Chapter 10
Evolution of Islanding Detection Methods for Microgrid Systems

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ABSTRACT

A microgrid is a representation of controllable electrical power network, which comprises the distributed generation (DG) such as micro-hydro, wind turbines, photovoltaic arrays, bio-mass generation, battery energy storage systems (BESSs), and a group of interconnected load. A typical microgrid can be operated in either grid connected or island mode. The issue of unintentional islanding in microgrid is a major challenge for power engineers as it may harm the service personnel working during maintenance or restoration of the main grid. In literature, various passive, active, and hybrid islanding detection methods (IDMs) have been developed and implemented by researchers/engineers. In this chapter, the proposed IDMs from the recent literature have been analyzed and briefly discussed. The primary requirement of IDMs is fast and accurate detection of main grid failure and should not deteriorate the power quality of distribution networks.

INTRODUCTION

Microgrid is a group of small, interconnected electrical network consisting of distributed energy resources (DERs), energy storage devices, load and have the capability to act as a single controllable power network (Farrokhabadi et al., 2020). A Microgrid can be interconnected at low (400 V) and medium voltage (69 KV) distribution networks. Also, it can be operated in both grid connected or island mode. The term islanding is defined as the phenomena in which both generation and connected load of mirogrid becomes isolated from the main utility grid. As shown in Figure 1., the microgrid is connected to the distribution network through point of common coupling (PCC) with the main grid. To ensure the microgrid operational stability and reliability, the primary and secondary controls are used. The main function

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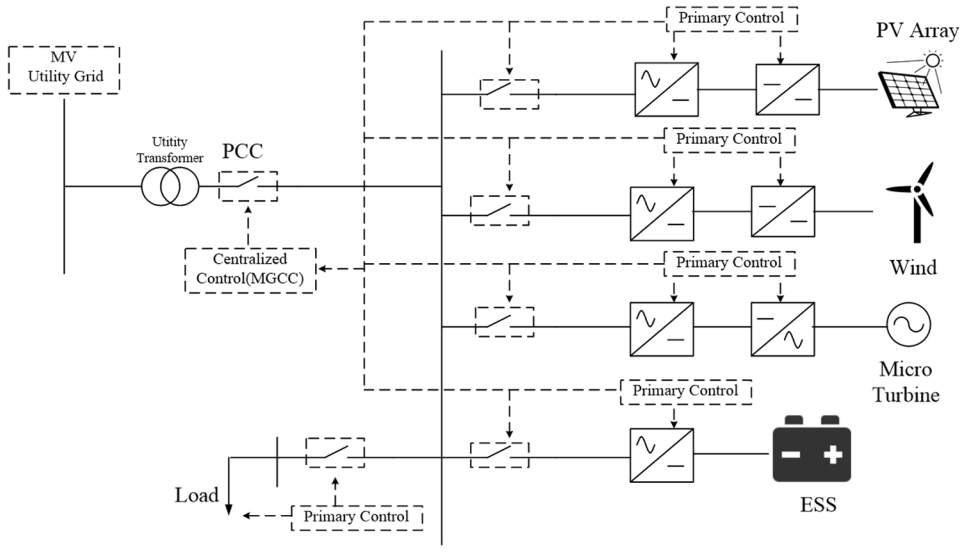
of controllers includes: (i) To maintain the equilibrium among power generations and connected loads (ii) keeping the microgrid voltage, frequency within desired limits (iii) demand side management and economic dispatch (iv) smooth switching between various mode of operation (v) islanding detection. The primary control includes the active and reactive power flows, control of voltage and frequency. The microgrid central controller (MGCC) facilitates a high level management of the microgrid operation and connected to the primary controllers through communication links (Justo et al., 2013).The distributed energy sources, i.e., solar photovoltaic (PV), wind energy, microturbines, energy storage system (ESS) etc. are connected to a distribution feeder through the power electronics converters (i.e., DC/AC, AC/DC, DC/DC). When microgrid connects to grid, the DER operates in a current control mode to regulate the active and reactive power exchange with the main grid. While during island operation, the microgrid drives in voltage control mode to regulate the voltage and to maintain balance among generations and load demands by generation curtailment or load shedding. According to IEEE 1547 standard, **"***An island is defined as a condition in which a portion of an area electric power system (EPS) is energized solely by one or more local EPSs through the associated PCCs while that portion of the area EPS is electrically separated from the rest of the area EPS*" (IEEE Application Guide, 2009).

Figure 1. Typical configuration of Microgrid



The unintentional islanding is an undesirable phenomena, it may cause of safety hazard to service personnel working on the main grid and can also lead to damage of utility equipment due to asynchronous reclosing of circuit breakers. The islanding operation includes two scenarios: (i) intentional/planned islanding (ii) unintentional/unplanned islanding. The intentional/planned island operation is done for maintenance purposes, long term voltage dips or general faults in the main grid. The unintentional/ unplanned islanded operation can lead to threat to the emergency service personnel, utility workers, and public because the DER represent an unknown source(Bevrani et al., 2014). According to IEEE 1547 standard, "*For an unintentional island in which the DR energizes a portion of the Area EPS through the*