

# Chapter 5

## Modeling and Operating Strategies of Micro-Grids for Renewable Energy Communities

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### ABSTRACT

*Electric power is flexible, easily controlled and is used in everyone's daily life. Humans can't use other form of energy except electric power because electric power, is one of the main factor to economic development, improved health care, poverty alleviation, and cleaner environment for a society. According to an estimate people more than 1.5 billion worldwide don't have sufficient access to electric power due to inaccessibility, electrification via traditional centralized form of grid was not a feasible option. This led to phenomenal research interest in microgrid based energy supply. Microgrids are low voltage network's that are designed to generate, transmit and distribute electrical energy. These grids accomplish specific goals such as cost reduction, CO2 emission reduction, reliability and diversification of energy sources. Microgrids are an ideal way to integrate renewable energy resources in the local community and allow consumer participation in an energy enterprise. In this chapter, we present a comprehensive overview of recent advancement in Microgrids.*

Abbreviation used in Chapter

**MG:** Micro-grid

**SG:** Smart Grid

**PV:** Photovoltaic Cells

**DG:** Distributed Generation

**GHG:** Greenhouse Gases

**FAN:** Field Area Network

**LAN:** Local Area Network

**AGM:** Absorbed Glass Mat

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**FFN:** Full Function Nodes  
**HAN:** Home Area Network  
**VSI:** Voltage Source Inverter  
**WTG:** Wind Turbine Generator  
**RFN:** Reduced Function Nodes  
**DEG:** Diesel Energy Generator  
**RES:** Renewable Energy Sources  
**MCC:** Microgrid Central Controller  
**IMC:** Inter Module Communication  
**WLAN:** Wireless Local Area Network  
**VRLA:** Valve Regulated Lead-Acid  
**CCHP:** Combined Cooling, Heating And Power Production  
**WiMax:** Worldwide Interoperability for Microwave Access  
**OFDMA;** Orthogonal Frequency Division Multiple Access  
**SC-FDMA:** Single Carrier Frequency Division Multiple Access

## **INTRODUCTION**

Worldwide electrical energy consumption was 17313 tera watt hour (TWh) in 2009 but this was not evenly distributed. It was estimated that about 260 million household did not had access to the power grid for various reasons including technological and economic barrier, natural obstacles, communities located in islands, environmental constraints, high distance (Henry.L, Acker.V, Szablya.V, & Dauenhauer.S., 2012). Existing technology has changed our life style, but our current electric grid system which we trust for to keep supplying power to domestic users which includes our houses, places of work, health care has not been updated to meet required demand therefore exponential growth in the demand of electricity has also brought forth the need to efficiently use electricity by optimizing the production, minimizing the losses and efficiently managing the loads. The concept of “Smart grids” has emerged due to the fact that efficient management of loads can provide a potentially strong solution to optimize the energy consumption in an intelligently controlled smart environment.

This new technology require an advanced control system that can use the potential of bidirectional communication. In a smart grid environment there is continuous and effective communication between the consumer based and grid based smart controllers which also used for load optimization. A smart-grid gathers information about the activities of electrical energy providers and customers and then improves the customers’ load consumption by employing the communication based monitoring and controlling scheme (Javaid & Nadeem., 2012). Smart-grid system consists of advanced sensing technology, control algorithm communication infrastructures and actuators for rapid diagnosis and power outages prevention (Hurttt.J, Jhirad.D & Lewis.J, 2014). The initial concept of smart-grid was to have bi-directional communication system to support intelligent mechanism such as real-time monitoring, protective relaying and satisfying consumer demand for power. As this system moves towards implementation, there were certain factors such as scalability, reliability, and cyber security which are becoming major obstacle in materializing the system, which necessitated the need for a more flexible and efficient electric power system that would have local generation and storage facilities near consumer premises. It was named Micro-grid (MG) system. Microgrid system can be defined as an intelligent distribution system which

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