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Micro-grid Grid Outage Management using Multi Agent Systems

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Abstract

The aim of this paper is to evolve a Multi Agent System (MAS) for grid outage management in energy administration of a micro-grid. We consider a micro-grid consisting of two systems each containing a solar Photo Voltaic (PV) system, wind system, a local consumer, and a battery. Initially we observe and record the load patterns and solar and wind power generated in the two units. Following which we implement outage management using Multi Agent System of the micro-grid with smart grid frame work. Simulation of the model is developed in Java Agent Development Environment (JADE) for dynamic model accounting the intermittent nature of solar power, randomness of load; dynamic pricing of grid and discrepancy of critical loads and choose the best possible solution for the grid outage management in the micro-grid. Furthermore, MAS improves the operating efficiency, thus maximizing the power generation of the micro-grid and minimizing the cost of operation. Thus MAS in micro-grid leads to best use of monetary and environmental resources. Simulated operation of solar generators and loads are observed by carrying out simulations under various agent objectives. Result of the simulation studies proves the efficacy of suggested outage management of the micro-grid.

Keywords: Autonomous Agent, Energy management, Multi Agent System, Micro-grid, JADE, Grid Outage Management;

1. Introduction

Electricity production scenario is evolving as a consequence of rapid increase of renewable resources and the

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active demand. As the result of incorporation of Information and Communication Technology (ICT), we are moving towards a more decentralized, more efficient, and smart power management system [1]. Micro-grid is a smaller, low voltage grid with resources and loads which are distributed. It subsists as the elementary unit of smart grid and is positioned to hold a critical part in bringing into practice the large scale implementation of sustainable, distributed energy resources in all working conditions including both grid-connected and off grid modes. Incorporation of renewable energy with micro-grid is the solution for optimization of both capital and environmental resources, generating sustainable and eco-friendly energy, thereby offering viable ways to curtail global warming. [2].The unpredictability in supply of renewable energy resources can endanger the reliability of micro-grid. Passive networks shall prove to be insufficient to manage with the high penetration of Distributed Energy Resources (DER) and complex control decisions owing to the absence of affability and resilience. The dynamics need to be efficiently managed for maintenance of a reliable and stable grid [3]. Latest technologies under development aid in augmentation of efficiency and diminish environmental impacts of energy production and consumption. The expert system and conventional methods for energy management in micro-grids are contended in [4]. Micro-grid operation problems are approached in a centralized manner in majority of the papers. But in the decentralized approach communication overhead is abridged and also and also robustness is enhanced. Multi-agent based designing of energy management schemes is a propitious avenue for dissension of a universal interaction platform for agents impersonating the self-governing physical constituents of the power system [5]. Agent based modeling of micro-grid considering non uniform availability of renewable energy resources in the efficiency and reliability of micro-grid is given in [6]. A MAS based energy management system for a solar, small hydro hybrid micro-grid is discussed in n [7].The functions of MAS for control of micro-grid are explained in [8]. The implementation of MAS in micro-grid energy management is elucidated in [9]. The real- time operation of a micro-grid using real time digital simulator with MAS is discussed in [10]. Distributed energy management based on MAS for intelligent micro-grid is discussed in [11]. The trends in micro-grid control are discussed in [12]. The review of micro-grids in multi-agent system perspectives are discussed in [13]. Though many micro-grid research activities involving MAS have been reported, no paper has examined every choice accessible in a micro-grid for grid outage management in an ever evolving, distributed environment. Hence we suggest distributed energy utilization of micro grid based on multi agent system by thoroughly considering every practical choice for grid outage management. A comprehensive optimization process employing multi agent system taking into account every logical option dynamically in a decentralized environment has not been examined hitherto. The MAS dependent integrated energy management is incorporated through JADE which is a Foundation for Intelligent Physical Agents (FIPA) compliant open source multi-agent platform. The multi- agent system consists of agents which interact cooperatively to augment the efficiency of the micro-grid

The remaining part of the paper is arranged as follows. In section 2, multi agent system approach is enunciated in detail. Problem formulation is elaborated in section 3. Implementation of grid outage management is given in section 4. Conclusion is given in section 5.

2. Multi Agent System approach

2.1 Multi Agent System

The concept of autonomous components and coordination are the fundamental components of any distributed system. The major constrains of distributed systems that include many heterogeneous entities are:

- They lack run-time adaptive behavior as the interactions among participating entities are already fixed by application developer while coding instructions.

- Sustaining communication is uneconomical. Hence distributed system with multiple simultaneous interactions are practically unobtainable

The above examinations encourage the growth of approaches to distributed system comprising agents which