Development of Reinforced Architecture of Energy Management System for Microgrid

S. Hemalatha[1], Anbirpriyal.R [2], R.Roop Rekha[3]
[1]Associate Professor, Department of Electrical & Electronics Engineering
[1]Prince Shri Venkateshwara Padmavathy Engineering College, Chennai- 600 127
[2] Assistant Professor, Department of EEE,
[2]Prince Dr.K.Vasudevan College Of Engineering And Technology, Chennai- 600 127
[3] Faculty, Prince Shri Venkateshwara Arts and Science College, Gowriwakkam.

ABSTRACT: This paper proposes a design of trustworthy microgrid energy management system based on retreating horizon control. A microgrid is pigeonholed by the combination of distributed energy resources and well-regulated loads in a power distribution network. This integration presents novel, distinctive challenges to microgrid management which have never been exposed to conventional power systems. To put up these challenges, it is obligatory to redesign a conventional Energy Management System (EMS) so that it can manage with inherent characteristics of microgrids. In this paper, a novel design is proposed by considering the cost values, power consumption and generation parameters, and other constraints. This paper is also describes the general architecture of a microgrid energy management system (EMS) based on retreating horizon control. Ambiguity due to variations in the generator parameters is considered into account. The efficiency of the proposed approach is validated through simulation results. The obtained results show that predictive control is a viable approach for providing optimal energy management solutions accounting for costs, profiles and constraints

Key words—Microgrid, **architecture, energy management system, microgrid, renewable source, horizon technique.**

1. INTRODUCTION

A microgrid is a small-scale power grid which can operate autonomously or collaboratively with other small power grids. A microgrid is considered for exemplification, connected to an external grid via a transformer and containing a local consumer, a renewable generator (wind turbine) and a storage facility[1].The figure 1 shows the structure of microgrid. Microgrid consist of an progressive electrical digital identical model combined with intelligent automation and system protection to optimize and control complex electric and thermal systems.[2]energy management system (EMS) for microgrids. In [3], an on- line power energy management for a hybrid fuel cell/battery distributed power generation system is presented. The online architecture comprises of three layers: the first one captures the possible operations modes, the second is based on a fuzzy controller for power splitting between batteries and fuel cells, and the last one regulates each subsystem.

In [4], an EMS for controlling a virtual power plant (VPP) is presented. Here, the objective is to manage the power flows to minimize the electricity generation costs and to avoid the loss of energy produced by renewable energy sources. Lu & Francois [5] explain an energy management system based on day-ahead power scheduling for a microgrid It provides the real-time power set points for microgrid units and synchronizes the droop controllers for the initial frequency control.

In Teleke et al. [6], a rule-based control strategy is intended for a battery energy storage system with photovoltaic arrays and a wind farm. Wang et al. [7] designed a power management system for a stand-alone grid that is composed of a wind turbine, photovoltaic arrays and a fuel cell. Gupta et al. [8] developed steady-state models for a hybrid energy system for determining its optimal operation. The hybrid system is composed of micro-hydro, biogas, biomass, photovoltaic panels, a battery bank and a fossil fuel generator. An economic dispatch strategy with mixed integer linear programming is executed. Westermann and John [9] describe a combination of wide-area measurement and ripple control for DSM. The proposed control systems moderate the impact of increased renewable sources on adjacent transmission grids. Hamidi and Robinson [10] propose a responsive demand for a system with significant intermittent generation, e.g., a microgrid with renew- able sources. In this system, the demand can shift to reduce the peak and also be reduced to mitigate the power fluctuations; however, this action requires evaluating the value of the lost load for consumers.

2. CONTROL OF MICROGRID

Supervisory control and data acquisition (SCADA) is a control system architecture including computers, networked data communications and graphical user interfaces (GUI), programmable logic controllers (PLC) and discrete proportional-integral-derivative (PID) controllers to interface with power plant. In summary, for the communication between devices, the microgrid uses a SCADA with the following capabilities:

- Electrical measurements for all generation elements,
- Electrical measurements in the grid and control capabilities.
- Energy consumption measurement of the electrical loads in the network.

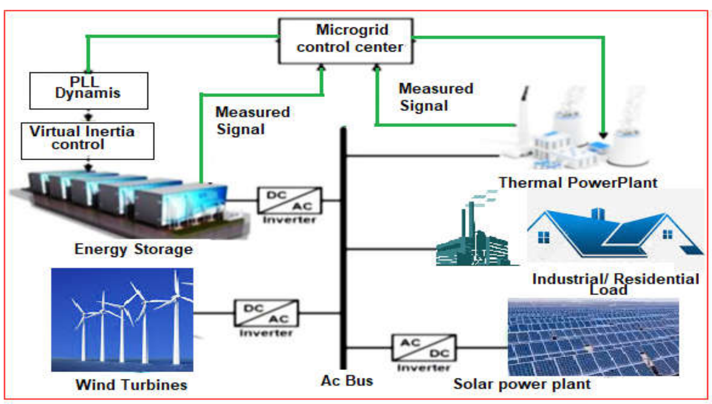

Figure 1: microgrid

- Power control

- Grid connection control for all generation units.
- Sun tracking control for the main PV plant.
- Wireless communication with the interfaces of the DSM system.

The figure 2 shows the energy management system of

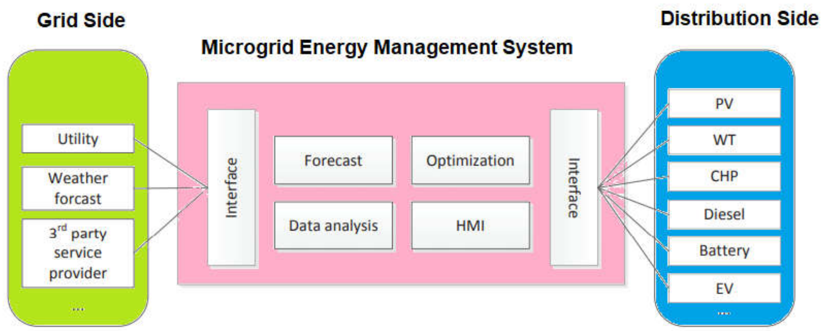

Figure 2: microgrid Energy Management system

3. MICROGRID ENERGY MANAGEMENT SYSTEM

In microgrid Energy Management system, two categories of design considerations are highly influenced, the primary one is grid side management and distribution management. In grid side the utility, weather forecast and third party service provider are influenced. In distribution side solar power plant, wind turbine, cogeneration power plant, DG set and battery are important. Figure 1 illustrates an overview of a microgrid EMS system for our discussion; internal boxes denote its roles.

A 48-hour forecast horizon was used because the battery state of charge at the end of the first day depends on both the weather. The Figures 3 and4showstheaveragevalue ofthe108samplesforload,waterconsumption,andsolargenerationforboththesummerandwinterseasons.Itcanbeobserved a similar profile for the village load .

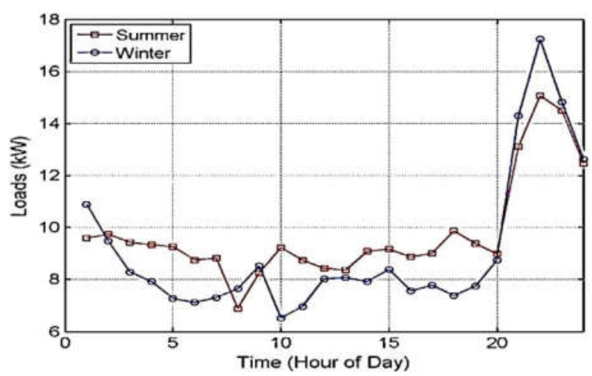

Figure 3: Average load for the summer and winter seasons

The Table1 shows that the UC-RH reduces the anticipated total cost because of the lower start-up and operation diesel costs. For the lower solar radiation in winter, the ESS operates close to

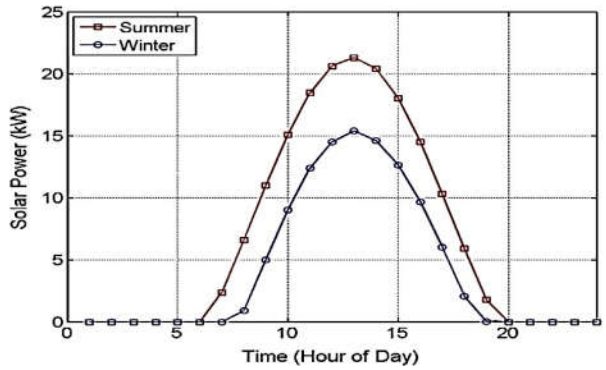

Fig. 4. Average solar power for the summer and winter seasons

its minimum energy capacity. Consequently, if there is a forecasting error, it would be possible to reach values below the minimum.

Table: 1. Average solar, diesel power for the summer and winter seasons

		Summer		Winter	
		Control Strategy		Control Strategy	
		UC	UC-RH	UC	UC-RH
Cost [CLP$] (std)	Start-up, Diesel	2006	1173	4891	1488
	Operational, Diesel	19997	18192	26836	24546
	Total Diesel	22063 (1641)	18309 (1036)	31727 (3465)	26034 (1581)
	Energy Deficit	-1613	-1559	2355	-1018
	Unserved Energy	0	0	1500	240
	Total Costs EMS Performance	20450 (1855)	16750 (861)	35582 (3592)	25256 (1671)

Consequently, the diesel generator starts up off schedule. Because the input forecasts considered by the UC-RH are updated at each step, this problem is reduced, and a lower start-up diesel cost is observed in comparison to the UC. For the summer season, the energy value is similar for both methods. In contrast, for the winter season, the UC generates positive energy values, meaning that the stored level of ESS energy is greater than the reference value

4. CONCLUSION

This paper presents a novel energy management system for a renewable-based microgrid. The EMS offers the online set points for generation units while diminishing the operational cost and in view of the forecast of renewable resources, load and water consumption. The results of the EMS proved the economic profit of the proposed unit with a rolling horizon (UC-RH) in comparison with a standard UC. The rolling horizon provides the benefits of dealing with updated data from the forecast variables. The average operational costs of the microgrid (PV/ Diesel/ESS) using the UC-RH are condensed for certain profiles of demand and irradiance in comparison with the UC. For the case of the wind-based microgrid (PV/Diesel/ESS/Wind), the operational costs are also reduced because of a reduction in the energy deficit, implying a better management of the ESS in comparison with the UC approach.

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