Turkish Economic Review
www.kspjournals.org
Volume 3 December 2016 Issue 4

The Egyptian Electricity Market: Designing a Prudent Peak Load Pricing System

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Abstract. Electricity prices in Egypt have been set significantly lower than the real economic cost of its production and supply. These subsidies encourage the waste of energy and increase the fluctuation in demand, triggering a huge need of additional power generation capacity in Egypt. This dialectical paper addresses this problem by first theoretically analyzing the Egyptian electricity market and then discussing a possible peak load pricing system. According to the results, especially low income households will shift their demand from the peak period to the off peak period. A properly implemented peak load pricing system could reduce the need for power capacity expansion by significant 2000-3000 MW, accompanied by additional savings in the network transmission capacity.
Keywords. Energy, Electricity, Peak load pricing, Peak demand, Off-peak demand.
JEL. L51, L94, Q40.

Highlights

* In Egypt, total energy demand grows considerably faster than energy supply capacities, even in years when the increase in economic growth is moderate. The energy system is approaching its limits.
* Egyptian gas and oil reserves are not sufficient when compared to the increase in population and their consequent demand. That's why in the long run the risk of uncovered demand is unavoidable. As for the specific case of electricity, non-storability and the periodic and stochastic instability of demand are adding to the general energy scarcity.
* Finally, economists in recent years have made major progress in developing both theoretical and empirical models of electricity demand. Almost all the economic studies presented in this research, nevertheless, have relied on traditional economic and production variables such as income, prices, demographics, and stocks of electricity-using devices for countries like UK, USA, India and Canada..

Summary

Egypt, total energy demand grows considerably faster than energy supply capacities, even in years when the increase in economic growth is moderate. The energy system is approaching its limits. Also, the increase in oil prices is considered a real threat for the Egyptian economy. Egyptian gas and oil reserves are not sufficient when compared to the increase in population and their consequent demand. That's why in the long run the risk of uncovered demand is unavoidable.

† This summary depends on the Master thesis which was completed by advisory of Prof. Dr. Christian Richter in Department of Economics, in German University in Cairo. Thesis defense was made in 13.06.2015 to the Jury and accepted. The original language is Turkish and the thesis is consisted of 71 pages.

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As for the specific case of electricity, non-storability and the periodic and stochastic instability of demand are adding to the general energy scarcity. What is more, the demand for electricity, especially peak demand, has significantly increased due to the increasing use of electricity in production and consumption by different types of consumer such as domestic, commercial, agricultural, and industrial. Given that, the number of subscribers who receive electricity reached 22.8 million in 2007/2008, in which 70.3 percent of them are household consumers. For this demand to be covered, an average annual expansion of 2000-3000 MW is needed which is very costly, because the utility depends on natural gas mainly in production. Over and above, the electricity prices in Egypt had been set significantly lower than the real economic cost of its supply and production as it is subsidized by government. Charging customers such low prices encourages fluctuation in demand over the time and energy waste, in addition, lowering the net income for both the EEA and EEHC.

Thus, applying new pricing system will encourage electricity customer's especially low income household customers who are charged only 5 piaster per KW, and enjoying price subsidies to shift their demand from the PP to off peak period. Since their price elasticity would be much higher than the elasticity of high income customers, yet, this doesn't mean that PLP will only affect low income people, because, if high income customer kept utilizing the electricity during peak hours, they will have to bear a higher electricity price. Hitherto, it is vital to emphasize that PLP system might not be easily implemented, and producer might even charge all customers the same price during the whole period given that demand is strongly fluctuating and affecting the quality of service provided.

Finally, economists in recent years have made major progress in developing both theoretical and empirical models of electricity demand. Almost all the economic studies presented in this research, nevertheless, have relied on traditional economic and production variables such as income, prices, demographics, and stocks of electricity-using devices for countries like UK, USA, India and Canada. Modest if any attention has been given to the Egyptian electricity market, if at all, its price structure. consequently this research has faced some limitations as few improved data sources about the Egyptian electricity market was available, considering demand which vary over time, income elasticity and amount of electricity consumed by each category. Future research should pay more attention to the Egyptian electricity market, and the potential improvement for the Egyptian electricity pricing structure and the possibility of having a more competitive market.

The theory of Peak Load Pricing has been a theme of wide discussion amongst economists for many decades. It is considered a topic of great interest and controversial. The need for applying different pricing strategy as PLP basically emerged in response to problems that face most public utility, for instance non-storability, stochastic instability of demand and demand time varying where capacity in public utilities is not uniformly utilised. Amongst economists, Peak Load Pricing is known to be the golden solution for dealing with such problems (Main 1981:139). As it provides public utilities with an indirect load management mechanism that meets the double objectives; which is reducing growth in peak load or in other words peak clipping, and lessening the need for capacity expansion, through charging customers in peak time a higher peak price, and hence shifting part of the load from the peak to the base load plants which called valley filling and charging off peak customer a lower offpeak price, thus having some savings in used fuels during peak time (Crew et al 1995:215; Seeto et al, 1997: 169-171; Castell and Tanchuco 2002:1-2; Pillai 2003: 5-8; Viscusi 2005:453). The main motive behind writing this paper is the actual increasing demand for new power generation capacity that has been witnessed by the government in the last few years; given that the average annual growth rate in electricity demand recorded a 10.3 percent increase in year 2007. Moreover, a greater increase is expected to occur in the coming years. Many recent statistics have actually corroborated these facts, for instance peak load is expected to reach about 57 GW by the year 2027. It should be considered that the current total installed capacity is only 23,530 MW with a Peak Load of 21, 250 MW while total installed capacity is expected to reach 73 GW by the year 2027. However, not free of charge as it entails high cost of operation, installation and expansion, not counting increasing consumption for the non-renewable sources. It is additionally important to bring to light that almost 85% of electricity generated in 2007 is generated mainly by Oil and Natural gas (ElShehawy 2008: 3-4). These are considered non-renewable sources and of a very high price, thus sustainable growth cannot be assured. In fact, different studies have shown that the primary energy supply will not be sufficient to meet demand starting from 2015 (Beshara 2008:2).

In addition to these serious potential problem, electricity prices in Egypt had been set significantly lower than the real economic cost of its production and supply which encourages more energy misuse by different customers and further fluctuation in demand. Therefore, the energy sector in Egypt especially electricity is in a bad need for introducing new pricing system and accounting reforms, which will enable the utility to enjoy a healthier financial situation and better economic performance (Mehta 2005: 6). Accordingly, this research seeks such a solution, especially in the context of electricity efficient pricing in Egypt. In addition it addresses one of the most successful pricing theories; the Peak Load Pricing theory, which will be constructive in this case, as it would decrease the utility costs and increase its efficiency and profit.

The literature on the problem of Peak-Load Pricing has been quite extensive, as for example Hirshleifer (1959), Williamson (1966) and Turvey (1968). Subsequent contributions in the studies of Bailey (1972), Waverman (1975), Webb (1977), Kay (1979), Saving and Vany (1981), Craven (1985), and Kleindorfer and Fernando (1993) have extended the theory to deal with various forms of rationing and with a profit-maximizing framework. Chao (1983) generalized earlier work to encompass both supply as well as demand uncertainty. These theoretical results have found their way into the practice of ratemaking in different public utility sectors, especially in electricity market of USA, UK, India and Canda like Manning, Mitchell and Acton (1979), Slater and Yarrow (1983), Benders (1996), Karki et al. (2005) and Mehta (2005). It is ironical that the Egyptian electricity market, especially its pricing system, has not received any attention from researchers, while on the other hand, the European electricity market has hundreds of theoretical refinements. Thus the aim of this research is to fill the gap found in the literature and to redress the imbalance by presenting the theoretical foundations for analyzing the Egyptian electricity market and the possibility of maximum demand charges.

This is the first research to tackle such a problem in Egyptian electricity market; it is considered a conceptual or dialectical paper as it studies the Egyptian electricity market condition thoroughly from the official market statistics and data available. Into the bargain, reviewing different literature about the theory of Peak Load Pricing, its technicality and advantage along with its potential problem. In an attempt to find answers for questions as: a) What are the characteristics of an efficient price structure? (b) Can Peak Load Pricing be efficient? (c)What obliges producers to impose a single price despite the periodicity of demand? (d) Can Peak Load Pricing be applied successfully for the Egyptian electricity market? Answering these questions is very challenging, since pricing the electricity in

Egypt incorporates many different problematical social, political and economic factors. Additionally, only few researches about electricity market are available.

A wave of reform has been implemented in the Electricity supply industries in both developing and developed countries. In an attempt to reduce electricity costs through enhancing both economic and technical efficiency in developed countries, while in the developing countries the aim was to break the cruel cycle of deprived performance accompanied with low prices, high losses and insufficient electricity supply because of the state ownership for electricity and its political interference. Nevertheless, the main aim of these different electricity reforms in either developed or developing country was to enhance performance, decrease the financial burden on government and maintain a continues and flexible path of electricity sector operation. All these different reform plans have successfully created independent Power Production and competition in generation, in addition to unbundling of integrated utilities into generation, transmission and distribution. Moreover, the operation of an independent transmission system for either wholesale transactions or retail electricity (Karki et al 2005: 72-73).

After reviewing various literature and government statistics, it was quite obvious that the Egyptian electricity holding company has exerted too much effort, in making the electricity market a more competitive one. Hitherto, an efficient pricing system is still not yet implemented, given that, a manifest growth has been recorded in number of electricity customers' in Egypt, who increased from 4.5 million in early eighties to 23.8 million in 2007-2008 (EEUCPRA 2009). Egyptian Electricity holding company actually serves many different customers, such as residential, commercial, industry, agriculture, governmental sector and utilities. The major customer based on their consumption level as well as size is; residential customers, who reach 16,968,095 customers (71.3%), followed by commercial 12, 17,253 customers, and industry 621,103 customers. Although commercial are larger in number than industrial, industrial are still consuming more electricity (EEHC 2008: 39).

Thus, the main focus of this research would be on those three customers as they constitute the largest share in electricity consumption and considered the main cause of peak load problem as illustred in the figure below (4) also because applying the Peak Load Pricing system on those customers in specific, is quite easy and effective, because of their high elasticity of demand. Given that, those customers are charged far below the actual cost, for the first 50 KW consumed, they are charged only 5 piaster provided that, the real cost is more than 19 piaster per kilowatt per hour; this implies that the government is subsidizing the primary category That can't afford paying the real cost with, LE 3.2 billion (Elyan 2008; Osman 2008: 2).These low prices have actually caused a decrease in the net income for both the Egyptian Electricity Authority and Egyptian Electricity Holding Company. Besides, it has led to a severe short term liquidity problem for EEA and EEHC, and encouraged fluctuation in demand.

Accordingly, the financial capability of the utilities is expected to be fatally at risk (Mehta 2005: 6) Since the requirements discussed in previous chapters for applying PLP, can be easily fulfilled by EEHC, it is highly recommended for the EEHC to implement such pricing model. As applying Peak Load Pricing would solve these formerly mentioned problems and it would be technically applicable, if the utility succeeded in obtaining reliable information about load curve changes which is needed for many fundamental reasons. First, adapting certain rating structure as in Peak Load Pricing should be based on measuring economic efficiency gains realized by marginal cost pricing in comparison to the next most efficient pricing, including costs metering and billing with a more detailed price. Given that the current used pricing might not be the next best pricing, calculation for the changes in the load curve by priceperiod is needed. Second, it is essential to predict the level of load after applying the new pricing especially during the peak period, since the application of a peak-load price will alter the rate at which the utility's capacity must be expanded. Lastly, basic change results from the application of Peak Load Pricing in the shape of the load curve will adjust the optimal mix of generating equipment and accordingly have an impact on the calculation of the marginal costs themselves (Manning et al 1979: 131-132). Furthermore, the PLP will successfully achieve its target, if government, could calculate marginal costs in a complex supply system along with, the expected quantitative changes in the sequential pattern of the quantity demanded of electricity -the load curve- after applying new tariff. Even though this economic analysis of marginal costs is considered a standard practice in many European utilities, yet it is immature in America for example.

Nevertheless, getting most of the information required to calculate marginal costs can be easily derived from the investment planning models, whilst cost-minimizing -procedures are now regularly used by utilities. What still remains under research sight are the methodological questions, however by applying the European methods to these data an approximated measure for the short-run marginal costs in addition to foundation for calculating peak-load tariffs could be generated. Unlike the marginal costs analysis, no sufficient data base exists that enables the decision maker to predicate the changes in load curves that will result from adoption of peak-load rate structures (Manning et al 1979: 132). Nevertheless, it is vital to underline the fact that Peak Load Pricing system might not be easily implemented. If utility lack the information for differentiating prices across periods of consumption, or failed to obtain the cost of needed equipment to impose different prices depending on times of consumption because of its high added investment cost. Accordingly, producer might even charge all customers the same price during the whole period given that demand is strongly fluctuating and affecting the quality of service provided(Castell and Tanchuco 2002:1-2).

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