DEVELOPMENT OF A THREE PERIOD TIME-OF-DAY ELECTRICITY TARIFF FOR SRI LANKA

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ABSTRACT

Recent approaches to electricity pricing recognize the following objectives in addition to others.

1. *Efficient allocation of national economic resources.*
2. *Fair allocation of costs among consumers.*
3. *Achieving financial requirement of the utility.*
4. *convenience in implementation*

To address most of the above requirements the utilities all over the world started using marginal costing principles in electricity pricing almost two decades ago. While the initial research was confined to the area of long run marginal costing (LRMC) during the last decade the attention has been shifted to the use of short run marginal costing (SRMC).

The scope of this project discussed in the paper was to design a Time of Use (TOU) tariff using Short Run Marginal Costing (SRMC) principles for the electricity consumers in the Ceylon Electricity Board (CEB) distribution areas.

Some of special features in proposed tariff are simplicity, consideration of seasonality during the year, three distinct time periods within a day and the use of SRMC principles which has not been used in consumer tariff design to date in Sri Lanka

The analysis shows that the proposed tariff could achieve the utility's revenue requirement if implemented fully across all the consumer categories. Further this tariff is simple and easy to understand.

However, the requirement of tariff adjustments every three months and the necessity of doing away with subsidies call for further appropriate revisions at the final implementation stage

1.0 INTRODUCTION

In the Sri Lanka electricity supply industry, the absence of a well developed pricing policy and weaknesses in the pricing structure have led to a situation where the prices have progressively failed to reflect the true costs of supply to consumer groups. The weaknesses and the anomalies in the tariff structure have violated some of the very objectives of electricity pricing.

According to economic theory, the optimal allocation of resources is reached when marginal price is equal to marginal cost. In the short term, one is better off running a power plant if the short-term marginal cost is lower that the price paid for the energy.

Marginal cost pricing is used both in countries where there are still vertically integrated government-owned utilities as well as in countries having unbundled power systems. According to the ongoing reforms in the Sri Lankan electricity sector CEB is heading towards a vertically as well as horizontally unbundled entities within an already established regulatory framework.

Therefore the scope of this project was to design a tariff based on the SRMC principles using system operational data addressing most of the electricity pricing objectives mentioned above.

2.0 SHORT RUN MARGINAL COSTING

The short run marginal cost of supplying a given customer is defined as the incremental cost of providing an extra unit of energy considering the operating costs and the shadow costs corresponding to the system constraints. It is assumed that the system capacities involving generation, transmission and distribution remain fixed during the period involved. This leads to SRMC becoming the variable operational costs of different components in the supply system consisting of generation, transmission, primary distribution and secondary distribution.

When the system capacity is constrained the SRMC values tend to increase sharply to reflect the requirement of expanding the already constrained system.

3. REVENUE RECONCILIATION

The strict marginal cost calculated need to be modified to achieve the revenue target of the utility. Main methods of revenue reconciliations are mentioned below.

1. Modification of marginal Price
2. Surcharge or Refund
3. Method of revolving funds

Of these what is most commonly practised is the modification of the individual marginal costs so that the final total income matches the revenue requirement of the supply utility.

4. METHODOLOGY

The system marginal generation cost data and the daily load profiles were collected from the system control centre for seven representative days in each month of the year 2003.

By examining the variation of the demand during these samples, three periods were determined (Figure 1)

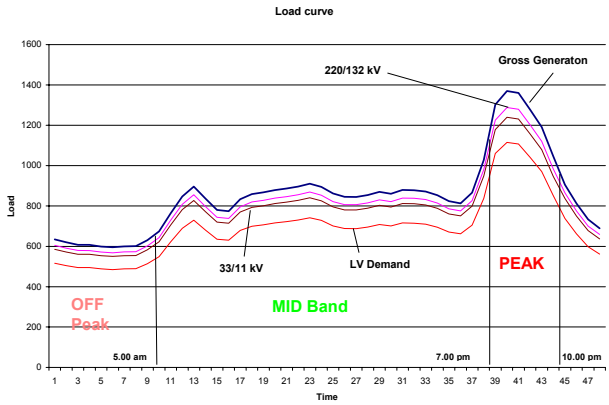

Figure 1: ***Demand Profile considering losses at each voltage level***

For each of these identified periods average marginal cost of generation was calculated by taking the weighted average of the appropriate marginal costs (Figure 2).

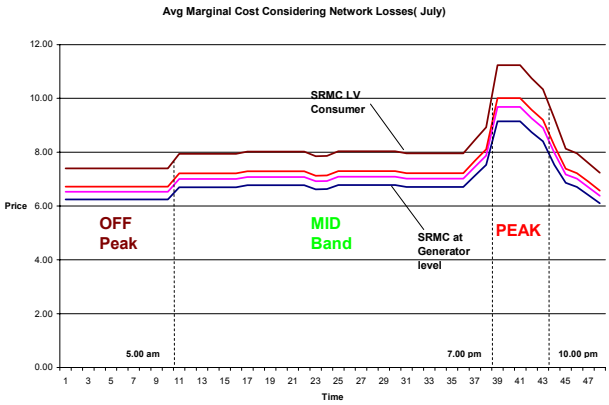

Figure 2: ***Marginal Cost Profile at each voltage level***

Then for each of these periods the average transmission and distribution losses were determined at different voltage levels. Further average incremental costs of transmission and distribution investment were also calculated.

With the use of the above the average marginal cost of supply at different voltage levels were calculated. Based on the estimated marginal costs and the demand in the system the total income was determined to compare it with the revenue requirement of the utility

5. RESULTS AND ANALYSIS

Marginal electricity prices undergo substantial changes during a year. This is due to factors like rainfall cycles, OPEC decisions of fuel price changes and Exchange rate fluctuations. Proposed tariff system includes seasonality and drastic changes in electrical prices over different months shows the repercussions of not adhering to Generation Expansion plan.

To fulfill the fairness and equity requirement in electricity pricing, consumers have been differentiated using the network losses (Figure1 and Figure 2) at each voltage level.

Again, peak consumers are penalized by allocating Average Incremental Cost (AIC) of Network Investment to them

As our final output we came up with following tariffs which change figures in every quarter the year concerned. We got the average figure for every 3 month to arrive at quarterly figure.

Existing tariff revision occurs usually once a year and frequent revision of figures in new tariff in every month could lead to a consumer resistance at the very beginning of the implementation. Therefore rather than monthly revising figures, Quarterly figures were arrived.

LV Low Voltage 230/400 V

MV Medium Voltage 11/33 kV

HV High Voltage 132/220 kV

OP Off Peak 10.00pm to 5.00 am

MB Mid band 5.00am to 7.00pm

PEAK Peak 7.00pm to 10.00 pm

January to March

Tariff - Quarter 1		
Consumer Category	**TOD**	**Rs/kWh**
	OP	9.32
HV	MB	10.53
	PEAK	12.70
MV	OP	9.59
	MB	10.84
	PEAK	13.34
LV	OP	10.56
	MB	11.93
	PEAK	15.50

April to June

Tariff - Quarter 2		
Consumer Category	**TOD**	**Rs/kWh**
	OP	7.10
HV	MB	7.92
	PEAK	8.91
MV	OP	7.31
	MB	8.16
	PEAK	9.35
LV	OP	8.06
	MB	8.99
	PEAK	11.11

July to September

Tariff - Quarter 3		
Consumer Category	**TOD**	**Rs/kWh**
	OP	7.33
HV	MB	8.54
	PEAK	10.80
MV	OP	7.54
	MB	8.79
	PEAK	11.38
LV	OP	8.31
	MB	9.68
	PEAK	13.30

October to December

Tariff - Quarter 4		
Consumer Category	**TOD**	**Rs/kWh**
	OP	7.10
HV	MB	7.92
	PEAK	9.09
MV	OP	7.31
	MB	8.16
	PEAK	9.61
LV	OP	8.05
	MB	8.97
	PEAK	11.31

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6. CONCLUSION

The final objective of the project was to design a tariff which covers key aspects of a desirable electricity pricing regime. This paper presented the use of Short Run Marginal Cost (SRMC) principle which is new to Sri Lanka for this purpose. Also it examined the possibility of expanding the structure of the time of use tariff to a three periods.

Other than the efficient resource allocation which stems from marginal cost theory itself, new tariff covers the aspects like seasonality, fairness and equity, Time of Use (TOU), revenue requirement of the utility and simplicity in understanding and metering.

According to the analysis it showed new tariff could achieve the utility's revenue requirement while concerning no interventions like subsidies. Since proposed tariff is easy to understand and being a single rate tariff it satisfies the requirement of simplicity.

However, considerable uncertainty / limitations exist about many issues Other than the validations of theoretical assumptions in real world such as perfect market conditions, new tariff inherited with following limitations. In this analysis we came up with some what high figures where it would be difficult to implement without considering subsidy. Again according to the proposed system tariff would revise in each month hence leading to uncertainty in the economy. Finally in this analysis we have totally ignored the emergency power purchases.

It can be concluded that the proposed tariff structure with three periods and seasonal variations is very appropriate to the Sri Lanka system and it recovers the utility's revenue requirement. Implementation of such a tariff structure in all large consumer categories will not be a major issue due to the availability low cost advanced metering technologies. Targeted subsidies and lifeline rates can be provided to the underprivileged groups without disturbing the marginal costing based tariffs for others.

5.0 ACKNOWLEDGEMENT

We wish to convey our gratitude to Professor Priyantha Wijayathunge for assisting and guiding us throughout the project by allocating his precious time.

We would like to thank Dr. D.P.N. Nanayakkara and Dr. Tilak Siyambalapitiya for the assistance and advice given to us.

We would like to specially thank Mr. K. Illeperuma (City Office), Mr. Nanada Kumar (System Control), Mr. Chinthaka Senevirathne (System Control), Miss. Madhavi Kudaligama (Generation Planning), Mr. Ranasinghe (Transmission Planning), Mr. Botheju (Distribution Planning) and Mrs. Amali Senevirathne (Tariff Branch) the CEB engineers who helped us immensely by providing necessary data and advice to make this project successful.

We would also like to thank Mr. Asanka Rodrego, our senior who helped us lot by providing necessary information and encouraging us throughout the project.

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