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# Smart Solar Power Connected Grid

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**Abstract- This paper presents review and Introduction of power system islanding and islanding detection techniques. Islanding detection techniques, for a distribution system with distributed generation (DG), can broadly be divided into remote and local techniques. A remote islanding detection technique is associated with islanding detection on the utility side, whereas a local technique is associated with islanding detection on the DG side. Local techniques can further be divided into passive techniques, active techniques and hybrid techniques. These islanding detection techniques for DG are described and analyzed.**

**Index Terms- Distributed generation, islanding detection**

## I. INTRODUCTION

To meet the energy consumption demand of the world, all are looking towards the renewable DG. The research on the growth of DG systems and their utilization is increasing around the world because of their advantages and low pollution compared to the burning of fossil fuels. In the conventional power system, the power is received by the consumers, but in the DG connected smart grid, consumers can also produce the power. The small scale power generation systems such as photo voltaic, mini hydro, tidal, biomass connected to the grid at the consumer level are called DG.Islanding is the situation in which a distribution system becomes electrically isolated from the remainder of the power system, yet continues to be energized by DG connected to it. Islanding can either be intentional or unintentional. Intentional islanding is a purposeful isolation of a proportion of the grid during fault or disturbance in which can be designed to assist continuity supplying electrical energy to the load demand. In contrast, unintentional islanding is an uncontrollable operation which brings serious danger to the utility workers as well as the DG units in the island. The concern is mainly in regards to the fluctuation and variation of the voltage and frequency. Stability interference of the systems might cause complication for proper automatic grid reconnection and restoration [2]. Islanding causes the following adversities in a power system. Connections of renewable power generators to the utility are changing the structure of the electric power system (EPS). The system is evolving from a tree structure with the generation produced by big power plants to a net structure plenty of small distributed points of generation. These distributed generators (DG) offer the possibility to combine dispersed generation with local energy storage and use, reducing the energy losses produced along the transport and distribution lines and incrementing in this way the EPS effectiveness as well as the power quality.

## II. ISLANDING

**Islanding** is the condition in which a distributed generator (DG) continues to power a location even though external electrical grid power is no longer present. Islanding can be dangerous to utility workers, who may not realize that a circuit is still powered, and it may prevent automatic re-connection of devices. Additionally, without strict frequency control, the balance between load and generation in the islanded circuit can be violated, thereby leading to abnormal frequencies and voltages. For those reasons, distributed generators must detect islanding and immediately disconnect from the circuit; this is referred to as anti-islanding. Some designs, commonly known as a microgrid, allow for intentional islanding. In case of a power outage, a microgrid controller disconnects the local circuit from the grid on a dedicated switch

and forces the distributed generator(s) to power the entire local load.[1][2] A common example of intentional islanding is a distribution feeder that has solar panels attached to it. In the case of an outage, the solar panels will continue to deliver power as long as irradiance is sufficient. In this case, the circuit detached by the outage becomes an "island". For this reason, solar inverters that are designed to supply power to the grid are generally required to have some sort of automatic anti-islanding circuitry.

**Passive methods**

Passive methods include any system that attempts to detect transient changes on the grid, and use that information as the basis as a probabilistic determination of whether or not the grid has failed, or some other condition has resulted in a temporary change.

**Under/over voltage**

According to Ohm's law, the voltage in an electrical circuit is a function of electric current (the supply of electrons) and the applied load (resistance). In the case of a grid interruption, the current being supplied by the local source is unlikely to match the load so perfectly as to be able to maintain a constant voltage. A system that periodically samples voltage and looks for sudden changes can be used to detect a fault condition.

Under/over voltage detection is normally trivial to implement in grid-interactive inverters, because the basic function of the inverter is to match the grid conditions, including voltage. That means that all grid-interactive inverters, by necessity, have the circuitry needed to detect the changes. All that is needed is an algorithm to detect sudden changes. However, sudden changes in voltage are a common occurrence on the grid as loads are attached and removed, so a threshold must be used to avoid false disconnections.[1-9] The range of conditions that result in non-detection with this method may be large, and these systems are generally used along with other detection systems.[2]

**Active methods**

Active methods generally attempt to detect a grid failure by injecting small signals into the line, and then detecting whether or not the signal changes.

**Negative-sequence current injection**

This method is an active islanding detection method which can be used by three-phase electronically coupled distributed generation (DG) units. The method is based on injecting a negative-sequence current through the voltage-sourced converter (VSC) controller and detecting and quantifying the corresponding negative-sequence voltage at the point of common coupling (PCC) of the VSC by means of a unified three-phase signal processor (UTSP).

The UTSP system is an enhanced phase-locked loop (PLL) which provides a high degree of immunity to noise, and thus enables islanding detection based on injecting a small negative-sequence current. The negative-sequence current is injected by a negative-sequence controller which is adopted as the complementary of the conventional VSC current controller. The negative-sequence current injection method detects an islanding event within 60 ms (3.5 cycles) under UL1741 test conditions, requires 2% to 3% negative-sequence current injection for islanding detection, can correctly detect an islanding event for the grid short circuit ratio of 2 or higher, and is insensitive to variations of the load parameters of UL1741 test system. [4]

## III. LITERATURE REVIEW

**Aashish Jaiswal, Reinforcement learning based Islanding detection technique in distributed generation:** In this paper the author used reinforcement learning method which is a technique for introducing machines to learn by rewarding appropriate conduct and/or penalizing inappropriate behavior. The Remote technique, the Local approach, and the Hybrid approach were all observable in the Islanding detection methodologies. Passive islanding detection algorithms for inverter-oriented distributed generation systems based on Variational Mode Decomposition (VMD) and the microgrid approach are implemented throughout this research attempt. According to the comparison results of the study, the proposed system is more reliable and better than the compared technique. The comparison results show the detection time of suggested model which is 0.06 s. In contrast to active techniques, it is capable of functioning normally and without disrupting the usual operation of the system. As a result, it can be used effectively for real-time applications.

**Jethro Daniel A. Pascasio, Comparative assessment of solar photovoltaic-wind hybrid energy systems:** A case for Philippine off-grid islands: In this study, we simulated solar photovoltaic (PV) and wind power integration in 147 diesel-powered Philippine off-grid areas. Different configurations of solar PV, wind turbines, lithium-ion batteries, and diesel generators were evaluated based on levelized electricity costs and RE shares. The simulations show that solar PV should be utilized in all areas considered and wind power in 132 areas to guarantee reliable and continuous energy access with minimal costs. The hybrid energy systems have an average electricity cost of USD 0.227/kWh, an average RE share of 58.58 %, and a total annual savings of 108 million USD. The sensitivity analysis also shows that dependence on solar and wind power in Philippine off-grid islands is robust against uncertainties in component costs and electricity demand. With the promising off-grid solar PV and wind power potential in the country, policies that support RE-based hybrid grids should be implemented to address the trilemma of energy security, equity, and sustainability.

**J. Surya Kumari, A model predictive Goertzel algorithm based active islanding detection for grid integrated photovoltaic systems:** In this paper, an active islanding detection with integrated PV system for grid based on Predictive Goertzel algorithm is proposed. The proposed single-phase single stage photovoltaic system injects a small harmonic component of the output of the grid and checks point of common coupling (PCC). The Predictive Goertzel algorithm is a discrete Fourier transform that resolve Non detection Zone (NDZ) and detection time.

The highlight of this work is to demonstrate the performance of proposed islanding detection method, a single-stage single-phase grid integrated PV system embraces of 1-Φ full bridge inverter, LCL filter and local load (RLC parallel load) is considered. This algorithm is implemented in MATLAB Simulink environment. From the results obtained, the detection time for real time environment has reduced by 200ms compared to existing algorithm.

**Naveenkumar Tadikonda, A technique for detection of islanding in a microgrid on the basis of rate of change of superimposed impedance (ROCSI):** This estimated impedance is used to calculate the value of index (M), which is used to discriminate between islanding and non islanding events. To test the efficacy of proposed islanding detection technique, different islanding events (IE) and non islanding events (NIE) are created on modified IEEE 13 bus system integrated with two 2 MW solar photo voltaic distributed generations (PVDGs). The entire system is modelled and simulated on MATLAB/SIMULINK environment. Proposed islanding detection technique clearly identifies the IE during different active power mismatch, reactive power mismatch conditions and different quality factor loads. It also clearly identifies the NIE during load switching, single pole tripping, feeder disconnection, faults, and adjacent DG disconnection.

**Nauman Ali Larik, A comprehensive literature review of conventional and modern islanding detection methods:** Distributed Energy Resources (DER) offer significant advantages by means of raising reliability of distribution system, providing clean source of electricity and reduction in fossil fuel consumption. However, penetration of DER in distribution system poses severe challenges for control procedures and maintain protection coordination for secure operation.

Unintentional islanding is a threat to the safety of equipment and line worker. Different islanding detection approaches are broadly classified in remote type methods which employ communication infrastructure and local type techniques based on monitoring parameters at Distributed Generator (DG) side. In this paper broad assessment about Islanding Detection Methods (IDMs) with their limitations and benefits are explained with respect to accuracy, detection time and non-detection zone. Comparative assessments of different IDMs are listed in tabulation for conveniently judging the most economical and efficient approach.

**Colette Brogniez , Erythemal and vitamin D weighted solar UV dose-rates and doses estimated from measurements in mainland France and on Réunion Island:** estimated biologically-effective radiation (inductive of erythema and pre-vitamin D) using spectral solar UV radiation measurements on a horizontal plane at three French sites equipped with spectroradiometers: Villeneuve d'Ascq (VDA) (North of France); Observatoire de Haute-Provence (OHP) (French Southern Alps); and Saint-Denis de La Réunion (SDR) on Réunion Island,

in the Indian Ocean. These sites are very different: VDA is a semi-urban site in a flat region, OHP a rural mountainous site and SDR a coastal urban site on a small mountainous island. Biologically active radiation was analyzed by studying erythema induction and measuring pre-vitamin D synthesis.

**Ioan Viorel Banu, Passive anti-Islanding protection for Three-Phase Grid-Connected photovoltaic power systems:** This paper presents the performances of a new passive anti-islanding protection with minimal switching losses for three-phase grid-connected photovoltaic power systems. The novelty of the proposed strategy consists of five conventional passive relays, which are as follows: over/under current, over/under voltage, over/under frequency, rate of change of frequency, and dc-link voltage-based anti-islanding methods. Integrating these methods in a synergistic way reduces the limitations of each method, while combining the strengths and benefits of each method in islanding detection.

**Asim Datta , Anti-islanding selection for grid-connected solar photovoltaic system applications: A MCDM based distance approach:** In this research, the preferences of the criteria with their correlations have been evaluated by the analytic network process (ANP). And, these criteria preferences are made involved in the decision matrix of the technique for order preference by similarity to ideal solution (TOPSIS) which is a distance based optimization technique. Unlike hierarchy based approach, the proposed approach takes into account the interdependence relationships among all the constraint of IDM selection and the sensitivity analysis of the model indicates the robustness of the selection.

**Mohsen Tajdinian, Islanding Detection Scheme Using Potential Energy Function Based Criterion:** The proposed method employs the concept of potential energy function to drive the islanding detection index. Based on swing and potential energy function equations, an islanding detection criterion is derived based on the rate of change of the potential energy function. The islanding detection index (IDI) takes into account the frequency changes and the rate of change of frequency (ROCOF) of DG. The superiority of the proposed islanding detection method is manifested in the condition where the generation of distributed resources is in balance with the loading consumption.

**Yasser Ahmed Elshrief , Fast and accurate islanding detection technique for microgrid connected to photovoltaic system:** This paper illustrates the phenomenon of islanding and the passive methods which are used for preventing it. The main contribution of this paper is to detect this phenomenon as fast and accurately as possible using the technique of rate of change of power (ROCOP) based on the terminal voltage (TV) (ROCOP-TV) of the Photovoltaic (PV) inverter. The results of the proposed technique have been studied through extensive simulations using the MATLAB/Simulink platform. The ROCOP-TV technique results are compared with various types of passive detection relays after synchronization between the grid side and PV side. Furthermore, the proposed technique was not only able to detect islanding at the instance of its occurrence but also can distinguish between islanding and regular grid faults. The simulation results illustrate the proposed scheme's effectiveness and flexibility based on the MATLAB/Simulink platform.

**Sushree Shataroopa Mohapatra , Detection and diagnosis of islanding using artificial intelligence in distributed generation systems:** In this analysis, the strategies for the Eradicate Liability Passive Islanding Detection (ELPID) are used to detect islands from distributed generations that are Over–under voltage/Over–under frequency (OUV/OUF), Conversion rate of voltage (CROV), Conversion rate of phase angle difference (CROPAD), Conversion rate of frequency (CROF) and Point of common connection (PCC). They penetrate to produce enormous NDZ (Non-Detection Zone) and struggle to sense islanding with low or zero power imbalances. So, the islanding detection with imbalance conditions, NDZ, and mal-operation of the fault have to diagnosis, therefore using Artificial Neurological Network (ANN) can obtain the better-quality result.

**Ruchita Nale, A passive communication based islanding detection technique for AC microgrid:** This paper presents a secured communication based passive anti-islanding technique, using phase angle difference information of superimposed impedance computed at both distributed generation (DG) and point of common coupling (PCC) ends. In the

approach, the PCC end signal information is transmitted every cycle to DG sites to analyze the event, hence more effective and reliable. The performance of the method is evaluated for different test conditions such as low power mismatch islanding events, different fault types and switching events.

**Omar A. Allan, A new passive islanding detection approach using wavelets and deep learning for grid-connected photovoltaic systems:** This paper introduces a passive islanding detection approach that uses deep learning combined with the continuous wavelet transform and hence no need for identifying the islanding features a priori as in the existing islanding detection approaches. The numerical examples demonstrating the effectiveness of the proposed approach are presented and the conclusion is drawn.

**Nouman Shafique, A simplified passive islanding detection technique based on susceptible power indice with zero NDZ:** This work introduces a passive islanding detection scheme based on phase angle of positive sequence voltage (PAOPSV). The PAOPSV was selected on the basis of rigorous investigation of 13 different indices. Comparative analysis demonstrates that PAOPSV has the best sensitivity and accuracy for islanding detection among all other parameters. An extensive case study considering worst-case scenarios is accomplished in order to check the working efficacy of the suggested scheme that easily discriminates islanding events from non-islanding events such as load switching, different fault types switching, capacitor and motor switching. The suggested scheme is simple with fast execution and easy to implement that is established on IEEE 1547 generic test system in MATLAB/SIMULINK environment. Islanding is detected within 0.10 s even with a zero non-detection zone.

**Kanche Anjaiah, P.K. Dash, Detection of faults and DG islanding in PV-Wind DC ring bus microgrid by using optimized VMD based improved broad learning system :** This paper presents a novel approach for the detection and classification of photovoltaic with wind based DC ring bus microgrid DC faults and DG (distributed generation) islanding events. This novel approach consists of adaptive variational mode decomposition (AVMD) and an improved broad learning system (IBLS). Initially, DC fault current signals are captured from the DC bus under different operating conditions and processed through the AVMD to decompose the signals into intrinsic mode functions (IMFs). The VMD is made adaptive by minimizing the objective function of the L-kurtosis index for optimal modal number (K) and penalty factor through the improved whale optimization (IWO) algorithm. From the optimal IMFs, the most significant IMFs are chosen based on the threshold of the L-kurtosis index, and they are passed through statistical features to extract efficient data.

## IV. PROBLEM IDENTIFIED

From the literature review, the problem identified are as follows:

- The active islanding method alone causes high Transient and power quality deterioration and is also not suitable for DG sources.
- The passive islanding techniques have the limitations of large NDZ and annoyance of false tripping. Also, the threshold limit setting is tedious. Hence, hybrid islanding techniques incorporating parametric-based methods overcome the limitations.

## V. OBJECTIVES OF RESEARCH

Objectives of Research Implementation Following objectives of research implementation

1. Identification of Islanding effects.
2. Evaluation of islanding detection outcomes,
3. Measurement of its effects.
4. Protection of DG using devices.
5. Controlling of Total DG outcomes.
6. Regulation of all system grid.
7. Identification grid utility.

## VI. CONCLUSION

Review of all islanding detection methods with their desired traits is done in this paper for the recent development in micro-grid and distributed energy resources. As unintentional islanding is annoying and destructive, it should be detected within minimal time and appropriate action must be taken to evade it. Many researches were done on IDM are given in this paper with their comparison on different parameter and it is cooperative for getting correct method for definite application. A new IDM will be

introduce in future, based on finding ripple content of voltage at inverter side for given single phase grid connected micro-grid system and it will be analyzed for different load condition.

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