Chapter 7
Decentralized Energy Management System Enhancement for Smart Grid

Hadjira Belaidi
Signals and Systems Laboratory, Institute of Electrical and Electronic Engineering, University M'hamed Bougara of Boumerdes, Algeria

Zakaria Rabiai
Signals and Systems Laboratory, Institute of Electrical and Electronic Engineering, University M'hamed Bougara of Boumerdes, Algeria

ABSTRACT

In these last decades, electrical power grids become more intelligent. Hence, sophisticated software and hardware were introduced to the power grid, which makes it a smart grid. This chapter is an introduction on smart-grid technology; thus, microgrids are explained, and the use of multiagent system in centralized/decentralized energy management systems are discussed and compared. Smart agents are an emerging technology for decentralized computation and data storage. Hence, in this chapter, decentralized energy management system is created basing on multi-agent system technique where sources and loads are considered as separated agents each of them. After that, these sources and load create a microgrid and each microgrid can be considered as an agent. The work proposes an approach for load supplying optimization to decrease the microgrid cost and enhance its efficiency.

1. INTRODUCTION

Smart devices and processes are gradually introduced into the electric power delivery (transmission and distribution) networks. In the coming two decades, it is foreseen that the electric power grid will be electronically controlled network rather than an electromechanically controlled system. The most envisaged challenge is how to update, redesign, refit, and re-implement the existing conventional grid into a smart grid (Amin M. and Stringer J., 2008).

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Micro-grid energy management approaches are often classified as centralized and decentralized approaches. In centralized ones, all control processing occurs in a single agent with lack of coordination between the micro-grid performers (Yimy E. et al., 2019). Their advantage is that Off-the-shelf energy management algorithms can be directly applied; however, if the dimensionality of configuration space increases, it leads to an increasing running time. Whereas, in decentralized approaches Control processing is distributed among the agents and each one computes its solution independently; then, a strategy for coordinating the micro-grid participants is implemented; where each participant evaluates its own optimal settings. The advantage of these approaches is that dimensionality of configuration space does not increase running time since each agent is independent from others; but in the other hand, coordination is not always possible, which does not complete the decoupled management.

Centralized smart-grid energy management issue has been broadly studied in the literature Farhangi H. (2010), Borlase S. (2018) and several works have tried to improve the centralized approaches. Almada J.B. et al.(2016) used the master-slave strategy for a rule-based management system applied to a microgrid composed of multiple energy resources including a PV system, a fuel cell, and a battery bank. This approach is an appropriate solution only if energy resources are close to each other. In the same context, gravitational search algorithm (GSA) method was applied in the researches of Ji B. et al. (2014), Jahan, M.S. & Amjady, N. (2013), Radosavljević, J. et al. (2014) and Jiang S. (2014) to optimize power flow in given systems and the concept of centralized microgrid management system (MMS) was used make decisions when information was collected in a central point, while cooperation and prioritization are achieved more easily when using a central controller (Planas E., 2013). Other authors such as: Almada J.B. (2016), Patrao I. (2015) and Prabhash N. (2015) had addressed the problem of multi-agent power grid operation using centralized methods; however, the best results they got even near optimal, time consuming or higher control complexity.

Several models existing in the literature such as Capitan J et al. (2012) have been judged to be highly interdependent (a system is highly interdependent if an adjustment in one of the agents' model necessitates re-calculating policies for the others). Thus, Timothy M. H. & Edwin K. P. C. (2018) and Misra S. et al., (2013) proposed advancements to decentralize multiagent and to minimize the household electricity bill in such a Real-time pricing (RTP) market by applying Partially Observable Markov Decision Process (POMDPs). Whereas, the authors Raju L. et al. (2016), Weixian L. et al. (2016) and Raju L. et al. (2016) proposed an implementation of multiagent system (MAS) for the advanced distributed energy management and demand side management of a microgrid using Java agent development environment (JADE) frame work and MATLAB Simulink (MACSimJX).

The recent relevant works have addressed the problem of energy management system for an isolated MG to minimize its operating costs (Farzin, H. et al., 2017), regulation and supervision of loads and dispatchable energy inside a MG (Zachar M. & Daoutidis P., 2018) and improving the efficiency of the hybrid renewable energy systems (HRESs) (Faccio M. et al., 2018).

Hence, this work proposes an approach based on a decentralized energy management system to enhance the performance of a smart-grid. This approach is build upon Multiagent system where the coordinator commands are merged to solve the problem of microgrid management. The approach is based on distributing the problem solving tasks between the different agents as done by Belaidi H. et al. (2018). Each agent calculates its coefficients and needs and exchanges the data with the other data to improve the performance of the overall microgrid.

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