

Fuzzy-Logic Based Control for Battery Management in Micro-Grid

Yashar Sabraei Marjili, *Student Member IEEE*, Amir Rajaei, *Student Member IEEE*
Brian Kelley, *Senior Member IEEE*, Mo Jamsheidi *Fellow IEEE*

Abstract— In this paper, a Fuzzy-Logic based control framework is proposed for Battery Management in Micro-Grid System. The Micro-Grid system operates synchronously with the main grid and also has the ability to operate independently from the power grid. Distributed renewable energy generators including solar, wind, and batteries supply power to the consumer in the Micro-Grid network. The goal is to control the amount of power given to the storage system in order to minimize a cost function based on payment/profit and distribution loss through reasonable decision making using predefined profiles of system variables such as Load Demand, Electricity Price, and Renewable Generation.

Simulation results are presented and discussed. The proposed intelligent control system turns out to be capable of achieving effective energy management.

Index Terms—Micro-Grid, Control, Power Flow, Fuzzy-Logic, Load Demand.

I. INTRODUCTION

Micro-Grid is can be referred to as a small scale grid that is designed to provide power for small communities. A Micro-Grid is an aggregation of multiple distributed generators (DGs) such as renewable energy sources, conventional generators, and energy storage systems which work together as a power supply network in order to provide both electric power and thermal energy for small communities which may vary from one common building to a smart house or even a set of loads consisting of a mixture of different structures such as buildings, factories, etc. Typically, a Micro-Grid operates in parallel with the main grid. However, there are cases in which a Micro-Grid operates in islanded mode, or in a disconnected state [1]. In this article, in addition to both of the states already mentioned, a third state is assumed for operation of Micro-Grid in which excess power in the Micro-Grid is delivered to the main grid, i.e. the excess power is sold to the grid.

II. SYSTEM MODEL

A three bus system is used to model the Micro-Grid network for simulations in this article. One of the busses in the

distributed generation system model is assumed to serve the renewable generators which include either solar farm, wind farm, or any other renewable generation units. Another bus is assumed to be working as the grid (utility) bus which will provide the complement part of the power demand that renewable generation system cannot afford to the load. The third bus will be the specific load to which the demanded power is to be provided. This load can be anything from a common building or a smart house, to even a group of plants and factories or a mixture of all of them. Figure 1 shows an overall Micro-Grid schematic including Renewable Electricity Generators and Storage Unit, Utility, and Typical Load.

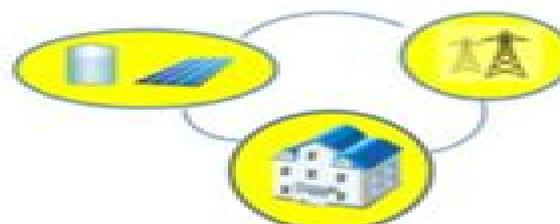


Figure 1. Micro-Grid Schematic

There are two scenarios assumed for simulation in this article, scenario 1 deals with a Micro-Grid which includes the renewable generation unit without any battery storage unit. Therefore there will not be any approaches required for controlling the battery storage system in this scenario. The second scenario deals with the same Micro-Grid system as mentioned in scenario 1 but with the battery storage unit considered to be connected to the same bus as the renewable generators. These two scenarios will be described in more detail in the next section "Problem Statement". The characteristics of busses in each of the two scenarios are as follows:

Scenario 1:

- Bus1 is of type PQ and is used as the renewable generation unit's bus.
- Bus2 is of type Slack (reference) and is used as the Utility (grid) bus.
- Bus3 is of type PV and is used as the Load bus.

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Table of Contents Fuzzy Logic Based Control For Battery Management In Micro Grid

1. Understanding the eBook Fuzzy Logic Based Control For Battery Management In Micro Grid
 - The Rise of Digital Reading Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Advantages of eBooks Over Traditional Books
2. Identifying Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Fuzzy Logic Based Control For Battery Management In Micro Grid
 - User-Friendly Interface
4. Exploring eBook Recommendations from Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Personalized Recommendations
 - Fuzzy Logic Based Control For Battery Management In Micro Grid User Reviews and Ratings
 - Fuzzy Logic Based Control For Battery Management In Micro Grid and Bestseller Lists
5. Accessing Fuzzy Logic Based Control For Battery Management In Micro Grid Free and Paid eBooks
 - Fuzzy Logic Based Control For Battery Management In Micro Grid Public Domain eBooks
 - Fuzzy Logic Based Control For Battery Management In Micro Grid eBook Subscription Services
 - Fuzzy Logic Based Control For Battery Management In Micro Grid Budget-Friendly Options

6. Navigating Fuzzy Logic Based Control For Battery Management In Micro Grid eBook Formats
 - ePub, PDF, MOBI, and More
 - Fuzzy Logic Based Control For Battery Management In Micro Grid Compatibility with Devices
 - Fuzzy Logic Based Control For Battery Management In Micro Grid Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Highlighting and Note-Taking Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Interactive Elements Fuzzy Logic Based Control For Battery Management In Micro Grid
8. Staying Engaged with Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Fuzzy Logic Based Control For Battery Management In Micro Grid
9. Balancing eBooks and Physical Books Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Fuzzy Logic Based Control For Battery Management In Micro Grid
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Setting Reading Goals Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Fact-Checking eBook Content of Fuzzy Logic Based Control For Battery Management In Micro Grid
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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