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An annual framework for clustering-based pricing for an electricity retailer

N. Mahmoudi-Kohan [1], M. Parsa Moghaddam *, M.K. Sheikh-El-Eslami [2]

Tarbiat Modares University, Tehran, Iran

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ABSTRACT

In the competitive environment, it is necessary for a retailer to increase his/her profit as much as possible. There are few researches focused on the subjects related to the retailer and the retail market. In addition, those researches have mostly focused on the participation of the retailer in the wholesale market. In order to determine the optimal selling price, the knowledge of how and when consumers use electricity is essential to the retailer. This type of information can be found in load profiles of customers. In this paper, an annual framework for optimal price offering by a retailer is proposed which is based on clustering technique. For this purpose, load profiles of customers are used as their consumption patterns. Also, a profit function is defined as the objective of optimization problem based on the load profile considering conditional value at risk (CVaR) for risk modeling. Also, a new acceptance function is proposed to overcome drawbacks of the traditional ones. The objective function is a mixed-integer nonlinear problem which is solved by GAMS software.

1. Introduction

Over the past few years, the electric power industry has undergone significant changes due to restructuring and deregulation. The aim is to replace the previous monolithic regulated public utilities, with competitive power markets [1]. One of the results of this new marketplace is the emergence of third-party entities known as retailers or marketers. These entities purchase power from suppliers and resell to the end-user customers [2]. Therefore, the retailer must set up contracts both with the wholesale side and with the customers [1]. Consequently, retailers face with the problem of setting up contracts on both the supplier and end-user sides in such a way as to protect them from settlement risk [2].

Although many investigations have focused on the setting up contracts on the supply side such as [1,3,4], few references are found focusing on the determination of the optimal selling price for customers. In these researches, usually a single price is determined for selling electricity to all customers [1,3,4]. However, offering customers a variety of pricing options is an essential component of competitive markets and the key to improve customer well-being. For this purpose, it is necessary for the retailer to know how and when customers use electricity. This kind of knowledge can be found in historical data of the customers collected in load research projects developed in many countries. One of the most important tools defined in these projects is determining different customer classes represented by their load profiles [5]. Load profiling is known as a useful tool in the retail power market where small customers do not have the appropriate metering equipment. Information about the load profiles of customers can help retailer to improve his/her market strategies and develop new pricing strategies [6]. Since the purchasing and installation of new meters would lead to dramatically increasing of the costs, a method of load profile-based payment must be established [6]. Traditionally, utilities use some non-electric indicators such as the type of activity or commercial codes for developing electricity prices. In the liberalized electricity markets, sellers may formulate their own characterizations of customers by defining customer classes on the basis of the electrical behavior of customers [7]. One of the suitable tools widely used in power system studies and load profiling is the pattern-based clustering technique. Specially, in competitive electricity market, this technique has been widely used in load clustering for designing suitable tariffs and other applications.

In this paper, an innovative method for optimal price offering by the retailer is proposed which is based on clustering load curves technique. In this regard, an annual framework is developed. For this purpose, load profiles of customers are clustered in optimum number of classes (*ONC*) and then, the optimal price in different periods of the framework is offered for each customer class. Also, a new acceptance function is proposed to overcome the drawbacks of previous ones. The proposed model has been developed as a mixed-integer nonlinear problem which can be solved by GAMS software.

The rest of the paper is organized as follows. In Section 2, a literature review is provided and is followed by the statement of

* Corresponding author. Tel.: +98 21 82883369; fax: +98 21 82883369.
E-mail addresses: nadalimk@yahoo.com (N. Mahmoudi-Kohan), parsa@modares.ac.ir (M.P. Moghaddam), aleslam@modares.ac.ir (M.K. Sheikh-El-Eslami).
[1] Tel.: +98 21 82884334; fax: +98 21 82884334.
[2] Tel.: +98 21 88004556; fax: +98 21 88004556.

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