REGULATED INDUSTRIES COMMISSION

Tariff Principles and Structures

March

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As part of the second price control review for the electricity transmission and distribution sector, this paper discusses the fundamental principles of pricing of utility services. It also examines the various price structures for the electricity transmission and distribution sector that reflect these principles and discusses some of the key factors that have an impact on tariff structures for the second price control period.

Consultative Document

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1.0 INTRODUCTION

1.1 Background

The Regulated Industries Commission (RIC) under its Act No. 26 of 1998 (Section 48) is required to review the principles for determining rates and charges for services under its jurisdiction every (5) years. The RIC commenced the second Price Review for the electricity transmission and distribution sector in September 2017. In respect to rate setting, Section 67 (3) of the RIC Act requires that the RIC have regard to the following:

- The funding and ability of the service provider to perform its functions;
- The ability of consumers to pay rates;
- The quality and reliability of service from the service provider;
- The efficiency and economy of operation of the service provider;
- Economic and social factors;
- National environmental policy; and
- Long-term sustainability of the utility sectors.

Section 6(3) (d) also mandates the RIC to have regard to non-discrimination in relation to access, pricing and quality service. Consequently, the RIC must take the above into consideration when establishing an appropriate tariff structure.

The RIC's approach to the establishment of new price controls consists of three main steps. The first step involves establishing the service standards. The second step involves assessing each of the key components of revenue to ensure that T&TEC earns sufficient revenue to deliver reliable services to its customers. The final step involves determining tariffs that are consistent with the principles and approaches established by the regulator and which accord with the provisions of the RIC Act.

1.2 Purpose of the Document

This document briefly highlights the fundamental principles that regulators need to take into consideration when setting electricity prices. It examines various pricing structures that are used in the electricity sector. Finally, the paper will briefly examine the existing tariff structure for T&TEC and present recommendations on the way forward.

1.3 Structure of the Document

The remainder of this document is structured as follows:

Section 2: Rate Design and Pricing Principles

Section 3: Cost Basis for Allocation and Tariff Design

Section 4: Tariff Structures

Section 5: Setting Tariffs for the Second Control Period

Section 6: Conclusion

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2.0 PRINCIPLES OF RATE DESIGN

Rates[1] charged for utility services serve four primary functions[2] namely:

- **Capital attraction** – to enable utilities to provide service and to make provision for expansion and continuation of the service;

- **Efficiency incentive** – to simulate competitive outcomes in the provision of utility services by bringing cost and price in closer alignment;

- **Demand control** – to influence consumer behavior by eliciting demand-inhibiting choices with respect to consumption of utility services; and

- **Compensatory income transfer** – to determine a rate that is reasonable for different types of utility consumers.

These functional outcomes are realized through a number of objectives that guide how rate design is undertaken. These are discussed further below.

2.1 Objectives of Rate Design

Rate design involves establishing a system of prices for services that are offered by a utility. The primary goals of economic regulation, that is economic efficiency and equity[3], inform the rate design process. The overarching goal is to set economically efficient and fair prices, while simultaneously giving the utility a reasonable opportunity to recover its efficient costs of providing service. Bonbright *et al* (1988) state that a rate structure has certain objectives, which can be organized according to economic agents that comprise the utility sector, as follows:

[1] The words Rate and Tariff are often used interchangeably.

[2] Principles of Public Utility Rates, 2nd Ed. – Bonbright, J., Danielsen A., Kamerschen A. (1988)

[3] There are two broad fundamental justifications for regulation of utilities. The first is that the output of the utility sector outputs are essential to the well-being of the society and the second is that its technological and economic features are such that that a single firm can serve the overall demand for its output at a lower total cost than can any combination of more than one firm. This is called a natural monopoly. Thus the two main goals of economic regulation can be generalized as economic efficiency and fairness (equity).

Utility:

- To yield the total revenue requirement which is sufficient to cover operating and capital costs of the utility;
- To provide predictable and stable revenues for the utility over time and as circumstances change; and
- To promote innovation in supply and demand (dynamic efficiency).

Customer:

- To be fairly apportioned to customers and customer classes in a manner that is fair and not arbitrary;
- To promote economically-efficient consumption; and
- To avoid the subsidization of one group of users at the expense of another.

Society:

- To reflect the present and future private and social costs and benefits of providing service (i.e. account for internalities and externalities);
- To encourage the efficient use of the commodity (electricity/water) in terms of quantity used and timing of use;
- To encourage an efficient pattern of growth in use of the commodity and an efficient pattern of system development over time. Consequently, the marginal rate should reflect the long-run rather than the short-run marginal cost of providing the utility service; and
- To provide proper incentives for conservation, such as, investment by users in energy efficient appliances and water-saving fixtures.

These objectives/principles outlined above often conflict with one another, therefore, the economic regulator has to balance the many competing factors when setting the tariff structure.

3.0 COST BASIS FOR ALLOCATION AND TARIFF DESIGN

The costs that a utility incurs in carrying out its functions have a direct impact on rates, however, determining the level of costs for a utility can be complex. Two broad methodological cost-based approaches have evolved for the purposes of allocating costs, and ultimately, establishing tariffs; one is a Marginal Cost approach while the other is an Embedded Cost approach. These are discussed below.

3.1 Marginal Cost Approach

The marginal cost of the utility service refers to the increase in total cost that is imposed on the utility by a relatively small (unit or marginal) increase in its output, usually expressed as an incremental cost per unit. Marginal cost pricing is the most efficient approach to allocating resources to the point where there is no deadweight loss[4] to consumers nor to society. Rates based on marginal cost sends signals to consumers and producers that encourage them to balance the benefits from consuming the good or service with the costs of providing same. This approach places primary emphasis on sending users the right price signal about the scarcity value of the good or service. The approach is forward looking as the economic resource costs of future consumption are allocated as much as possible among the customer base according to the incremental costs they impose on the utility.

However, for an electric utility it is important to distinguish between short-run marginal costs (SRMC) and long-run marginal costs (LRMC)[5]. In the short-run, fixed costs, that is, the costs associated with fixed inputs (capital costs) do not vary with the quantity of a good or service produced and therefore do not impact on marginal costs. However, variable costs (e.g. operational and maintenance costs) vary with output and therefore, these impact marginal costs. In the long run the capital stock can be expanded and hence marginal costs not only include operational and maintenance costs but capital costs as well.

[4] Deadweight loss may occur from the loss of consumer or producer surplus that is not recovered by either party.

[5] Theoretically, short-run MC (SRMC) and long-run MC (LRMC) can be equal if the plant capacity can be optimally changed in small increments. However, this is not a valid assumption for electricity utilities as capacity expansion often requires large investments.

Despite the theoretical appeal of marginal cost pricing, departures from marginal cost can make sense for a number of reasons or under certain circumstances. Marginal cost pricing cannot guarantee that revenue will match the total costs of service provision. Whilst marginal cost pricing can lead to an over-recovery of revenue, it is more common to be faced with the problem of under-recovery[6] in a utility sector under conditions of natural monopoly. The lumpy nature of some capacity augmentations[7] and the presence of fixed and common costs mean that the efficient level of average prices may be higher or lower than forward looking marginal costs. This can result in the service provider incurring a loss.

Also, the marginal cost of serving each customer within a certain class may not be equal, moreso when there is information asymmetry or the disaggregation of customers was too broadly defined. Under these circumstances, the price of the service will not be equal to marginal cost, for at least some of the customers within each class.

3.2 Embedded Cost Approach

The embedded cost approach draws heavily upon accounting records of the utility for a selected test year[8], as the basis for deriving the cost of operating the utility. It looks backwards to the costs that the utility has already incurred, and emphasizes the estimation of historical (embedded) average cost. It is also known as the fully-distributed cost (FDC) approach and involves the allocation and assignment of total annual costs to broadly defined classes of customers, which derives the aggregate revenue that the utility requires based solely on costs of production. The general approach to cost apportionment is based on the principle of cost causality and considers assignment by:

- Functionalization – dividing the costs according to functional components of the utility's operations such as generation, transmission, distribution, general, etc.
- Classification - further separating functionalized costs by the primary driver for those costs, that is, the factors that costs are sensitive to.

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[6] When marginal costs are below average costs - typical in the presence of strong economies of scale and scope - this will lead to an under-recovery of revenues.

[7] There are many components involved in the supply of electricity. Additions of any of these may only be possible in pre-defined and specific quantities (hence, lumpy).

[8] The underlying assumption is that the past relationship among revenues, costs and investments during this test year is indicative of the relationship amongst them that is expected to continue into the future.

    - Demand related or capacity related costs vary with units of consumption, such as cost of generation capacity, transmission lines, distribution lines, etc.
    - Energy costs vary with units of energy generated, such as fuel
    - Customer costs vary with the number of customers on the electricity network, such as metering, billing, service drops, etc. system.
- Allocation – assigning the functionalized and classified costs of service to the different rate classes[9]. For instance, it is possible to define costs that are only incurred by certain customers (dedicated service) and likewise, costs that are not incurred by certain groups of customers (distribution lines do not serve customers that take power at high voltages such as directly off a sub-station).

The obvious advantage of the embedded cost approach is that it allows the service provider to recover the fixed and common costs that may sometimes not be recovered by marginal cost pricing. On the other hand, embedded approach incorporates historical costs incurred by the utility in its formulation, therefore, it does not offer the same price signaling advantages that are inherent in marginal cost pricing.

Utility rates that accurately reflect costs, send signals to consumers about the value and cost of utility service and thereby discourages wasteful consumption. The objective of both cost approaches is to arrive at economically efficient and fair rates that allow the utility the opportunity to recover its costs, however, this outcome is often difficult to achieve. Legitimate embedded (historical) costs that a utility incurs may not resemble its marginal costs; consequently, the reconciliation of the need to cover historical costs with the desire to set economically efficient prices requires considerable judgment.

In its first price review for the electricity transmission and distribution sector, the RIC utilized embedded-cost as the basis for cost-allocation for the utility. The RIC intends to continue its use of the embedded-cost for allocation in the second Price Review.

[9] A rate class is a relatively homogenous group of customers that possess the same characteristics which include energy consumed, delivery voltage, metering characteristics, load usage and end-use.

4.0 TARIFF STRUCTURES

A tariff structure is a schedule of prices for utility services that are designed primarily to recover the utility's costs. In this section, the RIC examines the basic electricity tariff structures used by regulators and utility companies. Most tariffs are a combination of some or all of the following elements:

- A **fixed charge** (sometimes known as a standing charge, flat fee or customer charge) which, is normally either equalized for each customer (e.g. within a given customer class or at a particular geographical location), or linked to some other customer characteristic (e.g. load factor). Fixed charges normally account for costs such as the physical meter, reading the meter, billing, maintaining customer records, etc.
- A **volumetric rate**, which when multiplied by the quantity of electricity consumed in a billing period gives rise to the volumetric (variable) charge for that period. Economic efficiency and environmental criteria both suggest that this element should ideally recover all costs that vary with average or peak demands made on the system (in both the short and the long-run).
- A **minimum charge**, usually imposed to protect the utility's finances, which specifies that a certain minimum quantity (of service or product) will be paid for in each period whether or not that amount has, in fact, been consumed.

The tariff components described above are derived from one or more methodological approaches that are used internationally in the development of electricity tariff structures. These approaches are outlined below.

4.1 Linear Prices

Linear tariffs are essentially uniform or simple tariffs, where one rate applies for all units consumed regardless of type of customer. However, where different classes of customers are each charged a different rate (albeit a simple tariff for every class), this structure is known as a Flat-rate tariff.

4.2 Non-linear Prices

There are two basic types of non-linear tariff structures:

- **Increasing Block Tariffs (IBTs)[10]** - Under this structure, consumption is organized into 'blocks' for rate making purposes. The first block of electricity consumed (consisting of a range of consumption and an upper threshold[11]) is usually set as the "lifeline block" and charged at a certain rate. Succeeding blocks also have an established range and respective lower and upper consumption thresholds and each block is charged a progressively higher rate. However, the rate per unit for each block is fixed[12].

  There are a number of issues that need to be considered when designing IBTs including:

  i. The number of blocks to be established and how they are to be applied over different customer classes.
  ii. The level of usage at which the first block should be set, that is, to cater to basic-needs level of usage and affordability for poor and vulnerable households.
  iii. The level of usage (height) and size (width) for subsequent blocks.
  iv. The relative price between blocks (rate differential) and elasticity of demand[13].
  v. The cost implications of inclining blocks on large households.
  vi. The complexity of an inclining block tariff.

  The relationship amongst the various issues is very complex and a more in-depth discussion on the above factors takes place in the Section 5.

  IBTs are typically used in conjunction with a two part tariff (this is discussed further below) and are applied to the variable component of the tariff. They are regarded as pro-

[10] Increasing Block Tariffs are also called incremental block, inverted block, inclining block or progressive tariffs.
[11] Range of consumption is otherwise referred to as width of the block, while the upper threshold is the height.
[12] When all customers are able to access the first block regardless of overall consumption, this is known as Telescopic Inclining Block and is the most common application of this rate structure. On the other hand, where low consumption customers pay the lower price for all units consumed while large consumption users pay the higher price for all units consumed, this is termed Non-Telescopic Inclining Block. However, this is riskier for low-income and vulnerable consumers as one unit of consumption into the next block triggers the higher rate.
[13] Price elasticity of demand measures the responsiveness of demand for a product following a change in its own price. The formula for calculating the co-efficient of elasticity of demand is: Percentage change in quantity demanded divided by percentage change in price.

poor tariffs and are often preferred because they easily recover the costs and they send the correct signals for resource conservation.

- **Declining block tariffs** - The first block of electricity consumed is charged at a given rate and the succeeding blocks are charged at progressively lower rates, that is, the price of successive blocks decreases as consumption increases. Such tariffs may be appropriate if fixed costs are to be recovered in the first block (even when kWh consumption is low) instead of using a separate fixed charge. Declining block encourages an increase in consumption so that the utility can achieve economies of scale. The main drawback is that if any block price is significantly below the long run marginal cost, then it sends incorrect signals to the consumer that the cost of electricity is lower than it actually is and therefore, encourages inefficient consumption and wastage.

4.3 Multipart Tariffs

Tariffs with several billing components are called multi-part and can take on various forms. The simplest form of this method is the two-part tariff[14], where customers pay a fixed charge[15] (such as an access charge) plus a volumetric charge (variable or usage charge). The volumetric portion can be flat (linear) or have a block tariff structure (non-linear). Multi-part tariffs can be tailored according to specific circumstances or goals, for example, customers can pay a very small fee for access and thereafter pay for usage alone, in order to be able to better manage their budgets**.** Another advantage is the option of a menu of tariffs with different combinations of access and usage charges, leaving customers to select the tariff structure that they find most attractive. Yet another variation of this theme is to include a free initial block of consumption in the fixed charge. Finally, another possibility involves keeping a common variable charge (usage fee) for all customers, but allowing the fixed charge to vary according to the socio-economic characteristics of consumers.

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[14] In some jurisdictions and moreso for commercial and industrial customers, the two-part tariff is further refined into a three-part tariff, which separates the fixed charge into a standing charge (to cover the costs of the meter and customer services) and a maximum demand or capacity charge (to cover generation & transmission capacity costs). The volumetric portion remains a kWh-based consumption charge in the three-part structure.

[15] The fixed charge is normally used to recover costs that vary based on the number of customers being served.

4.4 Ramsey Pricing

Frank Ramsey[16] derived a complex formula to adjust prices away from marginal cost in inverse proportion to the elasticity of demand. It is also known as the inverse pricing rule because prices are increased in inverse proportion to their elasticity of demand. This is accomplished by imposing proportionally larger price adjustments on customers whose quantity demanded is least responsive to price (inelastic demand) and smaller adjustments on customers whose demand is most sensitive to price (elastic demand). The basis of Ramsey pricing is that the profit maximizing position for a monopoly is when prices are set as close as possible to marginal cost, which leads to an economically efficient outcome[17]. Notwithstanding, some of the challenges associated with this approach include:

- Difficult to implement because it requires knowledge of all marginal costs and all demand elasticities.
- Relies on cross subsidization between customers and may be seen as a form of price discrimination.
- Assumes that consumers respond to marginal pricing in a predictable manner, which is more likely under simple tariffs or flat rates. Where there is a two-part tariff and the volumetric charge conforms to block rates, then customers are less likely to know what the marginal charge is.
- Inconsistent with achieving the goal of affordability to poor and vulnerable customers.

4.5 Time-Variant (Dynamic) Pricing[18]

The variation of prices based on time has long been used in many industries[19]. In the utility industry, time-variant pricing has become possible due to the introduction of smart meters, which record and digitally communicate consumption data at frequent intervals. The underlying premise of time-variant rates is based on the fact that there are certain periods during the day

[16] In 1927, Ramsey's paper titled "A Contribution to the Theory of Taxation" is regarded as a landmark paper in the field of public finance. In 1956, it appears that Marcel Boiteux independently applied a similar reasoning in analyzing optimal pricing for utilities.
[17] The efficiency referred to here is allocative efficiency which occurs when the value consumers place on a good or service (reflected in the price they willing to pay) equals the cost of the resources used in the production. The technical condition required for allocative efficiency is that price = marginal cost. When this happens total economic welfare is maximized.
[18] Time-variant pricing can take several forms including the most static time-of-use (TOU) pricing, critical-peak-pricing (CPP), peak-time-rebates (PTR) towards the most dynamic form, known as real-time-pricing (RTP).
[19]Airlines, commuter trains, hotels, tourist attractions, parking meters, telecommunications are just some examples where varying price according to time of day is utilized.

when the demand on the electricity network is highest. During these periods, the utility incurs additional resources in order to meet this short-term demand peak. If the pattern continues, the utility may also be faced with additional costs of installing additional peaking capacity infrastructure, including generation resources, to meet the demand. Time-variant pricing is utilized to recover the true cost of electricity at different periods during the day as well as influence consumer behavior toward shifting their demand to off-peak periods or reducing demand overall. Some forms of time-variant pricing are discussed below:

- Time-of-Use Pricing (TOU) – in this approach, the 24-hours in a day is divided into time periods[20] and a schedule of rates for each period is established. These tariffs smooth regular and irregular diurnal peaks (normally in the mornings and early evenings), by shifting demand away from peak hours. TOU is utilized primarily to address peak loads caused by heavy Industrial customers, however, it has also been implemented across other rate classes to curb peak-time demand. With TOU, there is certainty about what the rates will be and when they will occur, which can remain fixed for the duration of a multi-year price review.
- Critical Peak Pricing – customers pay higher prices during the days when the grid is severely stressed (critical event) and receive a discount on normal tariffs outside of this peak period. Customers are usually given one-day notification of critical events occurring on the system. Alternatively, if customers do not want to participate in CPP, then another option of Peak Time Rebates (PTRs) may apply. With PTR, customers are paid for curtailing demand during the critical event, relative to a 'baseline' level.
- Real Time Pricing – this is the purest form of Dynamic Pricing where customers pay for electricity at a retail rate that is linked to the hourly wholesale market price for electricity. This form of pricing is usually most applicable to large customers that may be able to automatically turn off certain equipment when prices rise above a specified threshold.

The feasibility of implementing Time variant pricing for the second price control period is discussed in Section 5.

[20] These time periods can be peak (high usage), off peak (low usage), mid peak, critical peak (a very short "super peak" period or a "needle peak" period of highest usage), shoulder (in between peak and off peak), etc.

4.6 Seasonal Pricing

As the name states, seasonal pricing is normally characterized by higher volumetric rates during certain months of the year (seasons), over which demand is notably higher. In the case of electricity, consumers in temperate countries utilize more energy in the summer months (mainly for cooling). In the case of water, in countries where there is a prolonged period of less rainfall (dry season), consumers may demand more water for irrigation and other purposes during this time. Seasonal pricing may be actually implemented as a modifier (seasonally adjusted) on multipart tariffs where rates for the volumetric portion is either flat, block or time-of-use.

The RIC intends to continue its use a combination of linear, non-linear and multipart tariffs for the second Price Control period.

5.0 SETTING TARIFFS FOR THE SECOND CONTROL PERIOD

The RIC's first Price Review for electricity transmission and distribution sector for the period 2006-2011 expired in May 2011. The prevailing tariff structure (and rates) as at May 2011 remained in effect and have carried forward to present date. Tariff structures include three main elements. First, they arrange customers that are served into classes (i.e., residential, commercial, and industrial, etc.). Second, they identify the charges or schedule of charges by which each class of customer will be billed. Third, they establish the frequency of billing. The tariff structures that are applied for the various classes of customers are outlined as follows:

- Residential - a fixed charge (Customer) and a volumetric consumption (Energy) charge that utilizes an inclining telescopic block structure. Inclining block pricing for residential rates were first introduced in the RIC's 2006 determination[21], with the creation of three distinct consumption blocks. All residential customers are billed bi-monthly (every two months).

[21] Prior to the 2006 rate determination of the RIC, electricity rates to residential customers were multipart, with fixed and volumetric components. The volumetric charges consisted of flat rates for energy, fuel and exchange rate adjustment.

- Commercial - a fixed charge and flat rate, volumetric consumption charge for either of the two sub-classes. The Commercial rate B customers are billed bi-monthly while the rate B1 customers are billed monthly.
- Industrial - a volumetric consumption (Energy) charge and volumetric capacity (Demand) charge[22]. There is no fixed charge however, there are several sub-classes within the Industrial class which are distinguished by their character of service and these customers are billed monthly.
- Street-lighting - a flat rate that is billed annually. The tariffs vary based on the location of the streetlight fixture[23] and also whether the installation cost of the fixtures and fittings are borne by utility (S1 rates) or the customer (S2 rates).

The current electricity tariff structure including class of customers and their respective rates are included in the Appendix.

On a periodic basis, it is prudent for the regulator to review whether its past approach was effective or whether any changes are required. Accordingly, there are some core issues that directly impact tariff structures and rates, which the RIC must address in its approach for the second Price Review. These are discussed further below.

5.1 Suitability of IBTs

As discussed in Section 4, the relationship amongst the various issues that need to be considered when designing IBTs are complex. These include:

- Understanding essential and discretionary electricity use – electricity satisfies a wide range of needs encompassing subsistence level consumption at one end and satisfying luxury needs at the other. At the subsistence level, demand for electricity is usually less

[22] While both are volumetric, the consumption (energy) charge relates to overall electricity use; capacity (demand) charge relates to peak intensity. It is not unusual for these two charges to be rolled into one volumetric charge for residential customers, however, the large variance between normal consumption and maximum demand by industrial customers (and sometimes commercial) require the utility to make and maintain additional capacity investment. As a result, the principles of cost-causality underpin the separation of demand charge from energy charge.

[23] The majority of streetlight bulbs are High Pressure Sodium (HPS) bulbs which are differentiated (by location and by output in Watts) for billing purposes. On highways, 1000W, 350W or 250W HPS bulbs are utilized. 150 -250W bulbs are used on main routes while on Secondary routes, local roads and walkways, 70 to 150W are utilized.

elastic when compared to high end consumption. It is important to delineate the consumption threshold associated with subsistence or basic needs, especially when making decisions regarding the lifeline block for residential customers. At the same time, setting the thresholds of higher blocks require similar understanding of consumption patterns associated with higher income households.

- Affordability[24] – along with the consumption thresholds of the blocks, the RIC must also look at the affordability of rates to consumers. When setting prices for consumers, especially low-income and vulnerable, the internationally accepted guideline is that expenditure on electricity should not exceed more than 10% of household income. In addition, the RIC will consider supporting mechanisms of the utility to facilitate customers that may be experiencing difficulty in payment of their bills and government initiatives with respect to social support programmes.

- Sending the appropriate signals for electricity conservation - beyond the subsistence level of consumption, the price of electricity is important to signaling the economic value of electricity. This includes the value of input resources used in its production and resource conservation. The degree to which increasing block rates encourages consumption depends on the distribution of customer usage across tiers of consumption and the magnitude of the price changes across the tiers[25]. Also, the time period over which consumption is billed controls the frequency with which price signals reach consumers.

- Simplicity of the tariff structure – this is an important factor in deciding on the number of consumption blocks to include in an inclining block tariff. The fewer blocks there are, the more readily customers will be able to understand the tariff and make appropriate electricity consumption decisions. A tariff structure consisting of two or three blocks is likely to be easily understood by customers.

[24] The RIC published a consultative paper in February 2018 that addresses the Affordability of Regulatory Prices. This paper can be accessed on the RIC's website at www.ric.org.tt

[25] Faruqui, A, Hledik, R. Davis, W. – The Paradox of Inclining Block Rates – Public Utilities Fortnightly, April 2015

5.1.1 Relevant Local Factors

Currently, a three-tiered inclining block for residential customers is in use. In 2006, the RIC determined the lifeline block as a bimonthly consumption level of 0-400kWh, and this allowed households to pay a lower rate for basic-needs or subsistence level consumption[26]. At the time, 28% of residential customers were using less than 400kWh bi-monthly. The RIC arrived at the upper threshold of this lifeline block based on benchmarking information and conducting its own analysis using the energy consumption of appliances that would be found in a typical household to meet basic needs[27]. The second block was set at 401-1000kWh which accounted for 45% of residential customers. The third block (>1000kWh) accounted for the remaining 27% of customers. However, this situation has changed with time, especially at the higher levels of electricity consumption, as shown in tables 1 and 2 below.

Table 1 – Residential Consumption analysis for 2010

kWh Range	No. of Customers	% of Total Customers	Cumulative %	kWh-Units	% of Total Units	Cumulative %
1-400	77,193	21.05	21.05	17,804,716	4.56	4.56
401-1000	160,466	43.49	64.54	108,238,167	27.70	32.26
1001-1500	62,845	17.02	81.56	76,506,986	19.57	51.83
1501-2000	28,606	7.75	89.31	41,891,763	12.59	64.42
>2000	39,957	10.69	100.00	146,389,526	35.58	100.00

Table 2 – Residential Consumption analysis for 2017[28]

kWh Range	No. of Customers	% of Total Customers	Cumulative %	kWh-Units	% of Total Units	Cumulative %
1-400	80,257	19.42	19.42	17,168,692	3.44	3.44
401-1000	153,649	37.19	56.61	105,105,181	21.11	24.55
1001-1500	74,046	17.93	73.64	90,764,931	18.23	42.78
1501-2000	41,447	10.04	83.68	71,566,712	14.37	57.15
>2000	63,687	15.42	100.00	213,444,819	42.85	100.00

[26] T&TEC requested the threshold for the lifeline block be set at 500kWh, however, this would have resulted in poor targeting for subsistence level consumption.
[27] The monthly lifeline threshold for T&T was 200kWh. For comparison, the monthly lifeline tariff threshold was 50kWh-Belize, 75kWh-Guyana, 100kWh-Jamaica and 150kWh in Barbados, at the time of that analysis.
[28] The data is relevant to the bi-monthly period of November-December 2017.

From Tables 1 and 2, the percentage of customers that demand less than 400kWh was 21.05% in 2010 and declined to 19.4% by 2017, however, the electricity consumption for this lifeline block remained fairly stable over the last seven years. The percentage of customers in the 401-1000kWh tier was 43.49% in 2010 and this decreased to 37.19% by 2017. There was a relatively small decline in actual kWh consumption in the 401-1000 block over the period 2010-2017 however, the decrease in percentage of total consumption was noteworthy. In 2010, cumulative residential consumption of electricity below 1000kWh was 32.3% while this decreased to 24.6% by 2017, indicating a general shifting of consumption into higher tiers. There have also been significant changes in electricity consumption beyond the 1000kwh level of consumption. The percentage increase from 2010 to 2017 in the 1001-1500, 1501-2000 and >2000kWh consumption bands were 18%, 73% and 45% respectively.

In addition, per capita income levels were fairly consistent for the majority of the period 2010-2017 with a slight decrease over the last few years[29]. Income elasticity of electricity demand is relatively elastic as the demand for products that consume large amounts of electricity, such as air conditioning units, water heaters and clothes dryers, have increased over time[30]. However, the magnitude of income elasticity requires further analysis and the information regarding the import of such appliances into the country requires further analysis to understand the import patterns. Apart from this, the government introduced a low-income assistance programme in December 2016, which was initially intended to target 120,000 electricity customers but has actually benefitted more than 220,000 customers of T&TEC, which is more than 50% of T&TEC's residential customer base.

Therefore, it is difficult to estimate price elasticity of demand for electricity where prices have not changed for a lengthy period of time, income levels would have allowed the purchase of more household appliances to improve quality of life and electricity consumption distortions may have resulted from poorly-targeted government support programmes[31].

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[29] Data from the Central Bank of Trinidad and Tobago shows the per capita income was US$16,885 in 2010, increasing to an average of $19,500 for 2011-2014, declined to $17,500 in 2015 and $16,200 in 2016.

[30] Data from Ministry of Trade show that imports of all three types of appliances increased over the last 10 years

[31] Goddard-Pierre, L. (2017) – Assessing Utility Service Affordability Measures. The Compound Annual Growth Rate (CAGR) for electricity consumption of the beneficiaries was 190% over the 2011-2016 period, which was more than three-times the CAGR for number of customers (53%).

5.1.2 RIC's consideration on IBTs

Analysis of data from T&TEC shows that electricity consumption patterns have shifted within the last eight years, to higher levels of residential kWh consumption. There could be an argument for the introduction of an additional tier at the higher end of consumption, based purely on the statistical information from tables 1 and 2. However, this is a partial analysis as it implicitly assumes the elasticity of demand for electricity in Trinidad and Tobago to be known and furthermore, to be well-defined[32]. This is not the case in Trinidad and Tobago as the last price change for residential customers occurred in September 2009, where there was a $0.01 increase in each tier of the three-tiered block system. Customers have not faced a price change in the last eight years, therefore, the magnitude of price elasticity is not well-defined. Under these circumstances, caution must be adopted when considering changes to the tariff structure, especially without first considering the impact of moving to cost-reflective rates.

The RIC is of the view that the implementation of cost-reflective rates, on the existing three-tiered block structure, will send appropriate pricing signals to customers regarding the true cost of electricity. It is very likely that this price change by itself will strongly influence the desired demand response from customers and cause a downward adjustment to their consumption patterns, especially for customers that enjoy a significant amount of discretionary consumption. Notwithstanding, the RIC has a critical decision to make with respect to the pricing differentials amongst the blocks, in order to effect this type of change in consumer behaviour. The RIC would have to ensure that the magnitude of the price changes and consequently, the price differential between successive blocks, impact the final bills in such a manner (on a percentage basis), to achieve the desired demand response.

Also, stability in the tariff structure is important to influence consumers' knowledge, attitudes and practices where electricity consumption is concerned. By adjusting the price and keeping the existing tariff structure constant, it will be easier for consumers to see the direct link between their bill and level of consumption. In this economic climate, changing other variables within the tariff structure alongside concurrent rate changes, may cause confusion for customers regarding the cause of increased bills. In fact, the introduction of more tiers at the higher end may be

[32] Intuitively, the price elasticity of the lifeline block would be lower (demand is less responsive to changes in price) owing to basic-needs consumption, as opposed to more elastic (discretionary) consumption at higher tiers.

perceived by affected end-users as a punitive approach by the regulator rather than one that is intended to encourage electricity conservation by varying price. This is especially relevant to for this upcoming Price Review as kWh consumption over the last eight years has increased in the higher bands and exhibits a strong correlation to the increase in spending on mid-to-high-end consumer appliances such as residential air-conditioning units, water heaters and clothes dryers. Another probable impact of simultaneous tier addition and rate change could lead to over-sensitivity in the demand response. Due to undefined demand elasticity, simultaneous tier and rate change may result in under-recovery of revenue for the utility and consequently, greater volatility in electricity prices during the regulatory control period. The RIC would want to ensure as much stability and predictability in electricity prices as is possible, over the next price control period. The RIC has also noted that where certain jurisdictions had previously increased the number of tiers in their tariff structure this has now been adjusted downwards[33].

5.2 Customer Classifications

In the first Price Review (2006-2011), customers of T&TEC were classified into four (4) groups for the purposes of ratemaking, that is, Residential, Commercial, Industrial and Street-lighting. These four broad classes are typically utilized by electricity utilities and regulators internationally[34]. The customers that are assigned to each class are so grouped according to common distinctive features about their electricity usage. Apart from the typical customer classes, some utilities identify an institutional class while others define a class for public authorities which may include street-lighting, transportation authorities and consumption of other utilities.

It is generally the case that customers of each class have different electricity needs, however, these broad classes may be further subdivided. This can be done using clearly defined and

[33] For example, two California utilities, Pacific Gas & Electric Company (PG&E) and Southern California Edison (SCE) at one time had as much as five tiers during the period 2001-02. A few years ago the five tiers were reduced to four. The number of tiers has now been reduced down to two for both Pacific Gas & Electric and Southern California Edison (with an additional high usage surcharge).

[34] Jamaica and Guyana both use the same four classes. In addition to the core four, Australia included a class for Small and Microenterprises, South Africa included an Agriculture class, while St. Lucia has a class specifically for hotels. Barbados, Bahamas, New Zealand and Singapore have three classes – Residential, Commercial, Industrial.

identifiable characteristics such as size of load, usage patterns, usage levels and other technical characteristics of service. The creation of sub-classes is necessary because utilities have recognized more distinctive patterns of consumption within groups of broadly similar customers, and the cost of servicing these customers may differ.

5.2.1 RIC's consideration on Customer Classes

The preparation of detailed cost analysis of the resources used in provision of electricity to the different customer classes is a critical component to the developing effective tariff structures[35]. The overarching goal of classifying customers is to group customers with similar load profiles into coherent clusters that can be used for billing purposes. There are a number of techniques[36] that are used for purposes of identifying the respective classes and essentially, these condense into technical characteristics of service (objective) and other end-user factors (subjective).

The use of technical characteristics of service for identifying classes and sub-classes of customers is a simple but highly effective approach that has been traditionally used by utilities and regulators. It makes use of objective technical criterion with which to assign customers to respective classes, thereby ensuring fairness and equity in assigning the cost-of-service by class of customer. End-use factors (type of activity, weather conditions, etc.) become more important to the determination of tariff structures when employing a market-oriented approach, especially where there is competition within the electricity sector. This market oriented approach focuses heavily on the behaviour patterns of consumers in terms of their electricity consumption, which are directly related to the frequency of price changes.

Over the last eight years, the electricity transmission and distribution sector remains a natural monopoly with no retail competition and prices have not changed. Under these circumstances, it is difficult for a compelling argument to be made for the reliance on end-use characteristics as the basis for influencing the choice of class of customer. In any event, creating a new name for a certain set of customers based on end-use factors, does not change the fact that the characteristics of service of these customers have to be assessed for the purposes of determining cost of service.

[35] Chicco, Gianfranco, *et al*. - A Review of Concepts and Techniques for Emergent Customer Categorization

[36] These can be separated into time-domain approaches (clustering algorithms, neural networks, etc.), frequency domain approaches (discrete fourier transform, discrete wavelet transform) or feature selection approaches (load shape features, external features such as weather, type of activity, etc.).

Where the cost-of-service is assessed to be similar to the costs of servicing the broader class, then prices would be similar. To do otherwise, would be to introduce cross-subsidization into pricing, which goes against the principles of determining rates. Furthermore, a significant administrative burden (and cost) would be imposed on the utility without a concomitant rate to fund these costs. Notwithstanding, the government has the option to provide support to customers that it believes may be in need of further assistance, and the implementation of such social assistance programmes does not impact the regulator's process for principle-based rate setting.

5.3 Feasibility of Time-of-Use (TOU) Pricing

TOU rates are implemented to induce consumers to reduce their peak electricity consumption, either by shifting to off-peak hours, or reducing demand overall. TOU pricing has become possible mainly through the introduction of smart meters, which enable the utility to collect data on customer use at regular intervals. There are many studies that customers are very responsive to TOU rates[37], however, the demand response outcome is heavily dependent on price responsiveness, that is, both price elasticity and substitution elasticity (shifting of use to a different period). Price responsiveness also varies with time horizon, customer class and region.

5.3.1 RIC's consideration on use of TOU rates

It has already been established in an earlier Section in this paper, that reliable estimates of price elasticity are not available at this time. Therefore, establishing time-variant pricing at this time would be introducing a significant risk factor into a price-setting process that has been relatively stable. Also, the implementation of TOU rates is difficult when prices in the electricity sector are set on an embedded-cost basis, as TOU is intended to send price signals that would result in a delay or prevent avoidable marginal costs from being incurred in the future. Additionally, when the cost of producing electricity does not vary by time-of-day or when there is no competition in the generation market, as is the case in the local electricity sector, TOU pricing may result in over-recovery of costs during peak periods. Under these circumstances, there may need to be

[37] Many of the studies and pilot programmes on time-of-use rates have been done using consumers who voluntarily participate in dynamic pricing programs, therefore, care must be taken in drawing conclusions regarding the suitability and applicability of TOU to the entire customer base of the utility

below-cost prices at off-peak times in order to maintain overall revenue requirements. In order to counteract these distortions, TOU rates would need to be carefully designed to provide the desired incentives with minimal unintended consequences, especially where cross-subsidization is concerned.

Another major factor that impedes the use of TOU at this time is that this rate structure relies heavily on the results of detailed load studies, which in tandem with smart meters, require specialized software in order to perform the data processing. While the typical load curve for customers of T&TEC is known, the RIC does not have detailed load studies or any recent reports from T&TEC regarding the feasibility of TOU and their recommendations in this regard. Furthermore, T&TEC has several take-or-pay contracts with generators, therefore, there is no incentive to restrict demand (through TOU or otherwise) as T&TEC is obligated to pay for all of the contracted generation capacity[38].

5.4 Billing Frequency

Residential and commercial (Rate B) customers are currently billed on a bi-monthly cycle while Industrial customers are on a monthly billing cycle. The frequency of the billing cycle is an issue that may come under scrutiny during a Price Review because the frequency of collection of revenue has a direct impact on the cash flow of the utility and therefore, delays in collecting rates can negatively impact the operations of the utility[39].

5.4.1 RIC's consideration on Billing Frequency

One of the main arguments for monthly billing is that it improves the cash flow position of the utility and therefore, will enable the utility to repay its debts in a timely manner. The RIC concurs with this view. Another reason in support of monthly billing is that it would ease the burden on low-income consumers, on the basis they would be able to better align monthly expenditure on utilities in relation to all their other commitments. Some further argue that bi-

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[38] In fact, it would benefit the utility if it were able to sell more electricity, as there is currently a significant amount of excess capacity which is a situation that is expected to continue well into the second price control period.

[39] Under the current bi-monthly arrangements, a bill is considered due only until after 14 days have elapsed after the due date, that is, a period of 74 days between the sale of services and the actual receipt of income. Furthermore, the late payment charge is only assessed when the next bill is generated, i.e. approximately 60 days after the first bill was due or over four and a half months after services have been provided.

monthly billing cycle is unfair to them under the current inverted block tariff structure on the basis that combining their consumption over two months forces them to consume in the higher consumption block, thereby being charged at a higher rate.

The RIC does not agree with this view because it ignores the fact that the first Price Review utilized a Revenue Cap approach[40] and rates set by the RIC were designed with the current bi-monthly cycle, to return the required revenue for a two-month period at a time. If all things were held constant, reducing the cycle to monthly billing would have resulted in an increase in rates for the lifeline and first block, to ensure that the utility recovers the cost of providing service for that month. The RIC also developed and implemented Quality of Service Standards since 2004 and recently revised these Standards in 2017. The Guaranteed and Overall Standards each have at least one Standard that is based on the premise of a bi-monthly billing cycle, namely GES 6 and OES 2[41]. Apart from this, there would be additional capital costs for equipment to facilitate monthly billing as well as additional annual operating costs for postage, envelopes, labour, etc. In the second price control period, the RIC intends to continue with the billing cycles for each class as they currently apply.

5.5 Other relevant factors

Apart from the five factors discussed above, there are a number of other factors to be taken into consideration by the RIC, going into the second Price Review. These include the following:

- Regulatory Lag & Inflation - the first regulatory control period ended in May 2011 and the last rate adjustment for electricity took effect in September 2009, that is, almost ten years have elapsed since the last rate increase. The RIC has to consider the extent to which rates will change, and as far as possible, avoid rate shocks by gradually introducing rate increases. Electricity is a key factor of production in economic activity. As a result, pricing of electricity, especially for commercial and industrial customers which can be passed on to consumers, has to be sensitive to the impact of price changes on general

[40] Revenue Cap was utilized in the first Price Control (2006-2011). For further information, see "Establishing an Appropriate Form of Price Control", available on the RIC's website at www.ric.org.tt

[41] **GES 6 -** T&TEC must provide a substantive (written) response to a customer's billing and payment queries within fifteen (15) working days.

OES 2 - 98% of all bills must be mailed within ten (10) working days after meter readings prices of final goods and services. It is important to analyze the percentage changes to each class of customer, when arriving at final prices.

- Tariff rebalancing and Side Constraints – this involves setting limits to the extent of annual price increases to customers. In the absence of side constraints, individual customers could face significant price movements from year to year. While side constraints provide price stability for customers, they may have adverse effects in terms of the ability of the utility to fully recover its revenue requirement.
- Demand side Management (DSM) – generally refers to measures or programmes that are designed to influence the level or timing of customers' demand for energy and can be implemented by the utility, regulator, government and customers. These measures are designed to achieve three broad objectives of energy conservation, energy efficiency and load management. Apart from fulfilling its mandate to establish cost-reflective prices, the RIC has to look at creating incentives for T&TEC to invest in DSM practices such as, load management equipment and providing financial allowance for utility-led load-reduction initiatives.
- Renewable Energy – the introduction of renewable energy (RE) technology as an alternative source of electricity generation is currently being discussed at a policy level in Trinidad and Tobago at the level of the Ministry of Energy and Energy Industries, in terms of the appropriate technology, size, location and pricing. The issue of pricing of electricity from RE sources does not arise at this time of preparation for the second Price Review, however, it will be addressed by the RIC when the government has articulated its policy position on the way forward for RE within the electricity grid.
- Frequency of Tariff Adjustment within the Control Period – The price control formula sets out how prices will be adjusted annually to meet the forecast revenue requirements over the regulatory control period. At a minimum, the prices in each year of the regulatory control period will need to be adjusted by the rate of inflation and the X-factor[42].

[42] There may also be a case for adjusting prices where an unforeseen event that is outside the control of the service provider, impacts significantly on its costs during the regulatory control period.

6.0 CONCLUSION

The RIC's Draft Determination of Rates and Miscellaneous Charges for the period 2018-2023 will be published for public consultation. Once finalized, the Determination will specify the structure of electricity tariffs, the actual tariffs by class of customer and the resultant impact/implications for both service provider and customers. Amongst other things, the RIC will take the following into consideration:

- the link between prices and costs and, therefore, economic efficiency;
- incentives for efficient use of electricity;
- revenue risks and volatility for the service provider;
- equity and fairness for customers;
- the level of revenue raised from fixed charges relative to volumetric charges; and
- the impact of these decisions on the environment.

In deciding on appropriate tariff structures, the RIC will continue to focus on aligning the rates for all categories of consumers with the cost of supply and will be examining other options for addressing affordability and broader hardship issues more effectively. This may involve examining how T&TEC's policies and practices currently deal with customers who are generally unable to pay their bill, especially old age pensioners and disadvantaged groups. It will also include requirements for T&TEC to assist customers who have payment difficulties, through the provision of flexible payment plans where appropriate. The RIC will also engage in discussion with its line Ministry with respect to the performance of its existing social support programmes and measures that can be taken to improve the targeting and efficiency of the low-income support mechanisms.

The RIC welcomes comments on the issues raised in this paper

APPENDIX

Electricity Tariffs for Trinidad and Tobago in 2017

Rate Class	Customer Charge	Energy Charge (¢/kWh)		Demand Charge ($/kVA)
Residential (Bi-monthly)	$6.00	1 - 400 kWh	26	
		401 - 1,000 kWh	32	
		Over 1,000 kWh	37	
Commercial (Bi-monthly) Rate B:	$25.00	41.5		
Commercial (Monthly) Rate B1	Minimum bill of 5,000 kWh	61		
Industrial				
Rate D1		19.9		50
Rate D2		21.8		50
Rate D3		18.3		42.5
Rate D4		16.7		40
Rate D5		16		37
Rate E1		14.5		44.5
Rate E2		14.5		44
Rate E3		14.5		43
Rate E4		14.5		42
Rate E5		14.5		41
Streetlighting	**Annual Rates**			
S1-1		848.72		
S1-2		565.81		
S1-3		411.5		
S1-4		372.92		
S2-2		450.08		
S2-3		347.2		
S2-4		282.91		