MARGINAL GENERATION AND TRANSMISSION COST FOR TARIFFICATION

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In Studies And Research Department

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Submitted For The Partial Fulfillment Of The Requirements Of The Degree Of Master Of Science In Electrical Engineering

Faculty Of Engineering

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Cairo 1986

ACKNOWLEDGEMENT

It is through " Allah " grace that the present investigation of Marginal Generation and Transmission cost For Tariffication In Egypt was fulfilled. It was carried out by the author with the help of many persons to whom the author is thankful.

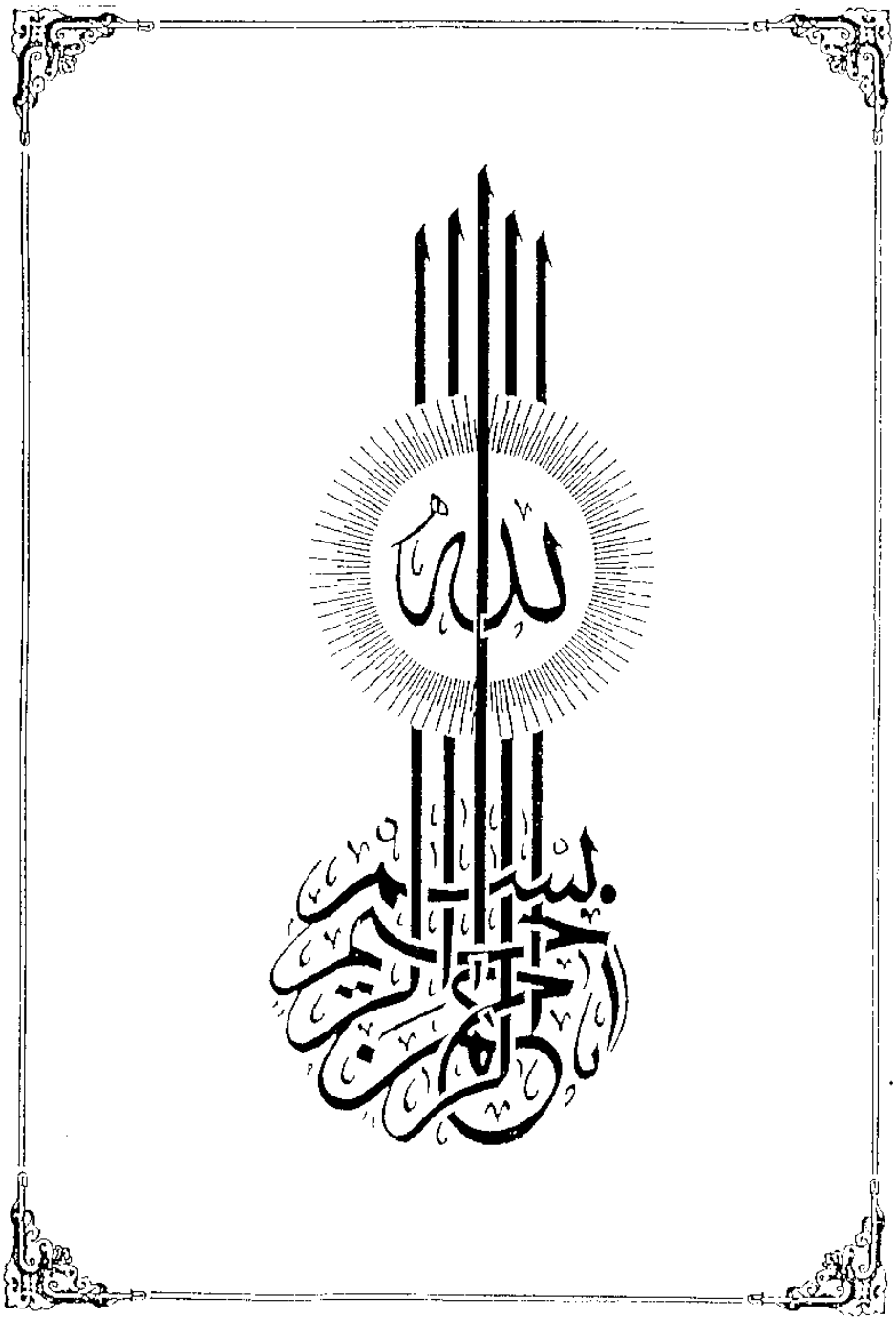
The author is deeply thankful to professor Dr. S. El-Debeiky, Professor in Electrical power and high voltage Engineering, Ain Shams University, for his kind supervision, valuable guidance and continuous encouragement.

The author expresses his gratitude to Dr. M. Abd-El-Aal and Dr. M. El-Gazzar, for their valuable advice, useful discussions and for every good help.

The author is thankful to professor Dr. E.A. Mansour and Dr. M. Tawfik for suggesting and planning for the present investigation.

The author is deeply thankful to Dr. F.F. Faragallah and Dr. E. El-Sharkawy for their keen interest and for every facility provided to the author.

Thanks are also due to the staff of the studies and research department for their continuous support.



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SUMMARY

OF THE M.Sc. THESIS

"MARGINAL GENERATION AND TRANSMISSION COST FOR TARIFFICATION"

BY

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The high rate of increase in the demand on electrical power in the last years in Egypt had its great effects on the expansion plans of power generation and transmission to cover the electrical loads needed for the social and economic development of the country.

The growth of electrical energy during such development periods is evident. But if this growth continued without control on the consumer's demand, on one side, and the available power on the other side, a deficit in the electrical production capacities of the electricity sector will be expected. This will lead to a great danger on the national economy since all the different production sectors in the country depend on the use of electricity.

This problem can be outlined by two main aspects, first, the higher rate of increase of electricity consumption than the national income, this means that the electricity use in consumption purposes is greatly higher than in production purposes, second, the increase in the gap between the peak load and the average load in Egypt reaching 1450 MW in 1984. This means that 1450 MW additional peaking units are added to the system to cover a period not more than five hours per day.

By studying the electricity tariff structures applied in Egypt in the past and at present, it was found that it enhances to a large extent the above mentioned problem since all those tariffs were based on the average cost pricing which could not reflect the correct cost signals of electrical energy, because of its almost flat structure. This called for the present

investigation towards imporvement and reevaluation of the existing tariff structure of electrical energy, to set up the most economic pricing system based on long run marginal cost which reflects the correct cost signal of electrical energy at the times of day and seasons. Thus, it will limit the waste in energy consumption, enable the electricity sector to fulfill its requirements, decrease the gap between peak and average load and will lead to the efficient use of the available generation capacities and economic scarce resources of the country, all with a reasonable burden and participation of the consumer.

This thesis, thus, comprises in the introduction a briefing of the importance of long-run marginal cost of generation and transmission of electricity in Egypt and its calculation on actual bases to be used in the determination of real economic cost of electrical energy, that reflects the efficient allocation of national economic scarce resources. This economic costing can enable the electricity sector to overcome the problems that are resulting now from the insufficient financial resources which may lead to a great deficiency in fulfilling the sector requirements, as well as using efficiently the available generation and transmission capacities.

The thesis comprises six chapters after the introduction. The First chapter presents a review of the literature related to the present work and the definitions of the related terms agreed by the electricity utilities allover the world. It also includes electricity tariff principles, types of electricity tariffs, types of electricity rate structures, types of electricity pricing, basic marginal cost theory and methods of calculating marginal cost.

The second chapter presents the electricity pricing in Egypt in the past and at present. It includes an analysis of those different tariff structures and the affecting factors.

The third chapter presents an investigation of the marginal production and transmission costs for optimal tariff structure in Egypt. It includes principles of long-run marginal cost investigation for tariff structuring, analysis of long-run marginal generation cost in power systems, marginal generation

cost in different types of generation systems, principles of calculation of marginal fuel and marginal capacity costs. Analysis and principles of calculation of long-run marginal transmission cost are also included.

The fourth chapter presents the calculation of long-run marginal cost in the Egyptian Power Network. It includes an investigation of the factors involved in this process, an explanation of the planning program WASP used for calculating optimum investment plan in Egyptian Power Network, details of the present investigated computer program which was used to calculate the expected long-run marginal fuel cost and the allocation factor of the long-run marginal capacity cost.

The fifth chapter presents the results of calculations concerning long-run marginal fuel cost with both subsidized and international prices of fuel. It includes an investigated formula for marginal fuel cost as a function of fuel prices, calculations of marginal capacity cost of generation and transmission. The obtained results are also discussed in this chapter.

The sixth chapter presents the main conclusions and recommendations that are of prime importance.

The present investigation concluded that as the load is growing, without system management or load management, the load factor is decreasing and the gap between the average load and the peak load is increasing.

Since the hydro generation in Egypt is limited and the other system management methods as pumped storage or renewable energy are limited too, it is urgent to apply load management using the time of day tariff structure.

As electricity cannot be stored in large commercial quantities, it must, therefore, be produced at the moment when it is demanded. Hence the electricity sector does not, in fact, supply a single commodity, but as many commodities per year. Accordingly in Egypt one kWh supplied at one of the periods of the day is different than that supplied at any other period. The difference of course, are found in the cost of

production and supply.

Charging customers prespecified prices which do reflect the actual costs encourage them to adapt their usage to times of low utility cost and to contribute to the higher costs only when they are obliged.

It is shown that long run marginal cost pricing is the concept that brings time varying cost of providing electricity into the price of electrical energy. The marginal cost pricing encourages the most efficient use of scarce resources as well as fulfilling the other main principles of electricity tariffs such as fairness between customers, contribution to load management and raising sufficient revenues to meet the Electricity Sector's financial obligations.

The great progress in the metering systems and the introduction of quartz time switches which does not depend in its operation on the system power as a feeding source, encourages the urgent application of time of day long run marginal cost tariff structure.

INTRODUCTION

Problem Definition:

The availability of electricity plays a major role in economic development as it is frequently a precursor for industrial development. Since electricity is a form of energy having the advantages of being clean and easy to be transferred and converted to other forms of energy, its consumption rapidly increased in Egypt with a higher rate than the other forms of energy.

However electricity has several disadvantages, such as low production efficiency,high capital cost needed for production and the main disadvantage of being demanded in a cyclical fashion and is to a large extent unstorable. Consequently, daytime and nightime electricity are best thought of as separate products with joint or common costs although the same machines may be used to produce electricity in the day and at night.

When two products with different costs of production are priced at the same price, there is a tendency for too little to be consumed of the overpriced product while too much is consumed of the under priced product. However, in the case of electricity in Egypt, the cost of expanding the system to meet peak demands have been far greater than the price charged. Consumers have been receiving the wrong signal. They make decisions based on a price of peak electricity which is too low, causing then to increase their consumption beyond the point where the costs of resources and the value of output of additional consumption are in balance. At the same time, daytime electricity is relatively inexpensive to provide, but by wrong signalling that it is more expensive, the price discourages people from using it.

This may be ascribed to the fact that the applied tariff in Egypt in the past and at present has been based on historical average cost, it does not reflect the time differentiation cost and it did not even cover the costs of expanding the system to meet peak demand. Hence it did not

enable the electricity sector to fulfill his obligations towards consumers as it led to the unefficient use of the available production capacities, meanwhile the electricity sector development is inhibited by the lack of other financial resources.

Objectives of The Present Investigation:

It is urgent that the electricity sector has to take the positive measures to affect both the demand and production sides, by using an economic electricity pricing which is the backbone of load management.

The electricity price have two sides, level and structure. The level of the electricity price has to reflect the economic cost of production, transmission and distribution either on the micro or the macro economic level, in order to gaurantee the efficient allocation of scarce resources of Egypt. One of the main resources is the fuel exports which decrease with the increase in electricity consumption. This economic level of price also can enable the electricity sector to cover his financial requirements, and hence be able to fulfill his obligations.

The structure of the electricity price have to reflect the time-of-day cost of production transmission and distribution. The consumer then may welcome this structure because it offers a lower price for off-peak electricity as a way out of ever-increasing electric bills, meanwhile; the electricity sector management sees it as a way to reduce the uneconomic growth of the peak.

It is the application of long-run marginal cost principles to electricity production which leads to proposals for time-of-day rates and seasonal variations.

Therefore, the present investigation aims to set up the most economic cost of production and transmission for tariffication. This will enable the electricity sector to efficiently use the available generating capacities and to overcome development difficulties as well as providing the