DEMAND RESPONSE LOAD FREQUENCY CONTROL WITH FUZZY GAIN SCHEDULING PID

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ABSTRACT

This paper peresents a novel approach of fuzzy controller to stabilize the frequency in all (normal and emergency) conditions under micro grid environment. Load Frequency Control (LFC) model plays a vital role in electric power system design and operation. From the literature, it is proven that the implementation of DR (Demand Response) is a key to the future micro grid. In practice, LFC-DR model is tuned by conventional controllers like PI, PD, PID controllers fixed gains. However, they are incapable of obtaining good dynamic performance over a wide range of operating conditions and load changes. This paper presents an idea of introducing a DR control loop in the traditional LFC model (called LFC-DR) using Intelligent Controller for a power system. DR communication delay latency in the controller design is considered and is linearized using Padé approximation. The addition of DR control loop guarantees stability of the overall closed-loop system and effectively improves the system dynamic performance. Simulation results show that Fuzzy Logic Controller based LFC-DR single-area power system have better performance and superiority over a classical controller under any operating scenarios.

Keywords: Load Frequency control; micro grid; Demand Response; Fuzzy Logic Control; pade approximation.

1. INTRODUCTION

The frequency of a power system is a very important performance signal to the system operator [1] for the stability, sensitivity and security considerations. Power system frequency control regulation have been one of the important control problems for research, traditionally termed as Load Frequency Control (LFC). It has been one of the functions of Automatic Generation Control (AGC)[2]. The frequency and tie-line power exchanges are two variables which should be considered under investigation in load frequency control problem [3],[4]. Frequency regulation in power system is achieved by pondering generation and demand through load following, i.e., spinning and non-spinning reserves. The future power grid, on the other hand, is foreseen to have high incursion of Renewable Energy (RE) power generation.[5].The ancillary services like frequency and voltage control, are essential parts of a power system. The parameter which is representing the balance of generation and consumption in a power system is frequency [6]. It is worth noting that generation and demand can be equally applied to the frequency control. Demand response is defined as: "changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the cost of electricity over time, or to incentive payments premeditated to induce lower electricity use at times of high wholesale market costs or when system reliability is jeopardized" by Federal Energy Regulatory Commission (FERC)[7] . In such cases, energy storage and responsive loads shows a very great swear for balancing generation and demand, as they will help to avoid the use of the traditional generation following schemes, which can be costly and/or environmentally unfriendly. With the limited availability, low efficiency, and high cost of large storage devices, real -time smart responsive load participation, known as Demand Response (DR), has been actively considered for power balancing. It can be achieved by active consumer involvement in real-time to maintain balance between generation and demand with two-way communication [8], [9]. It is well known that DR increases system reliability and flexibility, decreases the cost of operation and enhances system efficiency [10]. The use of electricity demand response as a new assess for fast reserves inside an autonomous (islanded) micro grid during different operating conditions including frequency controlled disturbance and normal ones[11],[12]. This kind of demand can respond autonomously to frequency variation and it provides fast reserve to the system by equipping them with frequency sensors and appropriate control intelligence [13],[14]. Simulation results show that, by using this approach, i.e. by introducing Demand Response (DR) control loop to the traditional LFC model (called LFC-DR), the demand side can make a significant and reliable contribution to major frequency response while preserving the advantages that consumers derive from their