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Autonomous Control of Smart Micro Grid in Islanding Mode

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Abstract

A Support Vector Machine based Dynamic Energy Management System (DEMS)to handle the Smart Micro Grid (SMG) in islanding mode is proposed and developed in this paper. DEMS controls the charge discharge transactions of the energy storage modules installed in the SMG, thereby handling the supply-demand imbalance. The proposed system also performs Demand Response Program based Load Management in the island as frequency control becomes crucial for an islanded SMG. DEMS being a self decisive system provides a unique solution enabling the distributed control of SMG to be performed autonomously. Field Programmable Gate Array (FPGA) is used to realize the proposed system as the response time is critical particularly when the SMG is islanded. The DEM Scheme is validated in a simulated MATLAB environment.

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*Keywords:*FPGA; DEMS; SMG; SVM;

1. Introduction

The proliferation of Microgrids (MG)is to integrate large numbers of Distributed Energy Resources (DERs) based generation units onto the legacy grid and in turn to enhance the generation and utilization of clean and green energy [1]. The system disconnects from the utility in times of crucial events (e.g., grid faults etc) or it gets purposely disconnected (intentional islanding) when quality power is not supplied [2]. Off-grid micro power systems provide great opportunities where the grid-connected power lines need to travel longer distances for expansion of electricity supply to a few people [3]. In such instances, MG needs to be 'smart' and capable of handling itself autonomously [4]. Energy Management plays a lead role in achieving the self-governing operation of the Smart Micro Grid (SMG).

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Several Energy Management Systems (EMS) are proposed in the literature for controlling the SMG in the islanding mode. In [5-7], the operation of SMG is formulated as a constrained/unconstrained optimization problem and various methods are used to solve it. Sometimes, SMG fails in supplying uninterruptible power to the loads of the island as the renewable resources are intermittent [8]. In such cases, Load Management (LM) has a significant role in controlling the SMG. EMS should be capable of performing LM either by conventional load shedding [9] or using Demand Response Programs (DRP) [10]. DRPs are beneficial in Home Energy Management systems [11] as well as for enhancement of power system security [12].Development of a simulator for Demand Response - DEMSi to study the Demand Response (DR) actions and schemes in distribution networks is reported in [13]. Diversity of load consumption patterns is utilized to create an agent based EMS in [14] that involves DERs, distributed storage and DR.

This paper employs Dynamic Energy Management Scheme [15] to perform distributed control on the islanded SMG. DEM Scheme controls the charge discharge transactions of the energy storage modules to oppose the frequency excursions in a real time environment [16]. The strategies for performing DEM in the islanded SMG are proposed which are implemented using Support Vector Machine (SVM) realized on a Field Programmable Gate Array (FPGA).

2. Smart Micro Grid

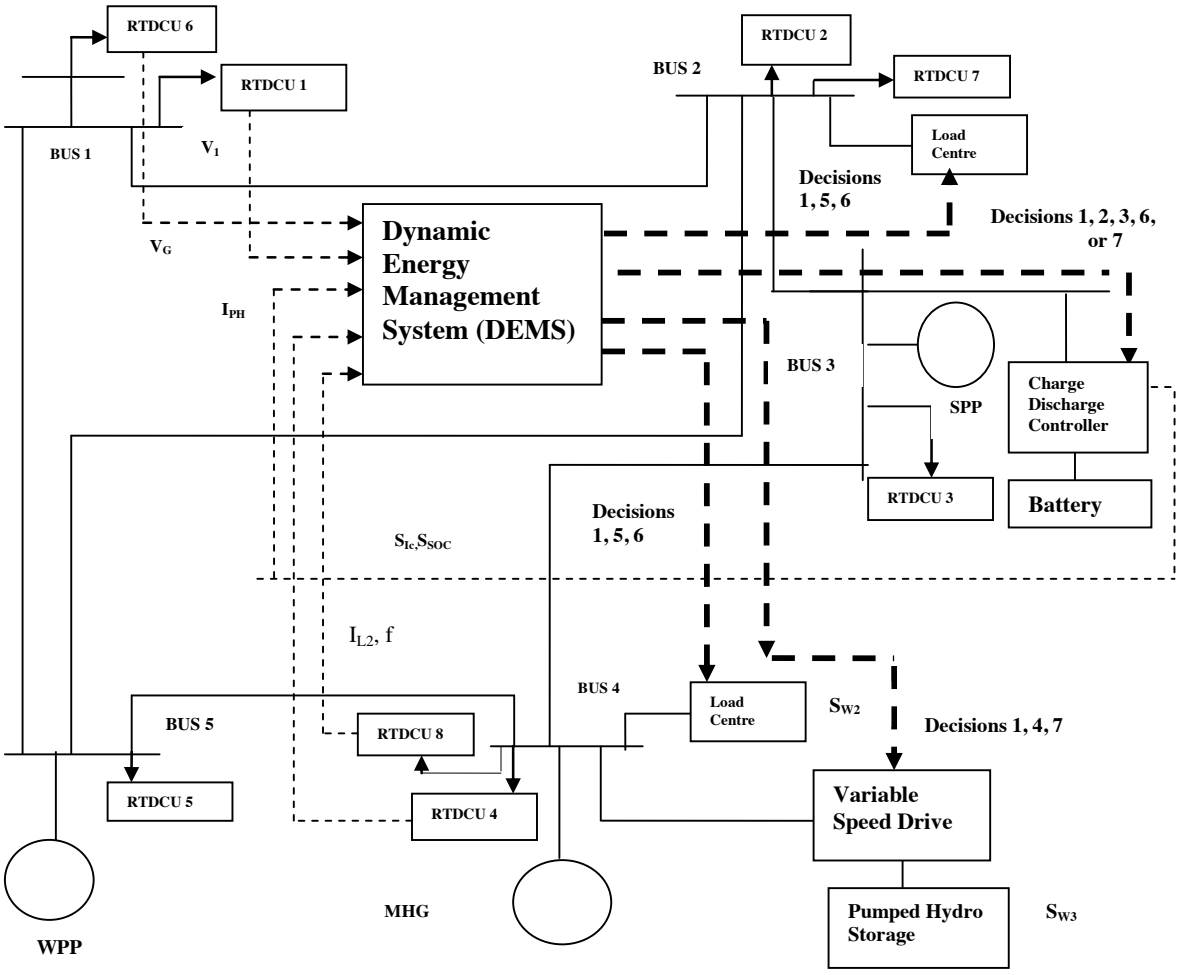

Fig.1.Smart Micro Grid used for implementation of DEM Scheme