

# Study of Database Management and Multimedia System Infrastructure for Micro Grid

Sunguk Lee

*Research Institute of Industrial Science and Technology  
Pohang, Gyeongbuk, South Korea  
Sunguk@rist.re.kr*

## **Abstract**

*This paper provides discussion of multimedia system infrastructure and database management for the micro grid. The micro grid is energy system that has power generator with renewable energy resources and load. The micro grid is an ideal power system for using renewable energy resources for isolated area. This paper provides a brief overview of micro grid and discussion of communication system infrastructure and database management for the micro grid. The Energy Management System (EMS) interacts with all subsystems through communication channel and status information like metering data from all subsystems is stored at data base system in the EMS. With this information EMS manages and operates the micro grid. The Powerline communication and ZigBee are one of ideal communication infrastructure for local communication and the cellular network like MiMAX and LTE can be a good choice for the backhaul of the micro grid.*

**Keywords:** *Micro grid, Renewable Energy Resources Data Management, Energy Management System, Communication*

## **1. Introduction**

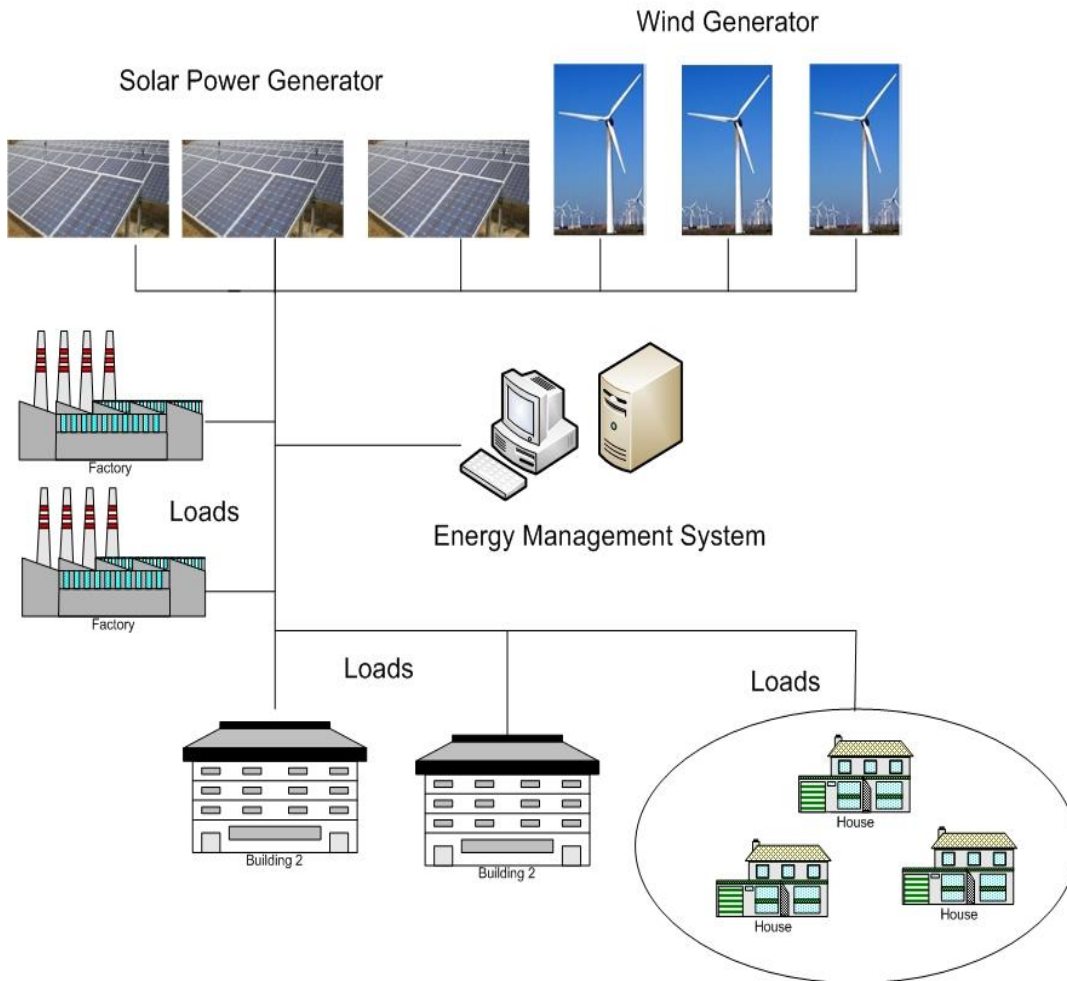
A micro grid [1, 2] is a small scaled energy system that can fulfill requirements of power load in a community with distributed power generating resources. Renewable energy resources like as solar power, wind power and fuel cells are used for generating electric power and energy storage system is also used to increase power security of the micro grid. The micro can be operated as two modes: grid-connected and island modes. The island type micro grid is isolated with any other power systems therefore power resources in the micro grid should meet demand of power load in the community. Geographically isolated area such as island is fit for island type micro grid operating mode.

The micro grids have several advantages comparing with conventional power system and benefits of the micro grid can be described as follows.

- Improvement of power quality and reliability
- Reduction of distribution losses

- Improvement of energy efficiency
- Reduction of carbon dioxide emission with renewable energy based power generation
- Low cost comparing with conventional power system

To get above benefits micro grid should coordinate operation & control of power generating resources with consideration of demand of power loads [3]. Energy resources and Energy storage devices are geographically distributed in the community level area therefore two-way communication is required to control and operate entities in the micro grid. With the bidirectional communication all equipments in the micro grid is monitored remotely and information from all entities will result in improvement of the accuracy and reliability of energy production.



**Figure 1. Example of micro grid configuration**

Figure 1 shows an example of micro grid configuration. Energy management system (EMS) has a function of monitoring and control of all subsystems in the micro grid. For this purpose the EMS receives real time data from all entities. These data are stored at database system in the EMS and used to analyze the status of system and manage power generating resources & controllable power loads in the micro grid. The monitoring and control of distributed energy resources and power loads in the micro grid may be conducted by Supervisory Control And Data Acquisition (SCADA) system.

The communication system should cover the whole entities in the micro grid and deliver information from all sensors and meters in the grid. The micro grid normally covers small area unlike smart grid which covers large geographical area. Therefore Metropolitan Area Network (MAN) and Local Area Network (LAN) may be useful and several technologies will be used together for the micro grid.

The remainder of the paper is organized as follows. In the following section data management in the micro grid is presented. Section 3 describes technologies and requirement of communication system for micro grid. Conclusion is given at section 4.

## **2. Database Management in the Micro Grid**

The Energy Management System (EMS) should communicate with all subsystems like as generators and power loads periodically in the micro grids. This system has a monitoring and control functions like SCADA [4]. The EMS receives real time data from all subsystem and monitors status of system, system efficiency, health of grid and so on. The real time information by all entities is stored and managed by data base system in the EMS and this information is used to manage generator and loads, emission of carbon dioxide and so on. Also the EMS may receive weather forecast to predict energy production from renewable energy resources such as solar and wind power. With analysis result using real time information from subsystem the EMS make grid meet power demand from loads and requirements for power quality.

The control scheme of the micro grid can be classified as centralized and decentralized control scheme. In the centralized control scheme a central controller communicates with each unit in the micro grid and sends periodic message to control the subsystem. Therefore communication between the central controller and subsystem should be reliable and secured. Otherwise in the decentralized control scheme each subsystem intelligently controls itself based on analysis using information from other subsystems. So each subsystem has to receive information at all the time from other units and analysis this information. It may take times to make decision to control itself at some case. Table 1 shows comparison between central and decentralized control scheme of the micro grid [5, 6].

**Table1. Comparison between centralized and decentralized control scheme [6]**

	Advantages	Disadvantages
Centralized control scheme	Easy implementation	High computational ability at central controller
	Easy maintenance	High bandwidth communication links needed.
	Low cost	Failure of central unit is critical
	Wide control over the entire system	Congestion at central node.
Decentralized control scheme	Easier expansion	Synchronization is needed.
	Low computational ability at each unit	Need time to make decision
	Robust for single point failure	Several maintenance points
	Suitable for large-scale, complex, heterogeneous systems.	New communication structure is needed.

The advanced metering device is installed at power loads and gets energy consumption data from various loads in the customer side. All customer side power applications or loads communicate with Smart Meter (SM) [7] with home network or Local area Network. The smart meter sends acquired data from customer side load to central controller. Also customer can get information like real time energy price and automated billing for a day or a week. The Smart Meter has several functions as follows:

- Real time pricing
- Payment or Prepayment
- Communication with other devices
- Monitoring power quality
- Energy consumption data

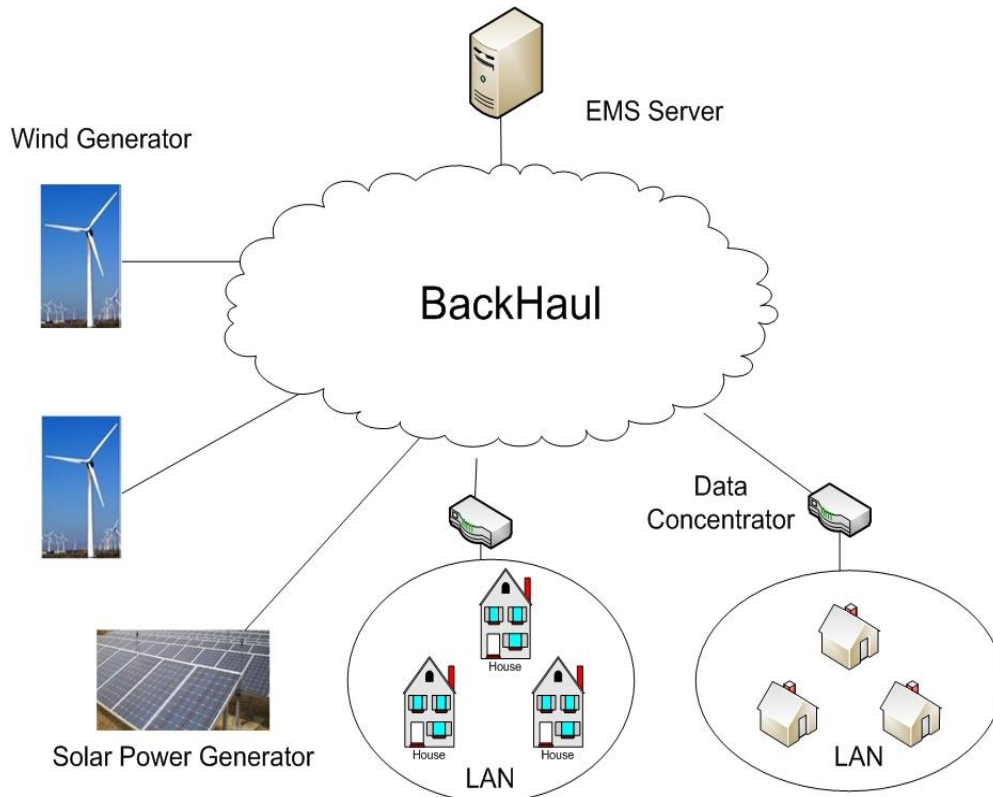
### 3. Communication technologies for micro grid

The communication infrastructure of the micro grid should provide continuous connection with all units in the micro grid. In central control scheme a central controller must interact with all units to manage the micro grid. Figure 2 shows an

example of communication infrastructure. Several kinds of network topologies can be used for the micro grid.

### 3.1 Technologies for Backhaul

A local data concentrator is commonly used to collect data from several groups of meters and devices to send the data to the central controller through backhaul. The selection of a communication technology and network topology for backhaul is not limited however latency requirement of the micro grid should be considered.



**Figure 2. Communication Infrastructure of Micro grid**

Numerous technologies for communication can be considered for backhaul of the micro grid as follows:

- Power Line Communication & Broadband over Power Line (BPL)
- Wired communication (DSL & FTTX)
- Wireless communication (Wi-Fi and ZigBee)
- Cellular communication (WiMAX and LTE)

A conventional dedicated wire like as copper and fiber optic cable are fast and most reliable medium for the micro grid however deployment of new wire is difficult and costly.

Power Line Communication (PLC) uses existing power cable as a medium. Therefore installation of new cable is not needed. But many repeaters are necessary to compensate attenuation of the signal.

Wireless communication is a promising technology for the micro grid [8]. Because wireless communication does not need any physical connection it is easy to install the wireless communication system. It also has high scalability. WiMax and LTE cover large scale area and support high data rate. But they are costly because of licensing & subscription fee. Wi-Fi and ZigBee just support short range communication. Therefore several intermediate nodes may be necessary to transmit data to the central controller. Both are cost effective technologies but ZigBee has limitation of low data rate.

### **3.2 Communication Technology for Local Area Network**

Home Area Network (HAN) or Local Area Network (LAN) is used for customer side network. For wired technology Ethernet and PLC are used for HAN or LAN. PLC is economical because of using existing power cable and in house or small building environment PLC can support high data rate and reliable connection for HAN. For wireless technology Bluetooth, Wi-Fi (IEEE 802.11) and ZigBee (IEEE802.15) are considered. The ZigBee consumes less power than Wi-Fi and provides acceptable data rate for communication for Smart Meter. In the case of wireless mesh network all smart meters and devices are connected directly or via intermediate nodes. The local concentrator receives data from all units in the HAN and communicates with the central controller of the micro grid.

## **4. Conclusion**

The micro grid is a small scale energy system with distributed power resources. The micro grid is an ideal power system for using renewable power resources. This paper presents a brief overview of micro grid. The data management of the micro grid is described and communication infrastructure is well explained. The Energy Management System (EMS) interacts with all subsystems in the micro grid through communication channel. The Local concentrator gathers information from several groups of smart meter and device then sends these data to central controller via backhaul. For backhaul MiMAX and LTE is adequate for long distance communication to meet the requirement of latency in the micro grid. For customer side network, Powerline communication and wireless mesh network with ZigBee may be an ideal choice for implementing home area network or local area network.

## **References**

- [1] N. Hatziaargyriou, H. Asano, R. Iravani and C. Marnay, "Microgrid" IEEE Power&Energy, (2007) July, pp. 78-94
- [2] R. H. Lasseter, "Microgrids", in proceedings of the IEEE Power Engineering Society Winter Meeting, (2001), pp. 146-149.
- [3] F. katiraei, R. Iravani, N. Hatziaargurian and A. Dimeas, "Microgrids Management", IEEE Power&Energy, (2008) May, pp. 54-65.

- [4] N. Cai, J. Wang and X. Yu “SCADA system security: Complexity, history and new developments”, IEEE International conference on Industrial Information, **(2008)**, pp. 569-574.
- [5] F. Katiraei, R. Iravani, N. Hatziaargyriou and A. Dimeas, “Microgrids Management- Control and Operation Aspects of Microgrids”, IEEE Power and Energy Magazine, **(2008)**.
- [6] W. Su and J. Wang, “Energy Management Systems in Microgrid Operations”, The Electricity Journal, **(2012)** October.
- [7] “Smart Meter”, [http://en.wikipedia.org/wiki/Smart\\_meter](http://en.wikipedia.org/wiki/Smart_meter).
- [8] V. C. Gungor, D. Sahin, T. Kocak and S. Ergut, “Smart Grid Technologies; Communication Technologies and Standards”, IEEE Transaction Industrial Information, vol. 7, Issue 4, **(2011)** November, pp. 529-539.

