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A demand response based solution for LMP management in power markets

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ABSTRACT

In recent years, most of the countries around the world have gone through the power system restructuring process. Along with this restructuring in power market there are some issues like LMP problems that need to be solved base on demand response. In this article, demand-side management (DSM) programs have been effective to address LMPs in the market and system operators experience throughout their day-to-day activities. In particularly, these programs can help independent system operator (ISO) to reduce price volatility during peak demand hours. For achieving this purpose, a multi-objective optimal power flow is proposed to study the impact of a model for a demand response program on price spikes. Actually a new framework using demand response program was presented for price spikes reduction. As a case study for the formulation, the IEEE 9-bus, load curve of Mid-Atlantic region of the New York network is used to compare local prices in the system with and without emergency demand response program (EDRP). The study results demonstrate the effectiveness of these programs in an electricity market and showing them as appropriate tools in managing the LMPs of the power market more efficiently.

1. Introduction

RESTRUCTURING and privatization of assets, when managed properly in conformance with sound socioeconomic principles pertaining to specific cultures across the globe, could lead to better services, technological improvements, improved reliability, and the reduction in customer costs [1]. Independent system operator in restructured power system tries to control reliability and security of the system while maximizing social welfare. To have reliable grid not only having enough generation reserve in system can help the system, but also having demand response on the other hand can lead to controlling LMPs.

Consequently, in addition to supply offers, participation of customers in electricity market increase the competitiveness overall. In response to price volatility, customers would normally modify their demand, which results in smaller price spikes, i.e. some customers can response to price spikes and hence shift their demand to cheaper hours [2].

Demand Response (DR) is defined as the changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time. DR is divided into two basic groups and several subgroups:

A: Incentive-based programs:

(A-1) Direct load control.
(A-2) Interruptible/curtail able service.
(A-3) Demand bidding/buy back.
(A-4) Emergency demand response program (EDRP).
(A-5) Capacity market program.
(A-6) Ancillary service markets.

B: Time-based programs:

(B-1) Time-of-use program.
(B-2) Real time pricing program.
(B-3) Critical peak pricing program.

The benefits of DR include increased static and dynamic efficiency, better capacity utilization, pricing patterns that better reflect actual costs, reduction of price spikes, decentralized mitigation of market power, and improved risk management [3,4]. EDRP is a DR program that provides incentives for customers to reduce loads during power system emergency states; however the curtailment is voluntary and no penalty applies if customers choose not to curtail, also the rates are fixed pre-specified and no capacity payments are paid [5]. Some of the EDRP currently used in electricity markets can be found with details in [6]. Bulk power system operators primarily rely on adjustments in generator's MW output to maintain system reliability [7]. In principle, changes in

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