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A Novel Architecture for Data Management and Control in Autonomous Intelligent Microgrid

R. Hari Kumar* and S. Ushakumari

College of Engineering Trivandrum, Thiruvananthapuram, Kerala, India

Abstract

Intelligent microgrid with distributed energy sources is considered as the next generation grid to mitigate the present day power system issues. Intelligent microgrid should facilitate monitoring and distributed control of the system using smart components. For effective, reliable and intelligent operation of such a system, it needs to use the advanced communication and intelligent information processing techniques. This paper explores the possibility of managing an autonomous intelligent microgrid with prioritized loads, utilizing the existing communication networks to acquire data and manage from a central location. The central control center runs an energy management algorithm, utilizing the load and source data acquired from the clients, to maximize the power delivery to the higher priority loads. The proposed scheme enables the consumers to dynamically set their load priority and fix the rate for selling the power generated by them within the autonomous grid, thereby ensuring consumer participation in the development of power infrastructure. Further, a load management algorithm for the reliable operation of autonomous intelligent microgrid with prioritized loads is proposed and its effectiveness is illustrated with a case study.

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Keywords: Autonomous Microgrid; Data Acquisition; Data Management; Intelligent Control; Prioritized Load Management.

1. Introduction

Conventional electric power system consists of three basic components; the generating station, the transmission system and the distribution system. In this scheme, large quantum of energy is generated at generating stations located far away from the load center using fossil fuels, nuclear and hydro sources. This energy is exported to the distribution system through the transmission lines which connects the generating stations and the distribution systems. Further, the distribution system feeds the individual loads in a locality.

With the ever increasing population, the per capita energy consumption has increased drastically, which demands increased power generation. In addition, power quality, reliability, environmental concerns and energy efficiency are the major issues to be confronted in the present-day power system. It is extremely difficult to address these issues with the existing infrastructure and can be achieved only by investing a significant amount for its upgradation. An alternative to meet these requirements in the deregulated power system scenario is to integrate small scale, modular and highly efficient DGs in the distribution system. Various distributed generation technologies, which are usually located in the

*Corresponding author. Tel.: +91-944-670-7870.
E-mail address: harikumar.cet@gmail.com

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consumer sites include, photovoltaics, wind turbines, fuel cells, micro-turbines and diesel generators. If the DGs are properly planned, there will be reduction in distribution losses, improvement in the voltage profile and reliability of the system. However, these DGs can cause as many problems as it may solve[1]. Hence, a better way to extract maximum benefits from DG and manage network safely and efficiently is to develop a system approach which considers a collection of generators and loads as a subsystem, called microgrid[2].

Nomenclature

IMG	Intelligent Microgrid
DG	Distributed Generator
DCM	Data Collection Module
CDLCM	Client Data Logging and Control Module
CMCM	Central Management and Control Module
ANN	Artificial Neural Network
MLP	Multilayer Perception
ICT	Information and Communications Technology

In microgrid perspective, the consumers are more demanding and the performance indicators are not only voltage, reactive power and load, but also the priority of load, reliability, cost, emissions and the revenue from the distributed generators installed at their premises. These additional considerations increase the complexity of the design and operation of microgrid than that of the conventional distribution system. This demands the development of a novel architecture for data management and control to ensure stable and reliable operation of microgrid, with prioritized loads, in autonomous mode. Such an infrastructure must have intelligent distributed and centralized controllers to mitigate the power imbalance between generation and demand. Further, it must have robust operating capability with plug-and-play features, wherein new sources and loads can be added to the existing system without any topology changes. Moreover, there must be algorithms for optimal management, and operation based on customer requirements. Such increased visibility and control of generation and demand in IMG will enable the utility to promote the integration of renewable based distributed generation, with increased grid reliability and security. The illustration of an autonomous intelligent microgrid is shown in Fig. 1.

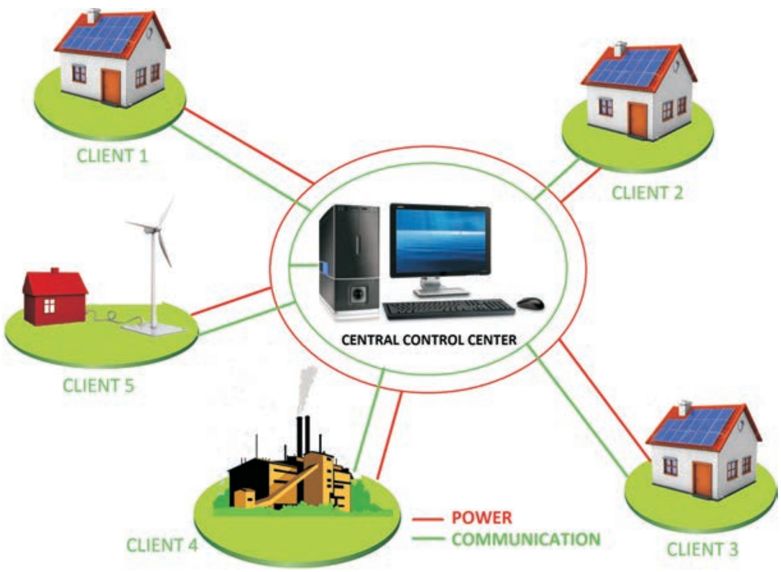

Fig. 1. Autonomous Intelligent Microgrid.