



## Robust performance of photovoltaic/wind/grid based large electricity consumer



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### ABSTRACT

In this paper, a new optimization framework has been developed for optimal operation of large industrial consumer under time-of-use rate (TOU) of demand response program (DRP) considering pool market price uncertainty. In order to model mentioned uncertainty, interval optimization method has been implemented. Based on this approach, a bi-objective optimization problem with average and deviation costs as objective functions is generated to be minimized instead of a single objective function. So, the bi-objective problem is solved using weighted sum and fuzzy satisfying algorithms. In addition to mentioned algorithms, large consumer able to use TOU of DRP to be capable of shifting its demand from expensive intervals to off-peak intervals which can lead to reduce operating cost of large consumer. A sample model is simulated under GAMS optimization software within uncertainty of pool market price through mentioned algorithms and the results obtained from simulations revealed that in the case DRP is ignored by increasing average cost up to 4.32%, large consumer deviation cost representing uncertain of pool price has been reduced down to 87.22%. Moreover, in the case TOU is employed large consumer has paid 4.21% more to reduce uncertainty effect up to 85.43%.

### 1. Introduction

Energy, an essential issue around which a lot of concerns have been made is now being paid much more attention than before due to lack of energy resources. One of industries within which energy efficiency is important is power system industry in which energy consumers with different load levels are involved. Penetration of renewable energy resources like wind generation (WT) (Krauter, 2018) and photovoltaic system (PV) (Nojavan et al., 2017) can help large energy consumers to meet their energy demand in various scales. In addition to mentioned resources, other options like bilateral contracts (Rezaei-pour and Zahedi, 2017), pool market (Fathabadi, 2017) and energy storage systems (Najafi-Ghalelou et al., 2018) are available for large consumer to sever energy demand.

The papers published about large energy consumers have been evaluated from different viewpoints in the following: pool market as one of energy resources has been available for large consumer to meet its energy demand through the purchased power from this market (Kirschen, 2003). Load management tools can help large energy consumers optimally meet its energy demand. The way these options can be effective on the economic performance of such consumers is studied in (Albadi and El-Saadany, 2008). In order to enhance and improve performance of large energy consumer in energy market, optimal bidding strategies and options has been available for large energy

consumer in (Zare et al., 2010; Zare et al., 2010). Taking price elasticity and consumer benefit into account, demand response options have been available and molded for large energy consumer in (Aalami et al., 2010). Impressive and valuable options related to operation of large energy consumers in the energy market environment have been presented in (Sæle and Grande, 2011). Various types of market pricing are available. So, time-of-use rate of demand response program has been discussed in (Tang et al., 2005). Uncertainty based purchasing energy from energy market with uncertain features is a little bit challenging and this has been discussed in (Liu and Guan, 2003). Moreover, behavior of large energy consumer in the energy market with the mentioned features is discussed in (Daryanian et al., 1989). Large energy consumer participation in energy market subject to technical constraints and uncertainty of load is discussed in (Sharma et al., 2016). On the other hand, large consumer participation in energy market has been investigated without taking mentioned uncertainty into account in (Conejo et al., 2005). Popular algorithm namely mean-variance method has been implemented to control cost of purchasing energy from power market subject to cost-exposure restriction from bilateral contracts and pool market in (Woo et al., 2004). Total operation cost of local distribution system including cost of purchasing power from energy market has been minimized through a theory based algorithm in (Woo et al., 2004). In addition to energy market, tolling agreement has been

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