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

Yashar Sabzaei Manjili, *Student Member IEEE*, Amir Rajaee, *Student Member IEEE*
Brian Kelley, *Senior Member IEEE*, Mo Jamshidi *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 Generation and Storage Unit, Utility, and Typical Load.

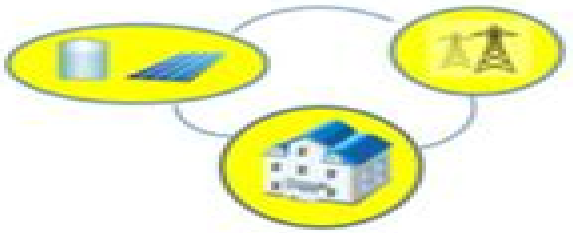

Figure 1 Micro-Grid Schematic

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.

Fuzzy Logic Based Control For Battery Management In Micro Grid

Yatish T. Shah

Fuzzy Logic Based Control For Battery Management In Micro Grid:

Intelligent Systems and Advanced Computing Sciences Hani Hagras,Younes Bennani,Mohamed Nemiche,2025-07-01 This book constitutes revised selected papers from the thoroughly refereed conference proceedings of the 4th International Conference on Intelligent Systems and Advanced Computing Sciences ISACS 2023 which took place in Taza Morocco in October 26 27 2023 The 30 full papers and 8 short papers presented in these proceedings were carefully reviewed and selected from 131 submissions This conference focusing on all theoretical and practical aspects related to information technology and communications security Computing, Internet of Things and Data Analytics Fausto Pedro García Márquez,Akhtar Jamil,Isaac Segovia Ramirez,Süleyman Eken,Alaa Ali Hameed,2024-02-22 This book covers selected papers presented at the 2nd International Conference on Computing IoT and Data Analytics ICCIDA in 2022 organized by Universidad de Castilla La Mancha Spain August 11 12 2023 It highlights some of the latest research advances and cutting edge analyses of real world problems related to Computing IoT and Data Analytics and their applications in various domains This includes state of the art models and methods used on benchmark datasets Optimizing and Measuring Smart Grid Operation and Control Recioui, Abdelmadjid,Bentarzi, Hamid,2020-11-13 Smart grid SG also called intelligent grid is a modern improvement of the traditional power grid that will revolutionize the way electricity is produced delivered and consumed Studying key concepts such as advanced metering infrastructure distribution management systems and energy management systems will support the design of a cost effective reliable and efficient supply system and will create a real time bidirectional communication means and information exchange between the consumer and the grid operator of electric power Optimizing and Measuring Smart Grid Operation and Control is a critical reference source that presents recent research on the operation control and optimization of smart grids Covering topics that include phase measurement units smart metering and synchrophasor technologies this book examines all aspects of modern smart grid measurement and control It is designed for engineers researchers academicians and students **Hybrid Power** Yatish T. Shah,2021-02-18 Hybrid energy systems integrate multiple sources of power generation storage and transport mechanisms and can facilitate increased usage of cleaner renewable and more efficient energy sources Hybrid Power Generation Storage and Grids discusses hybrid energy systems from fundamentals through applications and discusses generation storage and grids Highlights fundamentals and applications of hybrid energy storage Discusses use in hybrid and electric vehicles and home energy needs Discusses issues related to hybrid renewable energy systems connected to the utility grid Describes the usefulness of hybrid microgrids and various forms of off grid energy such as mini grids nanogrids and stand alone systems Covers the use of hybrid renewable energy systems for rural electrification around the world Discusses various forms and applications of hybrid energy systems hybrid energy storage hybrid microgrids and hybrid off grid energy systems Details simulation and optimization of hybrid renewable energy systems This book is aimed at advanced students and researchers in

academia government and industry seeking a comprehensive overview of the basics technologies and applications of hybrid energy systems *Design, Analysis and Applications of Renewable Energy Systems* Ahmad Taher Azar,Nashwa Ahmad Kamal,2021-09-09 Design Analysis and Applications of Renewable Energy Systems covers recent advancements in the study of renewable energy control systems by bringing together diverse scientific breakthroughs on the modeling control and optimization of renewable energy systems as conveyed by leading energy systems engineering researchers The book focuses on present novel solutions for many problems in the field covering modeling control theorems and the optimization techniques that will help solve many scientific issues for researchers Multidisciplinary applications are also discussed along with their fundamentals modeling analysis design realization and experimental results This book fills the gaps between different interdisciplinary applications ranging from mathematical concepts modeling and analysis up to the realization and experimental work Presents some of the latest innovative approaches to renewable energy systems from the point of view of dynamic modeling system analysis optimization control and circuit design Focuses on advances related to optimization techniques for renewable energy and forecasting using machine learning methods Includes new circuits and systems helping researchers solve many nonlinear problems *Energy and Exergy for Sustainable and Clean Environment, Volume 2* V. Edwin Geo,Fethi Aloui,2022-09-19 This multi disciplinary book presents the most recent advances in exergy energy and environmental issues Volume 2 focuses on fundamentals in the field and covers current problems future needs and prospects in the area of energy and environment from researchers worldwide Based on some selected lectures from the Eleventh International Exergy Energy and Environmental Symposium IEEES 11 and complemented by further invited contributions this comprehensive set of contributions promote the exchange of new ideas and techniques in energy conversion and conservation in order to exchange best practices in energetic efficiency Included are fundamental and historical coverage of the green transportation and sustainable mobility sectors especially regarding the development of sustainable technologies for thermal comforts and green transportation vehicles Furthermore contributions on renewable and sustainable energy sources strategies for energy production and the carbon free society constitute an important part of this book **Energy Management Strategies Based on Fuzzy Logic Control for Grid-tied Domestic Electro-thermal Microgrid** Diego Gustavo Arcos Avilés,2016 The environmental and economic benefits related to the reduction of both carbon dioxide emission and transmission losses have made distributed renewable generation systems became a competitive solution for future power systems In this context Microgrids MG are considered as the key building blocks of smart grids and have aroused great attention in the last decade for their potential and the impact they may have in the coming future The MG concept has captured great attention in the last years since it can be considered one of the most suitable alternatives for integration of distributed generation units in the utility grid However this integration involves some challenges to deal with especially when penetration of Renewable Energy Sources RES into the distribution network is increased Therefore an effective Energy

Management System EMS is required to ensure optimal energy utilization within the MG consequently facilitating both the grid integration and operator control In this regard the EMS strategy design depends on the application MG power architecture and the power management capability of the MG elements This dissertation research focuses on the design of different EMS strategies based on Fuzzy Logic Control FLC for a residential grid connected electro thermal MG including renewable power generation i e photovoltaic and wind turbine generators and storage capability i e battery bank and water storage tank The main goal of the FLC based EMS strategies is to minimize the grid power fluctuations while keeping the battery State of Charge SOC within secure limits In order to accomplish this goal the controller design parameters such as membership functions and rule base of the FLC based EMS strategies are adjusted to optimize a pre defined set of quality criteria of the MG behavior The analysis and design of the FLC based EMS strategies for electrical and electro thermal MG power architectures are developed considering two different scenarios A first scenario where the MG power forecasting is not provided and a second scenario where the forecast of generation power and load demand are considered A comparison with the different EMS strategies is presented in simulation level whereas the features of the enhanced FLC based EMS strategies are experimentally tested on a real residential microgrid implemented at the Public University of Navarre UPNa

Journal of Scientific and Industrial Research ,2015 **Science Abstracts** ,1995 **NASA SP.** ,1962 *Large Space Structures & Systems in the Space Station Era* ,1992 *Synerjy* ,1996 **International Aerospace Abstracts** ,1999

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Alternative Energy Systems M. Godoy Simões,Felix A. Farret,2008 Durable and cost effective induction power generators have undergone numerous improvements that make them an increasingly attractive option for renewable energy applications particularly for wind and hydropower generation systems From fundamental concepts to the latest technologies Alternative Energy Systems Design and Analysis with Induction Generators Second Edition provides detailed and accurate coverage of all aspects related to the design operation and overall analysis of such systems Placing a greater emphasis on providing clear precise and succinct explanations this second edition features new revised and updated content as well as figures tables equations and examples Each chapter introduces a multi step chapter length problem relating the material to a real application The solution appears at the end of the chapter along with additional practice problems and references New Material in This Edition Updated definitions for generated power and efficiency Technological advances such as new applications using doubly fed induction generators New methodologies such as the magnetization curve representation for induction generators Additional focus on renewable energy applications such as sea wind and hydropower systemsAlternative Energy Systems provides the tools and expertise for advanced students and professionals in electrical mechanical civil and environmental engineering involved in the development of power plants Electronic Engineering ,1995 *Intelligent Control in Energy Systems* Anastasios Dounis,2019-08-26 The editors of this Special Issue titled

Intelligent Control in Energy Systems have attempted to create a book containing original technical articles addressing various elements of intelligent control in energy systems In response to our call for papers we received 60 submissions Of those submissions 27 were published and 33 were rejected In this book we offer the 27 accepted technical articles as well as one editorial Authors from 15 countries China Netherlands Spain Tunisia United Sates of America Korea Brazil Egypt Denmark Indonesia Oman Canada Algeria Mexico and the Czech Republic elaborate on several aspects of intelligent control in energy systems The book covers a broad range of topics including fuzzy PID in automotive fuel cell and MPPT tracking neural networks for fuel cell control and dynamic optimization of energy management adaptive control on power systems hierarchical Petri Nets in microgrid management model predictive control for electric vehicle battery and frequency regulation in HVAC systems deep learning for power consumption forecasting decision trees for wind systems risk analysis for demand side management finite state automata for HVAC control robust synthesis for microgrids and neuro fuzzy systems in energy storage Electrical & Electronics Abstracts ,1997 Government Reports Announcements & Index ,1994-05 Index to Theses with Abstracts Accepted for Higher Degrees by the Universities of Great Britain and Ireland and the Council for National Academic Awards ,2004 Theses on any subject submitted by the academic libraries in the UK and Ireland

This book delves into Fuzzy Logic Based Control For Battery Management In Micro Grid. Fuzzy Logic Based Control For Battery Management In Micro Grid is a crucial topic that needs to be grasped by everyone, from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Fuzzy Logic Based Control For Battery Management In Micro Grid, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
    - Chapter 1: Introduction to Fuzzy Logic Based Control For Battery Management In Micro Grid
    - Chapter 2: Essential Elements of Fuzzy Logic Based Control For Battery Management In Micro Grid
    - Chapter 3: Fuzzy Logic Based Control For Battery Management In Micro Grid in Everyday Life
    - Chapter 4: Fuzzy Logic Based Control For Battery Management In Micro Grid in Specific Contexts
    - Chapter 5: Conclusion
2. In chapter 1, the author will provide an overview of Fuzzy Logic Based Control For Battery Management In Micro Grid. This chapter will explore what Fuzzy Logic Based Control For Battery Management In Micro Grid is, why Fuzzy Logic Based Control For Battery Management In Micro Grid is vital, and how to effectively learn about Fuzzy Logic Based Control For Battery Management In Micro Grid.
3. In chapter 2, the author will delve into the foundational concepts of Fuzzy Logic Based Control For Battery Management In Micro Grid. This chapter will elucidate the essential principles that must be understood to grasp Fuzzy Logic Based Control For Battery Management In Micro Grid in its entirety.
4. In chapter 3, this book will examine the practical applications of Fuzzy Logic Based Control For Battery Management In Micro Grid in daily life. This chapter will showcase real-world examples of how Fuzzy Logic Based Control For Battery Management In Micro Grid can be effectively utilized in everyday scenarios.
5. In chapter 4, the author will scrutinize the relevance of Fuzzy Logic Based Control For Battery Management In Micro Grid in specific contexts. The fourth chapter will explore how Fuzzy Logic Based Control For Battery Management In Micro Grid is applied in specialized fields, such as education, business, and technology.
6. In chapter 5, the author will draw a conclusion about Fuzzy Logic Based Control For Battery Management In Micro Grid. This chapter will summarize the key points that have been discussed throughout the book.

The book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Fuzzy Logic Based Control For Battery Management In Micro Grid.

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Fuzzy Logic Based Control For Battery Management In Micro Grid Introduction

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