Demand for Electrical Power and Power Tariffs in Bangladesh- A Preliminary Appraisal

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Abstract

The bvsiness of electrical utilities in Bangladesh are incurring loss in public scetor and rate differentials are a way of turning them into profitable entities. The paper estimates demand function of different groups of electricity consumers, to arrive at electricity charges based on differences in demand. The paper estimates relevant consumption function for residential and industrial (11 KV) customers with monthly data for Dhaka region. It finds that residential demand for power is more elastic than that of industrial demand. It tentatively recommends a basis of charging prices to the two groups using make-up on marginal cost, in order to ensure more electricity available at lower cost to customers. The paper briefly reviews the present state of regulatory policy in Bangladesh and ends with a few recommendations.

1. INTRODUCTION

Competitive markets automatically determine what production costs and normal profits are, and the entry and exit of firms result in prices that just cover these. In the case of utility a government agency is to find out the appropriate costs, profits and prices (Weiss 1967: 103 Chowdhury & Farooque 2001:1).

In addition to production costs, the government agency or commission as a rule allows the utility company a return on its investment. After determining expenses, valuation of assets and rate of return, commission needs to arrive at a price that covers these. This in turn, depends on elasticity of demand. Commission often avoids a careful study of demand. It acts as if the elasticity of demand were zero so that a 10 percent decrease in rates would reduce total revenue by 10 percent (Weiss 1967:110).

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The effect of this assumption is shown in figure – 1. Rate is originally Tk. 3 and output is 75,000 kw. If it thinks that there will be no change to the quantity purchased when rates change, that is, elasticity is zero, it might arrive at a rate of Tk. 2.5 to reduce excess profit. But demand will eventually be up to the 100,000 kw level because elasticity is actually more than 'O'. Excess profits will ensue and rate would be reduced again. Process would go on until after a few years it reaches Tk. 2. If rates, based on demand analysis is reduced from Tk. 3 to Tk. 2 in the first place, consuners would be benefited by lower rates and greater service sooner (Weiss 1967:110-11). If the company is incurring loss, reverse is likely to be true.

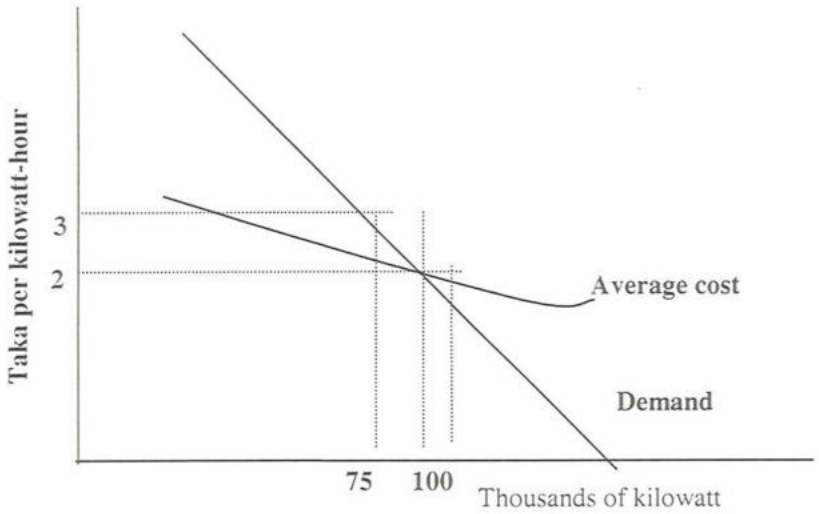

Figure 1: Relationship between rate and demand of electricity (in KW)

Power projects in USA that have priced electricity based on fairly elastic demand have had commendable results (Weiss 1967:111).

2. OBJECTIVES OF THE STUDY

The objectives of the paper are as follows:

a) To briefly examine the principles governing determination of rates charged to customers by power companies and rate differentials, both in the private and public sector.

b) To study pattern of demand, for electrical power, of residential and industrial consumers in Bangladesh with special reference to Dhaka region.

c) To analyze policy implications of the study and recommend ways for a broad based study of demand for electrical power in Bangladesh.

Following the introductory section, part II gives the objectives of the study. Part III presents methodology of the study. In part IV principles of rate determination and rate differentials are outlined. Part V provides estimation and analysis of power consumption functions designed in this study and their policy implications. Part VI summarizes the present framework of regulatory policy and its probable future course, in so far as it relates to power tariffs in distribution and generation of electrical power in Bangladesh. Part VII presents the conclusions and recommendations of the study.

3. METHODOLOGY

The analysis is designed so as to enable us to explore the price - consumption relationship of electrical power using time-series data. It is based on monthly consumption of power by individual units (of household or industry) corresponding to different tariff rates over a period of years.

Two sets of price – consumption relationships are estimated, one for residential group of consumers and the other for industrial group of consumers. The study is carried out in Dhaka and its adjoining region.

In all the different cases of price - consumption relationship, two different alternative forms of consumption functions are estimated for each of the two groups. The selection of the most appropriate consumption function for each group is made on the basis of the value of the function's R^2, the coefficient of determination, and its conformity with *a* priori economic reasoning regarding relationship between price and quantity demanded. It might be noted that economic reasoning envisages an inverse relationship between price of a commodity and quantity demanded.

The functions are:

(i) $B = A + P$

(ii) $\log (B) = A + \log P - t - t^2$

Where B = consumption of power, in kilowatt-hour, per residential or industrial unit per month.

P = monthly tariff rate in taka deflated by consumer price index.

t = time; April 1997 as the origin of the axis of abscissa

In the demand function (ii), in order to account for additional factors – as variations in income-their impact on demand is expressed by a certain function of

time (t). The last two terms (t, t^2) in the demand function (ii) constitute a parabolic demand trend (Schultz 1938).

The quantity variables (B) have been expressed in terms of consuming unit (residence or industry) by dividing sale of power in a category by number of consumers in that category during respective periods. The elasticity estimate of the linear function varies with variations in the level of tariff or price. For the average consuming unit, elasticity is estimated at the sample mean value of tariff, i.e.P.

Among the various non-linear forms, double log form is most extensively used. It has the advantage that the regression coefficient is the same as elasticity coefficient.

Data Source

The functions presented above have been estimated using monthly time series data for the period June 1992 to January 2001 (Annex 1 & 2). To this end relevant data have been obtained from secondary sources including commercial statistics of Dhaka Electric Supply Authority (DESA). Data on consume price index have been obtained from Monthly Bulletin of Statistics of the Bureau of Statistics.

4. RATE DIFFERENTIALS

Electric utilities display decreasing costs with increasing level of output. If the price is set by the regulator equal to marginal cost, it would leave the utility at a loss. Therefore, tolls are based on long – run marginal cost, which include the cost of additional capacity that has to be built to meet additional demand at peak hours (Chowdhury & Farooque 2001: 4).

Power entities seldom charge the same rates to all customers. Commonly there are different rates for residential, commercial and various types of industrial buyers. Power companies are in a good position to maintain price differences of this sort due to the reason that it is not possible for users who pay low rates to resell to those who pay more (Weiss 1967:111-12).

Figure-2 presents a simplified analysis of the principles determining rate differentials. There are held to be two separable groups of customers, with respective demand curve D1 and D2. The D1 customers could be provided alone at a uniform price P1 and their demand would justify the size of plant appropriate for producing an output Q1. But such a price would fall considerably short of

optimality. There are some D1 buyers and an entire group of D2 willing to buy a great deal more, Q1Q2 and Q1Q3 respectively at prices Q3B covering the long run incremental costs of that additional output. For simplicity D2 curve is drawn with its vertical axis at Q1 and therefore, the power consumed by D2 customers should begin at Q1.

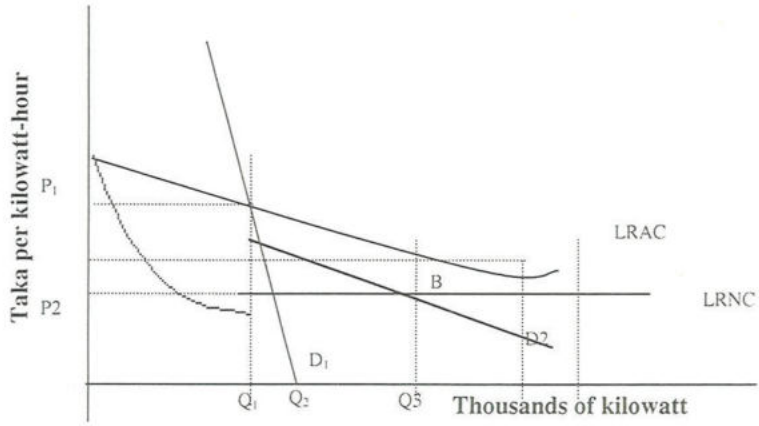

Figure 2 : Principles determining rate differentials

Given a separation of D1 and D2 customers, price differentials would be an improvement over the uniform P1 price to all. If a lower price P2 is set for D2 customers it would be possible to pick up their business and earn from it revenues sufficient to cover the full additional costs of supplying them. The unchanged P1 price to the D1 customers on their OQ1 output and the P2 for the Q1Q3 output to the D2 customers will together cover average total cost (ATC) (Kahn 1988: 138-9).

Public utility companies should be induced to ask different customers to contribute to common cost over and above the costs of delivering to them separately on the basis of their respective abilities and willingness to pay or the value of the service to them. (Khan 1988: 140). To achieve efficient allocation of resource, prices to each category of users are to be set at the respective marginal cost of serving them. In a decreasing cost industry it might leave the companies with a loss. In this situation, postulates of welfare economics indicate that the prices of the various services are to be marked up above MC in inverse proportion

to their elasticity of demand. This prescription stems from the idea that the optimal pricing scheme will be one that maximizes the surplus of all consumers taken as a group, subject to the constraint of raising sufficient revenue to cover total costs.

5. ESTIMATION OF DEMAND EQUATIONS AND POLICY IMPLICATIONS

The best tariff consumption function for each of the two groups- residential and industrial customers- has been selected, out of the two forms described above, on the basis of R2, or coefficient of determination, and on the basis of consistency with a priori economic reasoning meaning an inverse relationship between tariff and demand (see Part III above). The alternative equations and their corresponding estimates are given below in Table-1.

In the case of residential customers the linear equation (i) is the relevant equation (see part III above). Relation between tariff and power consumption is inverse and

Table 1 : Best Tariff Consumption Functions and Coefficients- Dhaka Region.

Consumer category	Best Equation	Variables	Coefficients	t value	R^2
Residential	(i)	P	- 1152.5	- 3.625*	0.14
		Constant	515.24	7.414	
Industrial (11kv)	(ii)				
		P	- 0.11	- 1.06	0.41
		t	- .28E - 03	- 6.36	
		t^2	- .06E - 04	- 3.00	
		Constant	10.687	84.05	

Source: Annex 1 & 2

* Significant at 1% level

therefore is in consistent with economic reasoning. However, value of R2 is not large. Only 14 percent of the variation in consumption of power is explained by tariffs. It implies that other factors, such as income, are also instrumental in determining demand for power. It should be noted, however, that data based on aggregate values on residential demand do not account for changes in distribution of household by income size overtime. Therefore, due to aggregation of data incorporating all households, effect of changes in distribution of household by income size is not taken into account by the estimates of consumption function

above. The value of the coefficient P1, that is tariff, is significantly different from zero, as indicated by t-value (Table-1). It indicates that influence of tariff on power consumption is significant.

In the case of industrial consumers, the double logarithmic equation (ii) is appropriate. Value of R2 is fairly large. Relationship between tariff and power consumption is inverse. Unlike residential consumers, though tariffs are not significant as an explanatory variable of power consumption. It is likely that other factors, as input prices, profitability, etc. exert greater influence on power consumption in industries.

Elasticity Estimates

Price elasticity estimates for residential and industrial units are provided in Table-2. Elasticity estimates underline certain tentative features First, the price or tariff elasticity estimates are negative for both industrial and residential units.

Table 2 : Price Elasticity of Demand for Power

Customer Category	Elasticity
Residential unit	- 0.95 *
Industrial unit	- 0 .11

Source: Table-1

* Elasticity estimated at sample mean value of P.

Second, estimates of elasticity are higher for residential consumers than for industrial units. In other words, residential demand, though less than unity, is more elastic than industry's demand. Industrial demand for power is apparently inelastic.

Relatively greater value of elasticity of residential customers is explained by the likely presence of large number of households with fixed or lower income, for whom cost of electricity represent a fair share of their budget. Presence of alternative uses of electricity, which might be pruned in response to higher tariff, also explains the higher estimates of elasticity of residential customers. In case of industrial customer low elasticity estimate and low significance is probably explained by the cost of electricity to industrial units, which probably comprise a smaller share of the budget that includes other costlier inputs.

Policy Implications

Policy implications of the above findings should be studied with caution. The present analysis is based on aggregate data and any aggregation means loss of information. Range of variation of the independent variable, P or tariff, is too narrow and the analysis covers a relatively short period of time. Nevertheless, a cautious appraisal of the implications of these preliminary results can be outlined.

In power utilities if marginal cost is lower than average total cost per unit, as in a decreasing cost industry, and prices are at the former level, total revenues will be less than total cost (Kahn 1988:130). In Bangladesh the problem is compounded as some of the prices are set below long-run marginal cost (M/o Planning 339). The problem might be resolved by price discrimination, which is acceptable in principle (Kahn 1988:131) Perfect price discrimination involve fashioning charges according to what each unit of traffic will bear. The basis is difference in demand. In reality and in rough approximation, it is the way private business or natural monopolies determine their differential charges - on the basis of the respective elasticity of demand of their various group of customers. (Part- IV above).

Economists have advocated that the long-run marginal costs be identified and rates be above those respective costs by whatever percentage required to generate the necessary aggregate revenues. It is to be noted that since the difference between marginal and average revenues will be greater the less elastic is demand, the company will charge a higher price or mark up in the market with less elastic and a lower price or mark up in the market with more elastic demand (Stigler 1968: 209-13 Kahn 1988:141).

In view of the above the residential customers having more elastic demand are, justifiably, to be charged a price with a smaller mark up above the respective long-run marginal cost of serving them. In comparison industrial (11kv) consumers with an in-elastic demand, could be charged larger mark up above marginal cost, in accordance with the notion that sellers give price to different markets based on what it will bear.

This also implies that the industrial or other customers who are being discriminated against need not be injured as the lower rate to residential consumers-permit fuller use of existing capacity (part IV above). If the additional output due to lower rate or mark up cover anything more than the additional cost it entails, then residential customers are making contribution to the common costs that others would other wise have to bear by themselves.

A group of customers would be less costly to serve if it had a large off-peak demand requiring no additional plant. Rate discrimination, according to peak and off-peak hours, might, in this case, ensure profitable working of the company. Rates of off-peak customers might be set in order to maximize their contribution to overhead costs, thereby reducing cost and prices to others or increasing net revenue. An efficient rate differential would entail estimation of respective elasticity's of peak and off-peak customers. Limitation of time and resources precluded an analysis along this line in the present paper.

6. REVIEW OF REGULATORY POLICY - PRESENT AND FUTURE

An earlier paper by the present authors recommended the formation of a regulatory commission for power sector in Bangladesh (Chowdhury & Farooque 2001: 19).. Confirming the recommendation, government has in the meantime approved the formation of a regulatory commission for energy. The major purpose of regulation is control over entry and approval of tariffs, although exact definition of the proposed commission's function awaits further appraisal.

Investment experts tend to find the regulatory process as a decade or two long transitory phase following which a period of partial deregulation is likely to follow. This is particularly applicable to power generation where a number of private generators obtain liberalized access to the system and bid in auction. Regulation of tariff with respect to transmission and distribution is likely to remain, even after transitory phase, as monopoly will prevail in these sectors.

Apparently, deregulation (of generation) implies opening the industry to free entry while incumbent companies remain regulated as to the rate structure. Tendency of the regulator, in this case, is to protect customers from eventual increase in prices with political overtones- like basic residential rates. Of late, there is a trend in the West toward the admission of competition in public utility markets. Critics have debated the dilemmas and distortions of a mixed regime of regulation and competition. Among other drawback, a major problem is that regulation of incumbent companies in the presence of freedom of entry of unregulated competitors introduces many distortions (Kahn 1988: XXXV).Further, there is the apprehension that the regulated monopolies may use their control over bottleneck facilities, distribution and transmission system, to deny rivals a fair access to customers.

It should be noted, however, that competition following deregulation is likely to result in substantial price reductions, as the experience elsewhere in the West indicate. Competition imparted discernible effect on the structure of rates, rather

than on their average levels. It forced individual rates into alignment with marginal costs, with a few rates going up and others going down. (Kahn 1988 XVIII- XIX).

Competition and Regulation

The foregoing study of demand for electrical power and its policy implications apply both to public and private entities. During the last decade, there was a genuine tendency in Bangladesh toward the admission of private enterprise into public utility sector. Power generation was opened to independent power producers (IPPs), though distribution remain a domain of public entities like Dhaka Electric Supply Authority (DESA) and Power Development Board (PDB) with rural distribution assigned to PBS, a cooperative aided by Rural Electrification Board (REB).

An earlier paper analyzed the comparative performance of PBS, a cooperative, and DESA, a government entity. The performance of PBS in terms of lower system loss and improved billing and collection indicated that cooperative perform relatively more efficiently and profitably than public entities. A policy of introducing privatization of distribution of electricity, the paper recommended, would be a step in the right direction (Mannan and Faqooque 2001: 15 - 19).

Competition entails construction of generating facilities by IPPs to provide power on a competitive basis to any or all distribution companies. In a competitive environment, distributors buy electricity at competitive prices from power producers outside their franchise territories. The present reforms in Bangladesh are amply short of full competition. There is a lack of unanimity as to the extent of competition to be permitted. A reason is that commission or the public alike are likely to be unwilling to permit rate structures aligned with marginal costs that unregulated competition would enforce to the extent this would entail increases in the politically sensitive charges - basic residential rates. It is to be noted that residential customers presently account for a major segment of electricity distributed in the country.

The two principal institutions of social control in a private enterprise economy are competition and regulation. Either one of these cannot always be relied on exclusively. The proper approach would be the best possible combination of the two.

In the near future the overwhelming majority of transactions in power utilities is likely to remain regulated. Tariff or price setting by enterprises generating and

distributing power will remain a principal aspect of regulation. The extent of regulation, though, remains a subject of debate, with reference to the legal and economic principles governing it. The primary task of the proposed regulatory commission in Bangladesh should be to ensure legal and constitutional safeguards for protecting the investors as well as public interest.

7. CONCLUSION AND RECOMMENDATIONS

Conclusion

Electrical utilities in Bangladesh are incurring losses due to, among other factors, inadequate tariffs and cost escalation caused by system loss. In this case, rate differentials or rate discrimination is a way of turning the enterprise into profitable entity or of avoiding loss. The present paper studies demand for electrical power of residential and industrial consumers in Bangladesh, with special reference to Dhaka region. The purpose of the paper, which is a sequel to an earlier paper on regulatory policy, is to help provide estimates of demand function for different groups of customers and for different hours of day to the policy makers, in order to assist in arriving at charges for each group of customers based on differences in demand.

The paper outlines the principles governing rate determination and rate differentials, in regard to power tariff to different groups of consumers. It analyses the justification for markup of prices of the various services above respective marginal cost based on their elasticity's of demand.

The study estimates the relevant consumption function for residential customers and industrial customers (11kv) using monthly data for Dhaka region, denoting the best function on the basis of coefficient of determination and a priori economic reasoning.

The study finds that residential demand for power is more elastic, though less than unity, than industrial demand. Industrial demand is apparently inelastic. Based on these elasticity coefficients it is tentatively recommended that the residential customers be charged a price with lower mark up above marginal cost of serving them, compared to industrial customers. The industrial customers be charged a relatively higher markup in accord with what the traffic will bear. It would ensure that residential customers would be contributing to the common costs that others would otherwise have to bear by them- selves.

The paper briefly reviews the state of regulatory policy in Bangladesh at present and in future. It notes the trend in the West and in Bangladesh toward admission

of competition in public utility market and outlines its advantages and drawbacks. The paper concludes with a few recommendations including the need to undertake a more broad-based study of demand for electrical power of major categories of consumers in Bangladesh over a longer period of time relative to the present study.

Recommendations

1. Tentative recommendations of the present study is to charge residential customers on an average a smaller markup and industrial customers a larger markup above their respective marginal cost (long-run) or present tariff level.
2. In setting rates for industry, industries requiring protection are to be charged lower tariffs with provision for internal subsidization.
3. A broad-based study of demand for power is undertaken for major categories of consumers in Bangladesh and for peak and off peak hour covering a longer period of time relative to the present study.
4. The proposed study should incorporate study of residential demand, with disaggregated data, by household income and location (rural or urban).
5. A pilot study in a limited geography area or zone be carried out as a prelude to the proposed broad-based study of demand. It will illuminate methodological aspects, like appropriate determining variables in the consumption function.

Annex- 1

Power Consumption by Industrial Unit in Dhaka Region

(1) Deflated Price (Tk. per kilowatt hour)	(2) Electricity consumed Per Industrial unit (kilowatt hour)
0.28	52795
0.32	51373
0.32	50341
0.32	48734
0.32	48633
0.32	48532
0.32	48365
0.31	53135
0.31	53850
0.31	53373
0.31	53715
0.3	48858
0.3	47173
0.29	47340
0.3	41818
0.29	48963
0.35	54397
0.29	52500
0.28	56736
0.28	58619
0.28	58407
0.28	56582
0.28	57045
0.28	54536
0.28	51283
0.25	50199
0.31	43373
0.32	49797
0.28	51740
0.28	55936
0.28	55681
0.29	57697
0.28	58715
0.28	56500
0.31	55881
0.31	51470
0.31	48591
0.34	48233
0.33	37060
0.33	48821

(1)	(2)
0.34	46865
0.34	52776
0.34	54130
0.37	56015
0.32	57121
0.33	55009
0.35	49825
0.32	50064
0.32	46097
0.32	44379
0.32	39311
0.32	46865
0.32	44408
0.32	49208
0.32	48360
0.31	50372
0.3	49408
0.31	45720
0.3	50510
0.3	47436
0.3	43887
0.3	37619
0.3	37124
0.3	44713
0.3	45997
0.29	47527
0.29	30311
0.29	46303
0.3	46324
0.29	45007
0.29	46274
0.28	43627
0.28	42043
0.29	38625
0.28	40087
0.28	41613
0.14	43242
0.29	45687
0.29	43803
0.29	47475
0.29	47568
0.29	44410
0.28	43543
0.28	40330
0.29	36666
0.29	38638

Source: DESA 2001

Annex- 2

Power Consumption by Residential Unit in Dhaka Region

(1) Deflated Price (Tk. per kilowatt hour)	(2) Electricity consumed Per residential unit (kilowatt hour)
0.25	192
0.24	210
0.24	206
0.24	204
0.24	204
0.24	204
0.24	202
0.24	240
0.24	247
0.24	244
0.23	249
0.23	210
0.23	199
0.22	207
0.22	194
0.22	211
0.23	244
0.23	253
0.23	261
0.22	255
0.22	256
0.22	246
0.22	262
0.22	220
0.22	206
0.22	215
0.22	198
0.22	239
0.22	234
0.22	248
0.22	261
0.22	278
0.22	280
0.22	285
0.22	274
0.22	237
0.22	232
0.22	239
0.22	194
0.22	242
0.22	238
0.22	271

(1)	(2)
0.22	286
0.22	293
0.22	290
0.22	288
0.22	301
0.22	242
0.22	236
0.22	256
0.22	214
0.21	251
0.21	242
0.22	280
0.22	290
0.22	295
0.21	291
0.21	272
0.21	316
0.21	291
0.21	279
0.21	264
0.21	258
0.21	316
0.21	304
0.21	316
0.21	354
0.21	348
0.21	356
0.21	333
0.21	293
0.21	257
0.2	238
0.21	220
0.21	219
0.21	252
0.1	284
0.21	300
0.21	306
0.21	478
0.21	434
0.21	326
0.21	334
0.21	336
0.21	306
0.21	258

Source: DESA 2001

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