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On Recent Advances in Electrical Engineering

A Review of Recent Developments in Micro Grid

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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. Any time a micro grid is implemented in a electrical distribution system and it have optimal size and need optimal location. Here, the concept of micro grid including, it's architecture, types, operation, controlling, management and about growth model, advantages and disadvantages of micro grids have summarized.*

Keywords: *Micro grid, point of common connection (PCC), grid-independent (GI), Smart generation, FACTS, HVDC, DG, GDP, ACM.*

I. INTRODUCTION

Economic, technology and environmental incentives are changing the face of electricity generation and transmission. Centralized generating facilities are giving way to smaller, more distributed generation partially due to the loss of traditional economies of scale. Penetration of distributed generation across the world has not yet reached significant levels. However that situation is changing rapidly and requires attention to issues related to high penetration of distributed generation within the distribution system [1].

The micro grid concept assumes a cluster of loads and micro sources operating as a single controllable system that provides both power and heat to its local area. This concept provides a new paradigm for defining the operation of distributed generation. To the utility the micro grid can be thought of as a controlled cell of the power system. To the customer the micro grid can be designed to meet their special needs; such as, enhance local reliability, reduce feeder losses, support local voltages, provide increased efficiency through use waste heat, voltage sag correction or provide uninterruptible power supply functions to name a few [2]. Micro grids comprise low voltage (LV) distribution systems with distributed energy resources (DERs) such as micro turbines, fuel cells, photovoltaic (PV) arrays, etc., together with storage devices (i.e., flywheels, energy capacitors, and batteries) and controllable loads, offering considerable control Capabilities over the network operation. These systems are interconnected to the medium voltage (MV) distribution network, but they can be also operated isolated from the main grid in case of faults in the upstream network. From the customer point of view, micro grids provide both thermal and electricity needs and in addition enhance local reliability, reduce emissions, improve power quality by supporting voltage and reducing voltage dips, and potentially lower costs of energy supply. From the grid's point of view, a micro grid can be regarded as a controlled entity within the power system that can be operated as a single aggregated load or generator and, given attractive remuneration, as a small source of power or ancillary

services supporting the network. Thus, micro grids comprise the coordinated behavior of DERs and DR, maximizing their benefits to customers and grids [3].

II. Micro grid Architecture

A micro grid may comprise part of MV/LV distribution systems and clustered loads that are served by single or multiple DERs. From the operation perspective, a micro grid may operate with a point of common connection (PCC) to the rest of the area's electric power system and/or seamlessly transfer between two states of the grid-connected and an isolated grid (IG) mode. While physically connected to the main grid, the operating and control mode of the micro grid may shift between a grid-dependent (GD) mode or a grid-independent (GI) mode (autonomous mode) depending on power exchange and interaction of the micro grid with the backbone system [4].

The micro sources of special interest for Micro grids are small (<100-kW) units with power electronic interfaces. These sources, (typically micro turbines, PV panels, and fuel cells) are placed at customers sites. They are low cost, low voltage and have high reliable with few emissions. Power electronics provide the control and flexibility required by the Micro grid concept. Correctly designed power electronics and controls insure that the Micro grid can meet its customers as well as the utilities needs [2]. Micro grids consist of several basic technologies for operation, Such as DG, DS, and control system.

Increasing reliability, efficiency and safety of the power grid. Enabling decentralized power generation so homes can be both an energy client and supplier (provide consumers with interactive tool to manage energy usage).Flexibility of power consumption at the client side to allow supplier selection (Enables distributed generation) [4].Increase GDP by creating more jobs related to energy industry in industry manufacturing, plug-in electric vehicles, solar panel and wind turbine generation and also in information technology industry.

Enabling informed participation by customers

- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Providing the power quality for the range of needs in the digital economy
- Optimizing asset utilization and operating efficiently
- Addressing disturbances through automated prevention, containment, and restoration
- Operating resiliently against all hazards

These objectives can be met by adopting the latest technologies to ensure success, while retaining the flexibility to adapt to further developments. Advances in simulation tools will greatly assist the transfer of innovative technologies to practical application for the benefit of both customers and utilities. Developments in communications, metering and business systems will open up new opportunities at every level on the system to enable market signals to drive technical and commercial efficiency [3].

III. 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 [5].

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 [5].

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. 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).

IV. TYPES OF MICRO GRID

Micro grids are classified in three types

A. Utility Micro grids.

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 [4].

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 [4].

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 [4].

V. 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 [1].

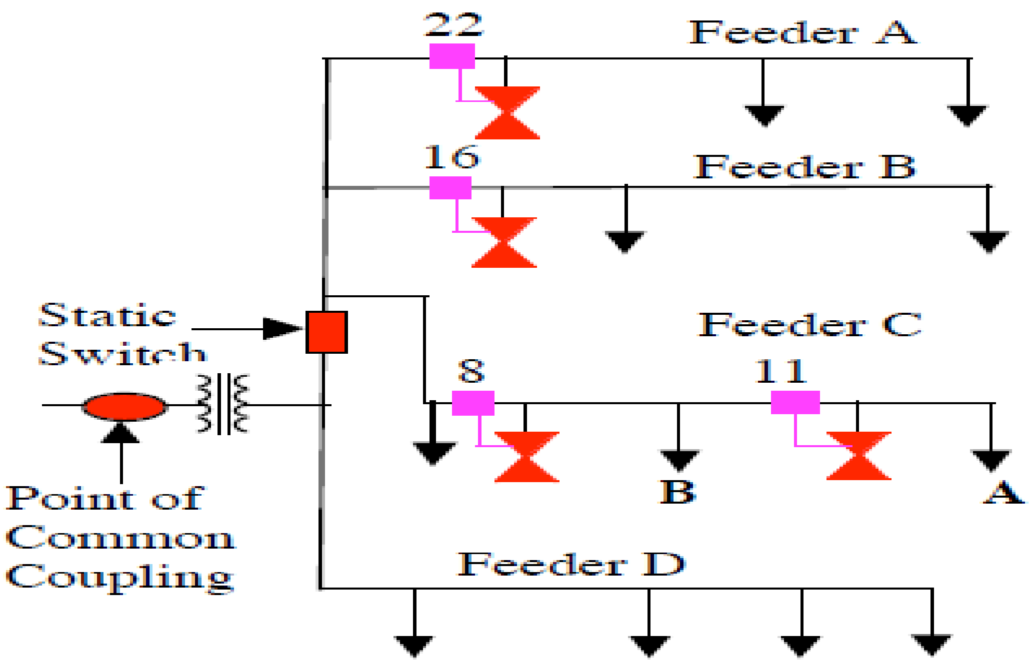

Fig 1. Micro grid [1].

VI. FEATURES OF GROWTH MODEL OF MICROGRID.

Features of growth model of micro grid [8] 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.

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. This combination ensures that there are no stranded assets and that resources are utilized to their design capacity for their planned lifetime.

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 neighboring 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.

e. Economics.

The droop control technique allows for behavioral 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.

VII. VII.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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