Proceedings of the Eighth IASTED International Conference
POWER AND ENERGY SYSTEMS
October 24-26, 2005, Marina del Rey, CA, USA

PROPOSED ELECTRICITY TARIFF PRICING FOR NEWLY DEREGULATED TRANSMISSION SYSTEM IN SAUDI ARABIA

Musaab M. Almulla
Saudi Aramco
P.O. Box 9420
Dhahran, 31311
Saudi Arabia
Email: musaab.mulla@aramco.com

Mohammed H. Shwehdi
Electrical Engineering Department
King Fahd University of Petroleum & Minerals
P.O. Box 81
Dhahran, 31261
Email: mshwehdi@kfupm.edu.sa

ABSTRACT

One of the most important functions of transmission systems is to provide electrical energy with an acceptable power quality. From the early 1990's, the North America and other countries have had the trend of deregulated services. Deregulation in Saudi Arabia has started only 1998. The aim of this paper is to study the electric power industry restructuring and deregulation in terms of electricity tariff and prices. This is done by adopting the main principles associated with electricity deregulation considered in the well-known markets in some countries. The paper proposes a new formulation for the industrial electricity tariff in Saudi Arabia considering the local partial implementation of the market liberalization and based on experiences in other countries.

KEY WORDS: Saudi Arabia transmission tariff deregulation

1. INTRODUCTION

The electric power industry throughout the world is undergoing considerable changes with regards to structure, operation and regulation. The traditional vertical integrated utility structure comprising of generation, transmission and distribution entities has been dismantled and, instead, distinct generation, transmission, and distribution companies have been established to perform a unique function in the overall electricity supply task. The power supply service is therefore unbundled and as a result, the overall responsibility of servicing customer needs, no longer resides in a single electric utility, as was the case in the vertical integrated utility structure. The structural, operational and regulation changes of the electric power industry are expected to initiate competition between the utilities. This competition will translate into reduction in the cost of electricity if the market is well structured.

In a liberalized market, electricity is provided by many suppliers, who are in competition with each other and the customers have the opportunity to buy electricity from the supplier of their preference at competitive price. The prerequisite to create competition on the market is unbundling of the electricity business sectors: generation, transmission and distribution.

2. ELECTRICITY DEREGULATED MARKET PRINCIPLES

Generally, deregulated monopolized utilities have either to be split into three independent companies or at least to keep separate and transparent account for each of these three business sectors.

Such split in market is primarily competitive on the generation level as there are many suppliers. In the transmission and distribution level, however, competition is practically not possible as the owner of the grid and distribution system have still the monopoly in the respective supplier area. A second prerequisite for liberalization is therefore that the grid operator is independent and obliged to provide free and non-discriminatory access of all generators and power suppliers such as Independent Power Producers (IPP's) and industrial facilities dispersed generators to the transmission system against a wheeling fee. Non-discriminatory access means that the transmission system operator shall not prefer any generator such as the generators of the own company. In other words, all suppliers have to be treated equally. [1]

The above main principle shall be enforced and monitored by the Electric Service Regulatory Authority that has to be established in such markets. The main duties of this authority include:

(1) Ensuring non-discrimination free access of all suppliers to the grid.
(2) Supervising a fair costing and pricing of electricity tariffs.
(3) Ensuring that investments in the grid are in line with the state-of-the-art and necessary for the security of supply and proper operation of the system.
(4) Arbitrate disputes between system operator and suppliers.

Such duties of the regulator shall be defined in the energy laws of the country.

In a liberalized electricity market, the relationship between the power suppliers and the customers is governed by one of the following models:

(1) The model of "Negotiated Third Party Access NTPA"
(2) The "Single Buyer" or regulated third party access model

In the NTPA model as shown in Figure (1), consumers can buy electricity from any generator or trader of electricity or even from the electricity bourse. Large consumers have usually two agreements, one electricity supply agreement with a generator and the second with the transmission grid operator for the wheeling of the power through the grid. Grid operators are obliged to publish their wheeling fees, usually twice a year.

Consumers may also have an "all inclusive agreement" with a trader of electricity, which buys electricity from generation companies or from the electricity bourse for a large number of consumers and also negotiates wheeling agreements on behalf of his clients. The client may have in this case only one contract with the trader and pays one bill for the full supply. In Europe, there are currently several electricity bourses (in Leipzig and in Frankfurt (Germany), in Zurich (Switzerland) and in Amsterdam (Netherlands) where electricity is traded in similar transactions as with stocks.

On the other hand, in the Single Buyer model as shown in Figure (2), the single buyer, who is usually also the grid operator, takes off the power from all the electricity producers according to the demand in the grid upon a merit order.

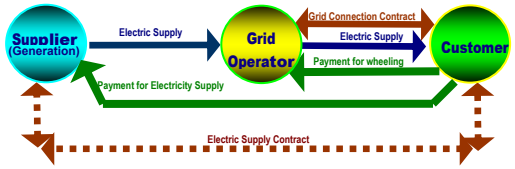

Figure (1) Negotiated third party access model

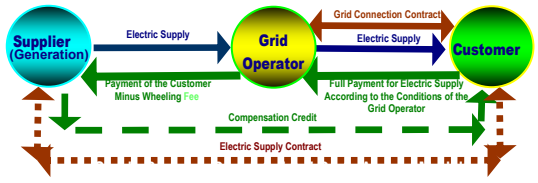

Figure (2) Single buyer model

The customers have to buy their electricity from the Single Buyer according to his conditions with an "all inclusive agreement" and they also pay the bill to him.

3. SAUDI ARABIA TRANSMISSION TARIFF PRICING PROPOSAL

3.1 BACKGROUND

In 1998, several strategic actions were taken by the Saudi Arabia government to restructure Saudi Arabia electricity industry and transform it to a liberalized and competitive-based industry.

Currently, there is no final decision, which deregulated market model will be applied in Saudi Arabia; however, the Single Buyer model is most likely the one that will be utilized. In this case, the industrial firm will have to buy their power from the grid operator and pay the bill also to him. In future, they will even have the opportunity to negotiate power supply contracts with different generators as soon as the liberalization process proceeds.

Also, the method of tariff formulation adopted in this proposal is the "embedded cost method". This is the most practical approach for a liberalized market. In liberalized markets, purchase of power is practiced on short terms basis (e.g. for the day or week ahead) and also the validity period of power purchase agreements is short (one to three years) and tariffs should therefore reflect the cost structures of the current system and not those of the long term structures.

3.2 CRITERIA FOR TARIFF FORMULATION

In formulating a new electricity tariffs for all modes of operations, the following criteria shall be employed:

- *Separate tariff for generation and transmission (wheeling):* This is necessary to ensure alignment with the new structure of the electric sector of separate transmission and generation organizations, appropriate cost allocation of the service segment and to allow energy conservation incentive for the consumer inherent to the proposed tariff structure.

- *Cost allocation according to the consumers' relative cost responsibility*: The tariff model shall be designed to reflect the impact of the consumers' load to the supplier cost for both transmission and generation. If the industrial facility is predominately a constant base load, then the utility company supplies most of that load through its base generation plants. Therefore, the tariff formulation was influenced accordingly.

- *Cost recovery and adequate profit for the utility:* The tariff shall be designed to achieve 100% cost recovery of the service rendered by the utility with a reasonable net profit margin of about 5% on turn-over.

- *Provision of incentives for energy savings*: The tariff shall be designed to be sensitive to the load factor of the consuming plants; efficient plant operation reduces tariff. Thus the plant's purchased power cost by managing and controlling demand peaks.

- *Simple & easy to apply*: To avoid complexity and ensure verification of consumption, the easiest approach and most commonly practiced in the industry was selected. (Generation & transmission tariff with two elements; capacity and energy rate).

3.3 TARIFF FORMULATION

In satisfying above set criteria for the various modes of operations, the developed tariff shall be structured to reflect the cost of transmission and generation relative load characteristic separately. The proposed tariff structure includes therefore the following elements: The Generation Tariff consist of two price components; the capacity rate and the energy rate. The capacity rate is to recover the associated fixed costs, the energy rate the associated variable costs of generation respectively. The c*apacity rate* in SR/KW per year is for the maximum power demand of a facility during a specified and agreed upon billing period. It is intended to recover the fixed cost investment in generation capacity to meet the power demand of the peak. This is formulated for 100% recovery of the fixed cost as capital investment, the O&M, labor cost and others such as loan interests and deportation, regardless of the energy produced. The *energy rate* in SR/MWh is to recover the cost of energy produced through its associated variable cost of fuel and other consumables. For the economical operation of a pool of power plants, limited generation units are run to meet the minimum required load demand with allowance for spinning reserve and standby capacity. Typically, the generating units with the highest efficiency and lowest O&M cost are operated by the utility company to supply the constant load over the year. This is defined as base generation for constant load scenario. Other generating units with lower efficiency and higher O&M cost are only operated to meet changes in power demand including load peak. This is refereed to as peak generation for supply of varying load. Because of the difference in the operation cost between peak and base scenarios, two separate tariffs are introduced.

- The Peak Generation Tariff and
- The Base Generation tariff

TRANSMISSION TARIFF: The tariff shall be structured to recover the costs of transmission services, which are mainly fixed costs as cost of capital investment of the lines and transformers, O&M cost, labor cost, spinning reserve cost, cost for line losses and other expenses. The cost allocation to the various consumers is based on their consumption share relative to the total consumption of the grid. Hereby, cost of upper voltage levels are partly allocated to the consumers of the same voltage level and partly rolled over to the consumers of the lower voltage levels based on the respective consumption. As the cost at each voltage level is different also different rates were developed for each of the transmission grids (e.g. 230, 115 and 69 kV).

3.4 TRANSMISSION (WHEELING) TARIFF STRUCTURE

The transmission tariff model adopted in this proposal is the "point-to-point method". The *point-to-point method*, which is also often called postage stamp model, is the simplest, most transparent and most common method. It is applied in all the countries of the European Union and in most of liberalized markets in the world. [2-3]

Basis of the transmission (wheeling) tariff calculation, independently of the model used, is the allocation of the annual costs of the grid for the consumers of the different voltage levels according to their cost responsibility. Thus the costs of higher voltage levels are rolled over to the users of the lower voltage levels based on the power demand. Figure (3) shows the scheme of the cost allocation at the different voltage levels in the case of 230, 115, and 69 kV grid systems.

The consumers at one voltage level (e.g. 115 kV) share the costs for the grid at their voltage level and for the transformers from the higher voltage level with customers of lower levels (e.g. 69 kV). They also share the costs of the grid above.

This is done casually and proportionally to the consumption at the different voltage levels. The key for the cost allocation to the different voltage levels of the grid is actually based on the contribution of the individual consumer or group of consumers to the annual peak demand of the grid.

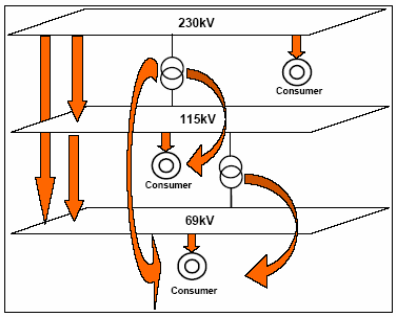

Figure (3) Scheme of the costs at the different voltage levels

3.5 COST OF REACTIVE POWER

Reactive power in reality does not useful work but it is indeed an inseparable part of the power system. Reactive power plays a major role in maintaining system

voltages thereby accounting for the security of the power system. It is therefore important to estimate the cost of reactive power. The cost associated with reactive power consists of fixed cost and variable reactive power cost. Theoretically, the equipment cost items that shall be considered additionally are the reactive power compensators such as Static Var Compensator (SVC). [4-5] [6-7]

According to common international practice in the utility business, reactive power up to a certain amount referred to the active power, or up to the corresponding cos (φ) factor is free of charge. It is, however, different from utility to utility. The amounts of reactive power as percentage of the active power and the corresponding cos (φ) factors which have been found in several agreement are stated below:

1) 75 percent corresponding to a cos (φ) = 0.80
2) 60 percent corresponding to a cos (φ) = 0.85
3) 50 percent corresponding to a cos (φ) = 0.90

Reactive power consumption per month exceeding the fixed amount is charged with a rate usually between 10% and 20% of the energy rate for normal supply. The appropriate cos (φ) is to be fixed by the grid operator/regulator considering the above additional cost items.

4. CONCLUSION

Several pricing paradigms and methodologies were discussed in this paper. These provide the equitable rates and coherent the economic motivations for the service providers to finance the expansion over time. It should be realized that not only the engineering aspects have to be considered but the market and political aspects also. The political and market can have influences on determining the transmission prices. The good pricing should achieve the equity and efficient in utilizations of the existing sources and distribute transmission expansion costs in some reasonable ways. Accordingly, and based on pre- determined principles highlighted in this paper, a transmission pricing proposal for the new partially deregulated market in Saudi Arabia is provided in this paper. If implemented, this hopefully will motivate the movement toward a full deregulated electricity market and encourage investment in this business sector.

REFERENCES

[1] B. Cory, "Charging for Transmission Services", IEE Colloquium on Optimal Power Flow, May 13, 1997, pp.6/1-6/6.

[2] D. Shirmohammadi, X. V. Filho, B. Gorenstin, M. V.P. Pereria, "Some Fundamental Technical Conepts about Cost Based Transmission Pricing", IEEE Transactions on Power Systems, V. 11, No.2, May 1996, pp. 1002-1008.

[3] C.W. Yu, A.K. David, "Integrated Approach to Transmission Services Pricing", IEE Proceeding on Generation Transmission and Distribution, v. 146, No. 3, May 1999, pp. 255-260.

[4] J. A. Momoh, and J. Zhu, "A New Approach to VAR Pricing and Control in the Competitive Environment," Proceedings of the Thirty First Hawaii International Conference on System Sciences, Vol. 3, 1998, pp. 104-111.

[5] F. Alvardo, R. Broehm, L. D. Kirsch, and A. Panvini, "Retail Pricing of Reactive Power Service," EPRI Conference on Innovative Approaches to Electricity Pricing, March 27-29, 1996.

[6] J. W. Lamont, and J. Fu, "Cost Analysis of Reactive Power Support," IEEE Transactions on Power Systems, Vol. 14, No. 3, August 1999, pp. 890-898.

[7] V. Leonardo Paucar, "Reactive Power Pricing in Deregulated Electrical Markets Using a Methodology Based on the Theory of Marginal Cost", IEEE Transactions on Power Systems, v.6, No. 4, November 2001, pp. 1546-1560.