US$/employee	Sales of electricity ($)/number of employees	The level of output that can be achieved with a given level of labour input is a measure for the efficiency of production.
Labour Productivity	Sales per employee (production)	Labour Costs	GWh/employee	Sales of electricity (GWh)/number of employees	The amount of sales that can be achieved with a given level of labour input is a measure for the efficiency of production.
Quality of Service	Average number of times a customer's supply is interrupted per year (SAIFI)	Operating Costs	interruptions	The total number of customer interruptions (in minutes) / the total number of connected customers averaged over the year	
Quality of Service	Average duration of each interruption (CAIDI)	Operating Costs	min	The sum of the duration of each customer interruption (in minutes) / the total number of customer interruptions	Reflects system and crew responsiveness during unplanned outages and emergency work
Quality of Service	Total number of minutes on average that a customer is without electricity in a year (SAIDI)	Operating Costs	min	The sum of the duration of each customer interruption (in minutes) / the total number of connected customers averaged over the year	Reflects the total performance of the distribution system
Technical Performance	Total System Losses	Maintenance costs	%	Electricity purchased – electricity delivered/electricity purchased x 100	

5. ISSUES FOR CONSULTATION

Consistent with its mandate, the RIC is keen to ensure that it has a wide range of information on potential efficiency gains and that such information be made available to all stakeholders for comment. The RIC welcomes any information that will assist in assessing the efficiency of T&TEC.

Consequently, views are invited on the issues raised in this document and in particular on the following:

- The use of different quantitative benchmarking techniques;
- The appropriateness of the RIC's proposed approach in applying benchmarking techniques for the setting of price controls for T&TEC;
- The appropriateness of cost and reliability comparisons identified for the measurement of efficient level of costs.

Advantages and Disadvantages of DEA

Advantages	Disadvantages
• DEA can be implemented on a small data set. Although the power to differentiate firms diminishes as the sample size falls, DEA still gives meaningful results. Regression analysis tends to require larger minimum sample size in order to stand up to statistical testing.	• The efficiency scores tend to be sensitive to the choice of input and output variables and, in some circumstances, inappropriate choices may lead to relatively inefficient firms defining the frontier. This is because there is likely to be at least one factor (use of input or production of an output) for which a firm is distinct. Even if this is not in fact an important variable, its use in a DEA could put that firm on the frontier. For example, the efficiency rankings of the Dutch electricity distribution companies changed significantly when network length was switched from being an input to an output variable in the DEA analysis.
• Once the estimation preparation has been done the methodology is quick and straightforward to implement using programs that are freely available. Companies can easily crosscheck results.	• The method does not allow for stochastic factors and measurement errors. In practice, there are always data handling errors and individual companies are subject to stochastic shocks. Both the Norwegian and Dutch regulators had to impose arbitrary restrictions on the translation of efficiency scores into X factors in order to prevent very low DEA scores (which may have reflected positive cost shocks) from leading to very high X factors.
• Inefficient firms are compared to actual firms rather than some statistical measure. Thus comparator firms can be identified and reported on to add to the plausibility of the results.	• As the frontier is determined by a piecewise linear function, where there are large gaps between data points it is likely that more efficiency combinations of inputs and outputs can be found. This is likely to be an issue where there are only a few data points but a large number of input variables are being considered. This has the effect of leading efficiency scores to be calculated relative to a linear combination of two or more very different firms.
• DEA is a non-parametric approach and therefore no assumptions are required about the technology or the specification of the cost / production function. DEA does this in a way that most favours the companies being analysed and hence reduces the arbitrariness that comes from scores based on assumed functional forms.	• Gaming is possible under DEA, enabling firms to look better relative to the frontier. The key problem with this is that gaming may affect non-gaming firms significantly.
• DEA can account for factors that are beyond the control of the firms but affect their performance, e.g. environmental variables, either directly as inputs or outputs or via second stage regressions.	• As more variables are included in the models, the number of firms on the frontier increases. Therefore, it is important to examine the sensitivity of the efficiency scores and rank order of the firms to model specification. This is a problem in small samples.
• The technique is easy to extend to multiple outputs. Until the development of parametric distance functions regression analysis of production functions was restricted to single output specifications.	• No information on statistical significance or confidence intervals is provided. This means that the analysis relies heavily on the initial choice of inputs and outputs being correct. Regression analysis can lead to the dropping of insignificant variables (the Netherlands regulator did make some use of this). The inclusion of statistically insignificant or absolutely small effect variables can give companies an opportunity for high efficiency scores by putting all of their weighting within the DEA on these variables.
• DEA requires only physical measures of inputs and outputs, rather than financial measures. These tend to be far easier to obtain. Regulators have often used financial measures of cost as physical inputs within DEA to get round the lack of data on input prices.	• Physical measures of capital, a key driver of total costs for many network utilities, may not be appropriate as such measures do not capture the age profile of assets or differences in design (e.g. voltage levels). This is a problem for both DEA and regression analysis which includes variables such as transformer capacity or network length.
• DEA has the advantage in that it is an operations research methodology and can be illustrated easily. It is thus a reasonably transparent method. Regression analysis tends to be treated with more suspicion by companies, complex forms of which give rise to implausible parameter values.	• The use of second-stage regression to increase the number of variables without reducing the number of peers for individual firms requires the imposition of a functional form, removing one of the key benefits of DEA. By doing second stage regression analysis separate from the DEA this leads to inefficient modelling of the interaction of the environmental and non-environmental effects. Regression based distance function analysis can efficiently include both environmental and non-environmental effects within the same estimation procedure.

Key Performance Indicators Data

Utility/Country	Customers per employee	Operating costs per customer	Operating Costs per KWh	Operating Costs per km	Sales per employee (economic)	Sales per employee (production)	Average duration of each interruption (CAIDI)	Average number of times a customer's supply is interrupted per year (SAIFI)	Total number of minutes on average that a customer is without electricity in a year (SAIDI)	Total System Losses
ACTEW Corporation	193	$389.91	$0.022	$10,187.00	$241,766.92	3.29	74.5	1.2	52.0	4.8%
Advance Energy	271	$249.43	$0.014	$720.60	$322,984.16	4.89	173.0	1.0	192.0	6.7%
Anguilla	93	$1,393.59	$0.161		$182,615.38	0.80				
APPA		$269.00	$0.052							4.3%
Argentina	126									20.0%
Australia (1994)		$215.00	$0.010	$1,846.00		2.96	79.0	3.0	200.0	
Australian Inland Energy	188	$1,196.74	$0.058	$2,496.22	$298.18	3.82	115.8	3.3	382.0	5.6%
Barbados	171	$732.78	$0.012	$73,095.71	$280,412.37	1.66				6.8%
Belize	261	$568.76	$0.116		$213,235.76	1.27				11.5%
Bermuda		$2,642.61	$0.145	$45,823.66						
Canada (1994)						6.43-13.92	69.5	2.0	135.6	
CAPELEC	172	$264.92	$0.008	$735.00	$383,313.84	5.69	62.0	4.8	298.0	3.4%
Cayman Islands	93	$2,552.53	$0.121	$114,210.18	$446,640.55	1.98				
Delta Electricity (Aus) 2001/02						27.60				
EEI (1999)							135.3	1.3	180.0	
Energex	359	$234.29	$0.017	$5,176.00	$354,493.36	5.16	133.0	0.9	113.0	5.5%
Energy Australia	373	$327.22	$0.021	$8,729.00	$443,389.08	5.95	39.7	1.8	73.2	4.6%
ETSA Power	462	$302.13	$0.022	$2,802.00	$440,845.40	6.15	96.3	1.2	118.0	5.8%
ETSA Transmission (T)			$0.005	$8,672.00	$670,856.21	85.00				3.5%
Great Southern Energy	266	$307.68	$0.020	$1,115.67	$296,891.46	4.03	85.0	1.6	135.0	6.3%
Grenada	182	$593.48	$0.157		$159,782.56	0.69				13.2%
GUS Electric (US) (1994)							197.0	0.3	105.0	
Hydro-Electric Corporation	494	$218.78	$0.016	$2,085.00		6.81	102.4	2.0	140.0	6.0%
IEEE 1366 (1998)							81.8	1.1	90.0	
Integral Energy	314	$351.15	$0.022	$8,481.00	$329,499.33	5.13	135.0	0.7	100.0	6.6%
IP&L Large City Survey (2000)							103.6	1.0	98.4	
Jamaica	323	$589.11	$0.102	$23,059.11	$269,033.43	1.87				18.0%
Japan (1994)						4.27-5.52	22.0	2.8	62.0	
Largest US Publicly Owned Nongenerator Electric Utilities 2000		$1,827.10			$569,294.00	10.07				
North Power	225	$250.04	$0.025	$1,254.00	$239,547.31	2.83	121.0	2.3	266.0	8.0%
PA Consulting (2001)									183.0	
Power & Water Authority	155	$615.11	$0.028	$6,463.00		3.38	5.7	8.1	46.5	5.2%
Queensland Transmission & Supply (T)			$0.002	$9,356.00	$294,871.40					5.3%
St Lucia	209	$540.78	$0.108		$160,705.39	1.05			1051.0	11.7%
Transgrid (T)			$0.004	$20,693.00	$279,569.32	52.30				3.0%
TRINIDAD AND TOBAGO	**149**	**$669.98**	**$0.038**	**$19,032.17**	**$99,176.51**	**2.63**	**87.6**	**9.5**	**838.2**	**4.9%**
United Kingdom (1994)						3.55-5.70	89.0	1.2	108.0	
US Electric Distribution Reliability Best Practices Survey							320.0	1.2	95.0	
Venezuela	113									19.0%
Western Power	522	$191.52	$0.013	$1,786.00		7.60	91.6	2.3	207.0	8.9%