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

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***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.

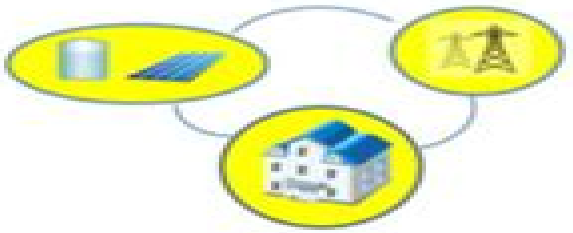

**Figure 1 Micro-Grid Schematic**

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

**Fausto Pedro Garcia Marquez,René Vinicio Sánchez Loja,Mayorkinos Papaelias**

**Fuzzy Logic Based Control For Battery Management In Micro Grid:**

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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

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the management of highly treatment experienced hiv infected patients is often complicated by baseline antiretroviral drug resistance patient intolerabilities drug drug interactions and quality of life issues which are all factors that can limit the ability to construct a potent regimen

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sep 1 2021 abstract although decreasing in prevalence heavily treatment experienced hte persons with limited options for hiv treatment present unique complexities even amongst experienced providers as there is no single approach to successful management

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this review evaluates current issues in the management of hiv infected treatment experienced patients it may provide guidance in selecting active tolerable drug combinations that promote a reasonable quality of life full adherence and a durable treatment response

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oct 18 2023 introduction access to early hiv treatment has improved markedly since 2015 following the global commitment to end the aids epidemic by 2030 through the unaids 90 90 90 and subsequent 95 95 95 targets in 2016 the who recommended providing art to all people living with hiv irrespective of who clinical stage and cd4 count this test and treat

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jan 20 2020 therefore in addition to virologic failure the management of the treatment experienced patient increasingly requires optimization of art to enhance tolerability avoid drug drug

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the medical care of patients infected with hiv is a problem involving a complex multisystem disease process multiple hospitalizations invasive diagnostic testing and an extremely high mortality rate hospital based medical services are particularly strained by these clinical features and community based services are strained additionally by the inadequate financial and social

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jan 15 2009 successful management of infection for treatment experienced patients with the new agents requires an understanding of their pharmacology and resistance patterns and the appropriate use of laboratory testing to optimize regimen selection

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jan 13 2023 approval was based on several studies showing evidence of virologic suppression in both treatment naive and treatment experienced patients on a daily regimen of the drug 126 127 studies have clearly shown that the successful management of patients with hiv is related to the expertise and hiv caseload of the treating physician in

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jan 15 2009 hiv aids the management of treatment experienced hiv infected patients new drugs and drug combinations the recent availability of new antiretroviral agents for the treatment of human immunodeficiency virus hiv infection has increased treatment options and has improved the durability tolerability and long term efficacy of antiretroviral

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oct 14 2012 abstract despite the success of combination antiretroviral therapy art in improving clinical outcomes treatment failure remains a significant challenge particularly for highly treatment experienced patients this review evaluates current issues in the management of hiv infected treatment experienced patients

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jun 6 2016 article here a step by step guide to the art management of hiv infected individuals who are heavily treatment experienced pills linavita shutterstock without question the management of previously antiretroviral art naÃ ve persons has become substantially easier in the last 3 years

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jun 7 2022 hiv treatment involves taking highly effective medicines called antiretroviral therapy art that work to control the virus art is recommended for everyone with hiv and people with hiv should start art as soon as possible after diagnosis even on that same day people on art take a combination of hiv medicines called an hiv treatment regimen

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mar 19 2010 in this subset of patients a reduced response to maraviroc compared to efavirenz was observed 54 6 vs 7 1 achieved 50 hiv rna copies ml respectively while for patients harboring r5 viruses similar responses were observed between maraviroc and efavirenz groups 69 3 vs 68 respectively figure 2 35 therefore the presence of x4