MARKET RESTRUCTURE IMPACT ASSESSMENT

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INTRODUCTION

Egyptian Electricity sector has been functioning under a vertically integrated structure for quite sometime. However, a restructure process to put the sector into a more competitive form has already started. The objective of the introduction of competition into the sector is to bring the sector into a state of self-sufficiency, i.e., the sector should be able to generate enough cash to cover all costs incurred and to support future expansion without the need of external assistance.

The Egyptian Electricity Market is currently arranged in the form of three separate subsectors; generation, transmission, and distribution. Both, the transmission subsector, one company, and the distribution subsector, nine companies, are fully owned by the government. The generation sector is mainly composed of: four government-owned thermal generation companies, a hydro generation company, and three privately owned pay-or-take BOOT projects. The market is arranged in a single-buyer form. The present ownership structure offers limited competition. Therefore, it does not appeal to investors willing to take share in the sector’s activities.

It has been proposed in a prior publication to gradually liberalize the market [1]. This paper is dedicated to the formulation of a methodology to assess the impact of implementation of such measures. The paper is arranged in five further sections. Section II describes the proposed market changes and their objective. Section III introduces the methodology adopted for the perceived market modeling. Section IV is an example for illustration. Section V is conclusions.

PROPOSED MARKET CHANGES

Market restructure is in full swing in many countries with various speeds, [2], [3], and [4]. It is the ultimate goal of the Agency to bring competition to all possible activities of the sector. In fact the Agency’s founding decree calls for a clear subjective mechanism to induce competition among the sector’s competitive activities, viz, generation [5]. This can be interpreted as how can the Agency attract investors to participate in the present market. The Agency has formulated a position that the ultimate goal is to put the electricity sector in the form depicted in Figure 1. Figure 1 shows that the Agency ambitions are to reach an electricity market where electricity is traded freely among producers and consumers with the role of transmission and distribution companies limited to delivering electrical energy from producers to consumers for a regulated fee.

![Proposed Market structure.](image)

It has been the belief of the Agency that this structure cannot be adopted all at once, since, this may bring a market shock that may bring the whole restructure process to a halt. Therefore, the gradual transition will enable the Agency to reach its goals without the risk of ruining the whole restructure process, albeit in a longer time frame. The transition is proposed in three main steps.

(i) Step 1: Energy expansion, additional electric energy requirements to present loads on both HV and EHV are served from the existing power generation plants on the basis of bilateral contracts on a competitive basis. The fact that those additional loads are served by present assets means that the associated cost is minimum, viz., Operation and Maintenance.

(ii) Step 2: Phasing into the free market; new HV and EHV customers are recruited as eligible customers. They have the liberty to enter into bilateral contracts with generation entities. Given an adequate frame of time, present EHV and HV customers are phased out from existing contracts that tie them to the single buyer market and enter into bilateral contracts with generation companies. The role of the transmission company is energy transmission. Transmission fees are determined by the regulator.
(iii) Capacity expansion; generation capacity to operate on a competitive basis can be added at anytime, whether by a government owned entity or by a private party. However, government owned companies have the extra burden of supplying all captive customers. Furthermore, they act as a quasi spot market for balancing the demand by eligible customers.

Figure 2 shows a flowchart that illustrates the sequential events that should eventually lead to the establishment of the promised free electricity market.

Prior to undertaking, the proposed transition, a major question is to obtain an estimate of the market clearing price for energy sold to customers on competitive basis. Providing an answer to this question is crucial to reduce the resistance to implement the proposed procedure.

**METHODOLOGY**

During transition two costing methodologies will be concurrently used; (i) traditional average cost of service, and (ii) long run marginal costing. Traditional average cost of service is used for costing for captive customers. Prices for captive customers are not dynamic. They are changed annually. However, serving captive customers will practically result in a deficit. Without a direct subsidy, this does not put government owned companies on equal footage with other participants who may enter the market. Therefore, this deficit is treated as a stranded cost that is endured by all participants in the competitive market. Furthermore, the gradual phasing of customers into the free market means that those initial customers will have to pay a larger sum to support that higher portion of the stranded costs in the pool.

Charges for promoting distributed generation, energy efficiency, and renewables also constitute a stranded cost to be picked by all market participants.

Assume that over a year period the total electrical energy consumption is $Q$. Assume that the estimate of energy sold on a competitive basis is $q_c$. Furthermore, the estimate of energy sold on a non competitive basis is $q_n$.

The deficit resulting from electrical energy sales to captive customers is

$$D_c = (P_c - C_c) \cdot q_n$$  \hspace{1cm} (1)

Where $P_c$ is generation sale average price to captive customers, and $C_c$ is the generation average cost. Assume that the total funding devoted to support renewables, energy efficiency, etc. is $F_r$.

This extra cost or additional stranded cost per kWh is

$$\text{Extra Stranded Cost} = \frac{(F_r + D_c)}{q_c}$$  \hspace{1cm} (2)

The market clearing price, for the competitive market, is the intersection between the overall supply curve of all generation entities and the demand curve. The supply curve can be obtained by analyzing costs of generation submitted by generation licensees as a license requirement. The supply curve for the competitive market is modulated by the captive market since it subsides captive customers.

![Figure 2 Proposed transition steps to transform the Egyptian market into a more competitive form](image-url)
assumed for both demand and supply curves, Figure 3. The price obtained is an estimate or a price signal of the electricity prices if proposed transition in Section II are implemented. Furthermore, all variables mentioned are deterministic except for the energy sold to captive customers, which is assumed as a stochastic variables that follows a normal distribution. Moreover, the uncertainty in the demand curve is ignored. It is assumed that contracts are annually reviewed, which is a fair assumption for this type of contracts. The objective is to obtain the market clearing price that will result in the market reaching equilibrium.

EXAMPLE

Consider that the energy traded in an electricity market on a non competitive basis is 7000 MWh. Assume that 2200 MWH are sold and consumed on competitive basis. The average cost of electric energy is 0.11 L.E./kWh. Assume that the average sale price to captive customers is 0.09 L.E./kWh. The renewables and energy efficiency fund is equal to zero.

For the competitive market, demand and supply curve are illustrated in Figure 3. For the supply curve, assume that doubling the price will bring the competitive consumption to zero. Furthermore, assume that the start point of 2200 MWh and 0.09 L.E./kWh lies on the demand curve. For simplicity, assume that fixed costs are equal to zero. This is the case in Step 1, where no assets are added, but energy efficiency measures are used to suffice the consumption of large customers.

It is assumed that contracts are annually reviewed. The forecasted value of the captive consumptions is assumed to be that of the previous year with a normalized standard deviation of 0.05. All estimated figures are the mean of the output.

For this example the electricity market will reach equilibrium in four years. Market clearing price mean is estimated to be 0.112 L.E./kWh. Consumption is estimated to drop to 1.022 MWh. If a more realistic value is assumed, where the forecasted captive consumption is 1.05 times the present one, market clearing price is estimated to be 0.106 L.E./kWh. However, competitive consumption is estimated to drop to 1.043 MWh. The price is less than the average generation cost for captive customers.

If a fixed cost of 70,000 L.E. is levied to fund renewables or to support other fixed costs, the equilibrium price is about 0.17 L.E./kWh the consumption will drop to 924 MWh. t must be stressed that the drop in the consumed energy is considerable in all mentioned cases. This is not desirable effect. However, actual loads may not show the same degree of elasticity.

Definitely the aforementioned example gives a conservative estimate, since the supply and demand curves are assumed linear. However, still further refinements are needed to further enhance the estimate produced by this kernel. Still, a realistic demand and supply curves need to be identified. Further factors still need to be considered, e.g., hydro-generation, emissions, critical customers, etc.

CONCLUSIONS

This paper has presented an effort to estimate the impact of transforming a market that enjoys a limited amount of competition into a more liberalized form. The basic concept has been introduced. It depends on treating deficits resulting from supplying under privileged as a stranded cost that is carried by all competitive market participants. A basic numerical example has been discussed. Still further work needs to be done to build on this kernel. This includes identifying accurate estimates of both demand and supply curves.

REFERENCES


