Supervised Learning based Demand Response Simulator with RTP and PTR in Context of Smart Grid

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Abstract:

Demand Response (DR) program empowers the dynamic prices to actively optimize the consumption. This optimized consumption plays a vital role in resolving the complex operation and reliability issues in the electricity market. The human behaviour aspect of consumers explained by several models that have been reported in the literature. These models depend on the classical utility factor. The effect of price on the consumer's decision in the field of energy efficiency and reduction of consumption based on behavioural characteristics are two important aspects of DR programs. In absence of such characteristics, results become non-viable. In this paper, the footprint of two time-based DR programs is explored on the peak reduction namely; Real Time Pricing (RTP) and Peak Time Rebate (PTR). Artificial Neural Network (ANN) based topologies for two DR programs are proposed. The proposed topologies employ variation in demand and price, subsequently for simulating an online DR simulator. Demand before and after the RTP and PTR were calculated and compared with four ANN based DR topologies namely; Radial Basis Function Neural Network-Demand Response (RBFN-DR), Feedforward Backprop-Demand Response (FFBP-DR), Layer Recurrent–Demand Response (LR-DR), and Generalized Regression-Demand Response (GR-DR). The proposed models are tested on hourly residential data of test smart grid. By assessing the results from test case, depicted that RBFN-DR proved its efficacy by giving better results for both price-based programs namely; RTP and PTR.

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I. Introduction

Dynamic pricing has an enormous fascination on an analytical level. It gives efficient consumption incentive-based demand response and improves overall welfare. It builds up the accord among the market players to get a financial incentive. It needs an effective decision-making technique to solve the complexity of electricity trading. Due to this, demand response remained defended from adorning prices in the wholesale electric trade. In such a habitat, on the behalf of consumers, the ISO and load aggregators buy the electricity and provide it to consumers on a flat rate basis. The average cost of electricity and risk premium combines by flat rate and sell it on the fixed rate. In the same rhythm, small consumers are isolated from on-time pricing, and then demand is calculated by their activity cycle [1]. The aggregate peak of the demand response is the key to designing and sizing the electric network. It makes the over-dimension network for an off-peak time. Dynamic fluctuating price slabs easily modify the consumer load curve by shifting the demand from peak time to off-peak time. Earlier, the utilities imposing dynamic price programs (DPP) owing to their technical intricacy and pricey framework. The energy sector of United States adopted a lively technic for such an environment to the demand response (DR) [2]. Further, initiatives have been taken for the development of the smart grid. Mobility on demand project is implemented to design electric vehicles and construct modern cities. Tennessee valley authority (TVA) and X-cel energy is doing great work and also launched a variety of dynamic pricing programs to construct an architecture for smart grid information processing [3]. Many utilities already launched different pricing schemes to analyze the feasibility and technical glitches in time-based pricing schemes [4] – [8]. There is a strong accord among behavioural engineers on the presumption of traditional economics [9]–[10]. Demand side management is classified into two main categories as namely; price based programs (PBP) and incentive based programs (IBP). Each category is again divided into other forms as shown in Fig. 1 and details of these DR programs are given in [11]–[12]. The IBP programs largely concentrated on industrial and commercial consumers. A variety of DR programs such as Automated DR, Load Shifting, and Load Scheduling Program offers by Southern California Edison (SCE) [13].

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