Modeling, Analysis, and Implementation of a DC micro grid Energy Management System

By

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Submitted in partial fulfillment of the requirement for degree

Master of Engineering in Electrical Engineering

in the

Department of Electrical Engineering

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

Tshwane University of Technology

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July 2024

Declaration

I hereby declare that the dissertation submitted for the degree M Eng: Electrical Engineering at Tshwane University of Technology, is my own original work and has not previously been submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated by means of comprehensive list of references.

F. I. Masango

Acknowledgments

I wish to convey my heartfelt appreciation to Prof JA Jordaan, my supervisor, for his positive outlook and invaluable guidance, as well as to Dr. AF Nnachi, my co-supervisor, for his mentorship, patience, and expertise. Under your supervision, I have gained immeasurable insights and knowledge.

To My Teachers:

I extend my appreciation to the faculty members at Tshwane University of Technology eMalahleni campus, particularly Mr. P Ehlers, Dr CG Richards, and Mr. Manana for their dedication to fostering my academic growth and intellectual curiosity. I would like to express my gratitude to the faculty members at Tshwane University of Technology eMalahleni campus, with special recognition for Mr. P Ehlers, Dr. CG Richards, Mr. Manana, Dr AO Akumu and Dr PF LeRoux. Their unwavering commitment to nurturing my academic development and sparking my intellectual curiosity is greatly appreciated.

For all those whose names I may have omitted but who have played a part in my academic journey, I express my heartfelt gratitude. This thesis is a testament to the collective efforts and encouragement of all these individuals and entities. Your belief in me has been a driving force behind my accomplishments, and I am profoundly grateful for your unwavering support.

Abstract

Microgrids (MG) are small-scale power subsystems that incorporate distributed generation, energy storage, local loads, system control, and coordination. Energy Management Systems (EMS) play a crucial role in fortifying the resilience of microgrids, ensuring their stability and continued operation even when energy supply is constrained. EMS enables centralized monitoring and control of energy consumption across various building systems. It is designed to collect, store, and analyze power consumption data from residential and industrial appliances. To achieve a fully automated and stable grid with plug-and-play capabilities, an agent-based EMS is proposed for use in a DC microgrid. This paper introduces an energy management system utilizing a systems-of-systems approach. We model and simulate an energy management system for a PV/Composite Storage DC microgrid in MATLAB. The primary aim of this paper is to enhance the performance of the DC Microgrid by integrating an existing grid with an energy management system at the residential level. The control system's objective is to ensure prolonged operation of loads by maintaining the local battery's charge until the PV modules cease power generation. Four scenarios of varying load demand were tested. The results obtained from both scenarios demonstrate the effectiveness of this control system design approach.

Chapter 1

Introduction

1.1 Statement of research problem

The utilization of renewable energy resources (RES) is on the rise, as many countries are making efforts to transition away from non-renewable energy sources due to their contribution to carbon emissions in the atmosphere. Microgrids combine distributed energy resources, energy storage, and load management. They have found applications in electrifying off-grid rural villages and remote regions. DC Microgrids (DCMG) have gained widespread use in aerospace, automotive, marine, and other industries. They serve as crucial components for integrating DERs (Distributed Energy Resources), especially since most renewable energy sources generate DC power. A nano grid, on the other hand, is designed for power distribution in a single house or small building [1]. A DC nano grid typically includes DERs, MPPT (Maximum Power Point Tracking), and ESS (Energy Storage System).

The use of renewable energy resources (RES) continues to grow. Numerous nations are seeking to transition from non-renewable energy sources as a result of the carbon emissions released into the atmosphere. A microgrid combines distributed energy resources, energy storage, and load. They have been used in the electrification of off-grid rural villages and remote areas. DC Microgrids (DCMG) have been widely used in aerospace, automotive, marine, and other industries. They are

the critical components in integrating DERs since most renewable energies produced are in DC form. A nano grid is a power distribution system for a single house/small building. A DC nano grid consists of a DER, MPPT, and ESS.