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Review on Observation and Identification of Islanding Phenomenon PV Connected Single DC Link

Jitendra Singh Solanki, Assistant Professor Raghunandan Singh Baghel
School of Engineering &Technology, Vikram University Ujjain, Department Electrical Engineering

Abstract- As distributed generators increase their importance on the electric power system, more and more parameters have to be controlled in order to assure the proper operation of the utility. One of the main problems encountered with this kind of generation is the potential formation of islands which could keep working in a normal way even if the utility grid has failed. Many methods have been developed to prevent this situation and they have been classified into three groups: passive, active and methods based on communication systems. This paper checks the validity of some of the active and passive anti-islanding methods. Some of them are shown to work properly with any kind of utility and local loads in the potential island. On the other hand, some others would not disconnect the power generator when the total power of the local load fits that of the generator.

Index Terms- Anti-islanding methods, renewable energies, dispersed generation, grid-tied inverters.

I. INTRODUCTION

As the distributed generation (DG) industry continues its path of rapid growth and technological revolution, integrated power and energy networks are emerging as a fundamental enabling technology. With the increasing energy demands globally and fear of depleting conventional fossil fuels, the integration of DG networks has become essential [1].

The integration of DG systems with conventional power networks has primarily been increased by providing significant relief in the technical and commercial development. DG networks offer the benefits of producing reliable electricity onsite, thereby reducing the need to build new transmission lines and avoiding the line losses [2]. DG units offer significant assistance to power system consumers while adding flexibility to an electric grid based on the traditional centralized model [3].

These systems are used in applications ranging from residential to small commercial, and to industrial users. Due to the economic, environmental, and strategic benefits offered by renewable energy resources, the current energy market is significantly developed and moving towards decentralization [4].

In the microgrid system, DG units are categorized as voltage control, commonly termed as grid-forming, and current control, commonly termed as grid-following [5]. Usually, in the grid-connected operation, DG units are controlled as grid-following, while in an islanded operation, they are controlled as grid-forming. Therefore, the conventional control and protection strategies are not capable enough to handle the transfer of electrical power and manage several parallel operations [6]. Islanding operation is, therefore, critically studied and analysed by the researchers to present the best solutions for a technically coordinated operation of the microgrid and the main utility grid. Among the challenges associated with integrated power distribution networks (IPDNs), islanding detection is an essential and difficult task.

II. DG ISLANDING

DG islanding refers to a situation in which distributed generation (DG) units (such as solar panels, wind turbines, small hydroelectric plants, or backup generators) continue to power a local area (an "island") despite being disconnected from the broader power grid. This disconnection can be intentional or unintentional and can occur for various reasons, including grid faults, maintenance, or extreme conditions that compromise the stability of the main grid.

1. Types of Islanding

Intentional Islanding

This occurs when a micro grid or a portion of the distribution network with DG deliberately disconnects from the main grid to maintain local power supply. Intentional islanding is often a controlled process, used for reasons such as enhancing reliability, reducing peak loads on the main grid, or improving power quality within the islanded area.

Unintentional Islanding

This happens without planning, often as a result of a fault in the power grid (e.g., a downed power line). In such cases, DG units may continue to supply power to local loads without coordination with the main grid, potentially creating safety risks and technical challenges.

III. CHALLENGES AND CONSIDERATIONS

1. Safety
One of the primary concerns with islanding, especially unintentional, is the safety of utility workers. If a DG unit continues to feed electricity into what is supposed to be a de-energized line, it can pose a serious risk to personnel working on repairs.

2. Power Quality
Islanding can lead to issues with power quality, including frequency and voltage regulation. DG units may not be capable of maintaining stable conditions within the islanded segment without sophisticated control systems.

3. Protection and Detection
Effective islanding detection and protection mechanisms are crucial to quickly identify and either maintain or terminate an islanded condition, depending on its intentionality and safety. Anti-islanding protection is a standard requirement for DG installations to prevent unintentional islanding.

IV. SOLUTIONS AND TECHNOLOGIES

Modern smart grid technologies and advanced control systems (such as those used in micro grids) enable better management of intentional islanding, allowing for more flexible and resilient power systems. These systems can automatically control DG units, storage devices, and loads to maintain stable and safe operation during both islanded and grid-connected modes. Effective detection and protection strategies are integrated into inverters and other components of DG systems to quickly respond to changes in grid conditions.

DG islanding, particularly when managed intentionally and with appropriate controls, can offer benefits like enhanced reliability, improved grid resilience, and support for the integration of renewable energy sources. However, addressing the challenges associated with unintentional islanding is essential for the safety and stability of both the main grid and the DG systems.

V. LITERATURE REVIEW

Byunggyu Yu et al Islanding phenomenon is undesirable because it leads to a safety hazard to utility service personnel and may cause damage to power generation and power supply facilities as a result of unsynchronized re-closure. Until now, various anti-islanding methods (AIMs) for detecting and preventing islanding of photovoltaic and other distributed generations (DGs) have been proposed. This paper presents an overview of recent anti-islanding method developments for grid-connected photovoltaic (PV) power generation, focusing on the concept and operating principle, mainly based on single phase system. For the performance comparison, the experimental results of the various AIMs with 3 kW PV inverter are provided based on the islanding detection capability and power quality. As a result, the active AIMs have better islanding detection capability rather than the passive one. However, the active AIMs have power quality degradation on harmonic distortion or displacement power factor based on the injected active signal type. In addition to the evaluation and comparison of the main anti-islanding methods, this paper also summarizes the related anti-islanding standards to evaluate anti-islanding capability for PV system. This paper can be used as a useful anti-islanding reference for future work in DG like PV, and wind turbine.

Nattapong Chayawatto et al Nonlinear modeling of a dc–ac full-bridge switching converter PV grid-connected system under islanding phenomena is proposed. It is a model that can be easily derived by using simple analytical techniques. A state-space averaging technique (no linearization) and voltage source inverter with current control are performed as "large-signal modeling" that is used to analyze the dynamic response of load voltage under 3 different resistive loads: 125%, 100% and 25% of inverter output and RLC when the grid system is disconnected as well as a step change of load. The nonlinear equation from the proposed modeling is handled by MATLAB/SIMULINK. The results of the proposed model are compared with experiments and PSpice simulation which shows good agreement among them. Moreover, it is found that the proposed model consumes much less computation time than PSpice and does not encounter any convergence problem.

Mohammadhesam Hasanisadi et al Islanding occurs when a utility-interactive distributed generator (DG) is disconnected from the utility grid and continues to supply power to local loads. This condition has several consequences including damage to the equipment and personnel safety risks. Therefore, it is required by utility interconnection standards for the DG to stop energizing local loads in the case of islanding. In this paper, an active islanding detection method (IDM) based on injecting a disturbance into the phase-locked loop (PLL) of a grid-connected photovoltaic (PV) inverter and monitoring the harmonic components of the point of common coupling (PCC) is proposed. A modified Goertzel algorithm is utilized to detect the injected harmonic which is effective for a wide range of load conditions in terms of load quality factor, resonant frequency, and reactive power.

The simulation results in MATLAB/Simulink show that the proposed technique is fast with minimum side effects on power quality features such as output current total harmonic distortion (THD). This method is implemented on a single phase 5 kW grid-tied PV inverter and is tested experimentally. The experimental results verify that the proposed technique is fast with zero non-detection zone (NDZ) which is effective for a variety of load conditions.

Debanjan Mukherjee et al The scarcity of fossil fuel in near future drove the researchers in integrating renewable energy sources with existing grid network. Among all the renewable energy sources, Photovoltaic (PV) system has its firm position in the heart of the research in power engineering owing to its advantages over the other alternatives. For connecting PV system with the grid, Cascaded H-Bridge (CHB) Multilevel Inverter (MLI) is generally preferred over conventional topology due to its isolated DC source provision. But due to the large size, cost, weight of CHBMLI, the researchers have moved to design Reduced Switch MLI (RSMLI).

In line with these PV applications, a 5 level RSMLI topology has been proposed as a maiden application for solving the problem of interfacing the PV system with the grid. Moreover, the optimized firing angles for the RSMLI can be used to improve the output power quality, low value of percentage Total harmonic Distortion (THD) of the output voltage and current. In this proposed work, a grid tied PV model is used where an Islanding Switch (IS) is used for isolation of the load with PV system from the rest of the network. Three popular Maximum Power Point Tracking (MPPT) techniques i.e. the Perturb and Observe (PO), the Particle Swarm Optimization (PSO) and the Levy Flight based Cuckoo Search (LFCS) are tested and compared for extracting maximum power from the proposed system under Partial Shading (PS). Simulation results show the superiority of the LFCS techniques as MPP tracker in this work.

Huan Pan et al The power of photovoltaic (PV) and electric vehicles (EV) charging in integrated standalone DC micro grids is uncertain. If no suitable control strategy is adopted, the power variation will significantly fluctuate in DC bus voltage and reduce the system’s stability. This paper investigates the energy coordination control strategy for the standalone DC micro grid integrated with PV, energy storage, and EV charging. The specific research contents include the following:

The maximum power point tracking (MPPT) control of the variable-step perturbation observation method is proposed to shorten the regulation time of the PV unit to reach the maximum power point; an improved droop control is designed based on the state of charge (SOC) of the batteries, and the power equalization and bus voltage recovery secondary controls are introduced to enhance the regulation effect of the DC bus voltage; a coordination control strategy based on the power difference is formulated to improve further the transient and steady-state performance of the DC bus voltage. The proposed coordination control strategy is applied to the integrated standalone DC micro grid model built by MATLAB/Simulink. The simulation results show that the proposed coordination control strategy can not only effectively improve the stability of the DC micro grid system but also reduce the capacity redundancy of the energy storage device.

V. CONCLUSION

A comprehensive review of various islanding detection methods (IDMs) is presented in this paper. IDMs are broadly classified into two types: remote and local. Remote-type IDMs use communication signals between the micro grid and the main grid and are fast, reliable and effective with zero non-detection zones. These techniques do not degrade the power quality and can be applied to multi-inverter micro grids; however, they are complex and expensive. On the other hand, local methods are classified as passive, active and hybrid. Passive-based IDMs measure micro grid parameters such as voltage, current, frequency and phase angle and monitor their changes to detect islanding. Passive methods are preferred as they are easy and cheap for practical implementation. However, passive techniques have a large non-detection zone. Active-based IDMs inject a perturbation into the system that affects the power quality, whereas hybrid techniques are a combination of passive and active techniques. Active and hybrid techniques need additional devices to introduce the perturbation, which increases the complexity and implementation cost. Compared to the passive, active, and hybrid techniques, IDMs based on signal processing have been gaining more attention recently for islanding detection to detect the islanding condition accurately and precisely within the shortest period without affecting power quality. Moreover, they have the potential of working for multiple inverters and can also overcome the non-detection zone and threshold setting requirements of conventional techniques. Several methods have been studied and a comparison has been provided based on important performance indices including NDZ, detection time, error detection ration and power quality.

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