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A Review on Development of Micro-Grid with load

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Abstract- Micro grids are modern, small scale, decentralized electrical energy system. These are solution for energy crisis, along with improving the power supply reliability, quality and efficiency .A small scale system and located near the consumer is called the Micro-Grid (MG) system. The interconnection of small generation to low voltage distribution systems can be termed as the Micro Grid. Micro Grids can be operated with and without a connection to the main power network. Micro-Grid(MG) is basically a low voltage (LV) or medium voltage (MV) distribution network which consists of a cluster of micro-sources such as photo-voltaic array, fuel cell, wind turbine etc. called distributed generators (DG's); energy storage systems and loads; operating as a single controllable system, able to operate in both grid-connected and islanded mode. In a micro-grid the DG's has sufficient capacity to carry all, or most of the load connected to the micro-grid. This paper presents the development of these micro-sources i.e photo voltaic array, fuel cell stack along with their power electronic interfacing circuits viz. boost converter, PWM inverter in Matlab/Simulink and finally combining these models to form a Micro-Grid. This paper aims at explaining a generalized Energy Management System involving the concept of a micro grid.

Keywords: Micro-grid, grid-connected mode, PWM inverter, distributed generators.

1.Introduction: The microgrid concept has been researched and implemented intensively by many experts worldwide with significant research conducted in U.S., E.U., Japan, and Canada. The interest on microgrid increases due to its potential benefits to provide reliable, secure, efficient, environmentally friendly, and sustainable electricity from renewable energy sources (RES). Before the microgrid concept was introduced, many researches had been conducted on distributed generation (DG). Researchers soon realized that installing individual DG in power systems may create problems as many as it solves. Hence, microgrid concept was proposed to overcome those problems [1]. MG provide higher flexibility and reliability as it is able to run in both grid connected and islanded mode of operation and its components may be physically close to each other or distributed geographically. To meet the increasingly growing demand of electricity,

and to improve energy utilization efficiency and reliability , new power generation technologies, including renewable energy , clean and efficient fossil fuels, distributed generations have been developed. The micro grid concept is based on the assumption that large numbers of micro generators are connected to network to lower the need of transmission and high voltage distribution system. However the micro grid can be integrated with the distribution system but it can also produce a threat to the safe and reliable operation of the grid due to the net loss in line flow, voltage and power quality [2]. Micro-grids may play a useful role in the future evolution of energy sector but the modes may be at variance with those of developed economies [3].

As energy generation and distribution companies compete in the market place, we have seen an increasing interest in renewable and alternative energy sources. In addition to this competition, companies are seeking demands from customers for higher quality and cleaner electricity. Also, considering the worlds coal stocks are reducing and the creation of legislation which is pushing for greener energy solutions, we are led to seek new energy generation methods. One solution which is currently attracting attention is Micro-Grid systems [4].

A Micro-Grid is a low voltage or medium voltage distribution network which consists of a cluster of micro sources/distributed generators, energy storage systems and loads, operating as a single controllable system. In a MG, the distributed generators should have sufficient capacity to carry all, or most, of the load connected to the MG. Distributed generators are located at strategic points, normally at the distribution level, near load centres, and used for capacity support, voltage support and regulation, and line loss reduction [5].

The micro-sources or distributed generators are usually made of many new technologies, e.g. fuel cell, photo-voltaic system and several kinds of wind turbines. These units having small capacities are interfaced with power electronics and are placed at the consumer sites. Power electronics provides the control and flexibility required by the micro grid system. The inclusion of energy storage systems (batteries/flywheels/super capacitors) in a Micro grid system allows the excess power produced, to be stored or alternatively the excess power could be put into the main grid [6].

Micro-grid is inevitable in future due to its obvious advantages in reduced central generation capacity , increased utilization of transmission & distribution capacity ,enhanced system security and reduced CO2 emission. However, micro-grid adds a number of complexities in control and protection aspects in a traditional distribution system [7].

Microgrid controllers have responsibilities to ensure that [8]:

1. Micro sources work properly at predefined operating point or slightly different from the predefined operating point but still satisfy the operating limits;
2. Active and reactive powers are transferred according to necessity of the microgrids and/or the distribution system;
3. Disconnection and reconnection processes are conducted seamlessly;
4. Market participation is optimized by optimizing production of local micro sources and power exchanges with the utility;
5. Heat utilization for local installation is optimized;
6. Sensitive loads, such as medical equipment and computer servers are supplied uninterruptedly;
7. In case of general failure, the microgrid is able to operate through black-start; and
8. Energy storage systems can support the microgrid and increase the system reliability and efficiency.

2. Micro Grid Components

A. Distributed Energy Resources.

Distributed energy resource (DER) systems are small-scale power generation technologies used to provide an alternative to or an enhancement of the traditional electric power system. Distributed Energy Resources (DER), including distributed generation (DG) and distributed storage (DS), are sources of energy located near local loads and can provide a variety of benefits including improved reliability if they are properly operated in the electrical distribution system. Micro grids are systems that have at least one distributed energy resource and associated loads and can form intentional islands in the electrical distribution systems. Within micro grids, loads and energy sources can be disconnected from and reconnected to the area or local electric power system with minimal disruption to the local loads [9].

B. Distributed Generation (DG).

Distributed Generation units are small sources of energy located at or near the point of use. DG technologies typically include photovoltaic (PV), wind, fuel cells, micro turbines, and reciprocating internal combustion engines with generators. These systems may be powered by either fossil or renewable sources. Some types of DG can also provide combined heat and power by recovering some of the waste heat generated by the source such as the micro turbine. This can significantly increase the efficiency of the DG unit. Most of the

DG technologies require a power electronics interface in order to convert the energy into grid-compatible ac power. The power electronics interface contains the necessary circuitry to convert power from one form to another. These converters may include both a rectifier and an inverter or just an inverter. The converter is and contains the necessary output filters. The power electronics interface can also contain protective functions for both the distributed energy system and the local electric power system that allow paralleling and disconnection from the electric power system. These power electronic interfaces provide a unique capability the DG units and can enhance the operations of a micro grid [10].

C. Distributed storage (DS).

Distributed storage technologies are used in micro grid applications where the generation and loads of the micro grid cannot be exactly matched. Distributed storage provides a bridge in meeting the power and energy requirements of the micro grid [11]. Storage capacity is defined in terms of the time that the nominal energy capacity can cover the load at rated power. Storage capacity can be then categorized in terms of energy density requirements (for medium- and long-term needs) or in terms of power density requirements (for short- and very short-term needs). Distributed storage enhances the overall performance of micro grid systems in three ways. First, it stabilizes and permits DG units to run at a constant and stable output, despite load fluctuations. Second, it provides the ride-through capability when there are dynamic variations of primary energy (such as those of sun, wind, and hydropower sources).

3. Types Of Micro Grid

Micro grids are classified in three types

A. Utility Microgrids

Utility micro grid can locally meet load growth and manage congestion on distribution feeders and medium-voltage sub transmission networks. At the utility level, small hydro, medium-size wind/photovoltaic (PV) generation farms, biomass, and biogas fuelled power generation plants are some of the alternative renewable energy sources that can be deployed along with low-emission gas-turbine generators to provide adequate levels of supply mix [12].

B. Commercial and Industrial Micro grids.

Commercial and industrial electricity users are normally defined as critical and/or sensitive load classes demanding a high degree of power quality and reliability. A critical load may not tolerate momentary power outages and the level of power quality typically found on most grids. A micro grid can be adopted to serve load demand of a multiple industrial/commercial facility; e.g., a university campus, a shopping centre, or an industrial installation [13].

C. Remote Micro grids.

Remote grids, which are necessary due to geographical features, such as islands. Depending on the geographical characteristics of a remote area and resource availability, diverse types of generation sources such as small-hydro, wind-turbine, solar PV, and low emission gas-turbine sources can be used. A major distinction in remote micro grid design is that the generation sources in a remote micro grid have to be sized to serve the entire load along with an adequate level of reserve capacity for contingency management [14].

4. Operation Of Micro Grid.

Basic Micro grid architecture is shown in figure 1. This consists of a group of radial feeders, which could be part of a distribution system or a building's electrical system. There is a single point of connection to the utility called point of common coupling. Some feeders, (Feeders A-C) have sensitive loads, which require local generation. The noncritical load feeders do not have any local generation. In our example this is Feeder D. Feeders A-C can island from the grid using the static switch which can separate in less than a cycle. In this example there are four micro sources at nodes 8, 11, 16 and 22, which control the operation using only local voltages and currents measurements. When there is a problem with the utility supply the static switch will open, isolating the sensitive loads from the power grid. Feeder D loads ride through the event. It is assumed that there is sufficient generation to meet the loads' demand. When the Micro grid is grid-connected power from the local generation can be directed to feeder D [15].

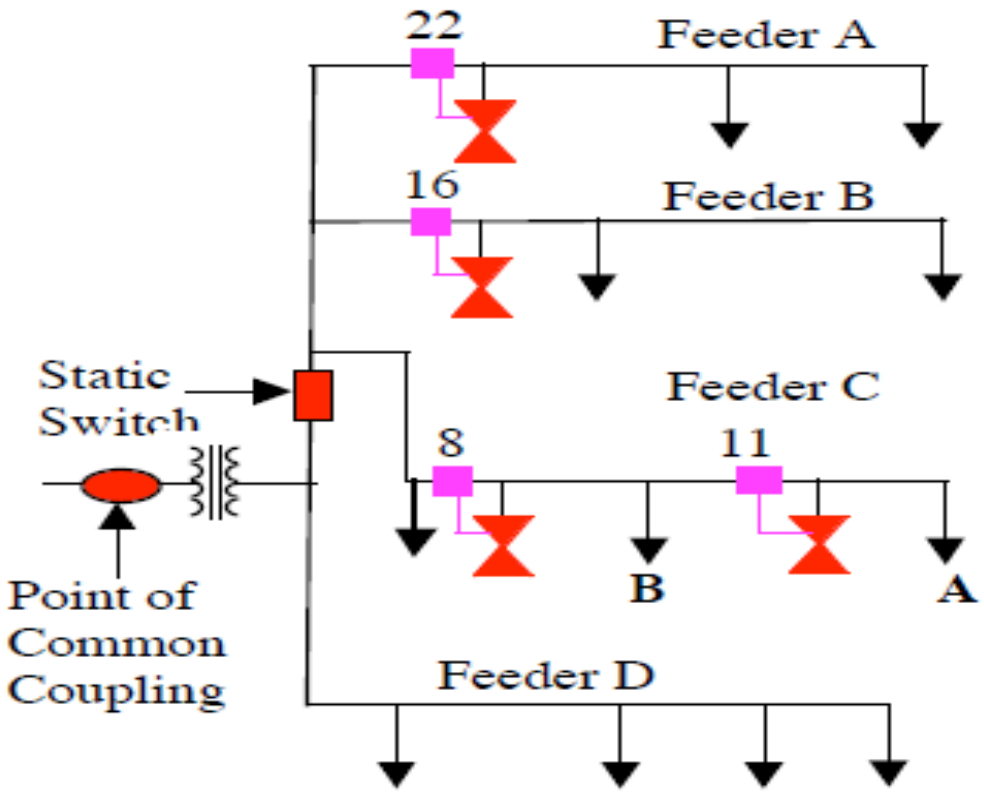

Fig 1. Micro grid

5. Features Of Growth Model Of Microgrid.

Features of growth model of micro grid [16] shows that the micro grids as attractive for accommodating a wide range of growth needs, mechanisms, and paths.

A. Autonomy: Micro grids allow for generation devices from a wide variety of primary energy sources, often renewable, along with storage devices and controlled loads operating in an autonomous fashion hopefully without need for fast real-time communication and control, as has been demonstrated by the consortium for Electric Reliability Solutions micro grid, and others[17].

B. Stability: The control approaches based on appropriate droop in frequency and voltage at the terminals of each of the devices in a micro grid can allow the entire network to operate in a stable manner during nominal operating conditions and during transient events.

C. Compatibility: Micro grids compliment and participate as a functional unit within the existing centralized legacy grid whose expansion is inhibited [18]. This combination ensures that there are no stranded assets and that resources are utilized to their design capacity for their plannedlifetime.

D. Flexibility: The rate of expansion and growth of micro grids need not be precisely forecast. Devices can be added as the need arises and presuming they are compatible with operating protocols, with neighbouring micro grids, or with the micro grid, as appropriate. Micro grids might be entirely technology neutral and accommodate diverse sources such as solar, wind, conventional fossil, storage devices, and end-use equipment [19].

E. Economics: The droop control technique allows for behavioural properties in response to costs, and market signals can be programmed into the operating protocol of the micro grid. The technical conceptualization does not dictate any particular pricing, market, or settlement mechanism within the micro grid, or in the transaction with the central grid.

f. Efficiency. Energy management layers can be accommodated within the framework to allow for concerns such as operating efficiency, environmental emissions, heat harvest, etc., to be optimized in a systematic manner [20].

6. Conclusion

Micro grids will provide improved electric service reliability and better power quality to end customers and can also benefit local utilities by providing dispatch able load for use during peak power conditions and alleviating or postponing distribution system upgrades. There are a number of active micro grid projects around the world involved with testing and evaluation of these advanced operating concepts for electrical distribution systems.

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