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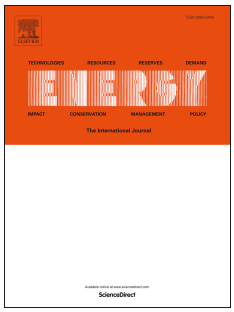

A Real-Time Demand Response Market through a Repeated Incomplete-Information Game

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A Real-Time Demand Response Market through a Repeated Incomplete-Information Game

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Abstract

Demand Response (DR) programs have been developed to help traditional power market to meet demand specially with increasing penetrations of renewable energies. This paper focuses on application of a game-theoretic framework to model competition between demand response aggregators to sell aggregated energy stored in storage devices directly to other aggregators in a market. This proposed market is cleared in each time interval of a day using a repeated game-theoretic framework. After finding optimal bidding strategies of the aggregators in each time interval, Dynamic Economic Dispatch (DED) is performed to update the dispatch of generators based on updated demand. Dynamic pricing has been considered in the proposed market framework in two forms: Real-Time Pricing (RTP) in each time interval of a day with updating demand and supply and Time-of-Use (TOU) with demand price-based scheduling through dynamic programing. The proposed method minimizes the fuel consumption and operation costs and optimally schedules the generation in grid's supply side. It also presents optimal prices during different periods simultaneously. Customers in light of the utility's optimal price minimize theirs electricity costs and optimally schedule their power consumption in order to participate in the DR market. The presented model is applied to IEEE 24-bus model.

Index Terms: **Demand Response (DR), incomplete-information game (*i*-game), Demand response scheduling, Dynamic pricing, Dynamic Economic Dispatch (DED)**

1. Introduction

Development and implementation of smart grid technologies offers advantages over traditional electric utilities. Both parties (generation side and consumers) stand to benefit from proliferation of these technologies [1, 2]. Many achievements have been developed in demand side of power grids which allow demand resources to participate in the power market for providing different services [3]. The main advantage of this market is to use the available energy resources more efficiently without installing new generation and transmission infrastructure especially in the grid with higher penetration levels of intermittent renewable energy resources [4]. End-users of electricity primarily wish to minimize the bill they pay to the utility for the energy they require to power their devices [5, 6]. Opposed to this, the utility company tries to maximize its own profit and is concerned with load scheduling as they must remain able to provide adequate supply. In this paper, a repeated game-theoretic market model has been developed which Demand Response Aggregators (DRAs) compete with each other to sell aggregated energy stored in storage devices. The proposed model finds the optimal bidding decision for each aggregator to maximize its own payoff in an incomplete-information game (*i*-game). In every time interval of a day, after finding the best bidding decision and Nash equilibrium of strategies through the game, a Dynamic Economic Dispatch (DED) is performed to update the Locational Marginal Price (LMP) based on the updated demand and updated generation supply. Two types of non-cooperative games have been considered in this paper: one is an unregulated game without limitation in transaction powers and price, and the other one is a Stackelberg game with a leader to control the transaction powers and price.

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