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A Review Article ofAnalysis of Islanding Phenomenon in PV Connected System with Protection of Its Effects

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Abstract- **The investiture in Distributed Generations (DGs) technologies have begun to monopolies transmission system's architecture instantaneously after announcing its liberation and deregulation of the energy market to the public. Such movement has propelled vicious competitions among power generation companies to initiate superior innovations in meeting consumers' needs, administering high power quality yet economical. With the integration of DG technologies, power grid operations have dynamically benefited from such commendable services which apprehend power failures from transpiring; securing power quality, accommodating capricious demand curve, fault compensatory applications and other auxiliary services. Subsequently, the presence of DGs have re-volutionised power grid management to conceive off-grid and self-sustaining criterion where grid/islanding topology adaptations are commonly affiliated.**

Keywords- **islanding detection; distributed generation; integrated power distribution network; non-detection zone; islanding detection method.**

I.INTRODUCTION

Islanding detection for the protection of distributed generator fed systems that has been tested on power distribution busses of 25 kV and less. Recent interest in distributed generator installation into low voltage busses near electrical consumers has created some new challenges for protection engineers that are different from traditional radially based protection methodologies. Therefore, typical protection configurations need to be re-thought such as re-closures out-of-step monitoring, impedance relay protection zones with the detection of unplanned islanding of distributed generator systems. The condition of islanding, defined as when a section of the non utility generation system is isolated from the main utility system, is often considered undesirable because of the potential damage to existing equipment, utility liability concerns, reduction of power reliability and power quality.

Current islanding detection methods typically monitor over/under voltage and over/under frequency conditions passively and actively; however, each method has an ideal sensitivity operating condition and a non-sensitive operating condition with varying degrees of power quality corruption called the non detection zone (NDZ). The islanding detection method developed in this thesis takes the theoretically accurate concept of impedance measurement and extends it into the symmetrical component impedance domain, using the existence of naturally and artificially produced unbalanced conditions. Specific applications, where this islanding detection method improves beyond existing islanding detection methods, are explored where a generalized solution allows the protection engineer to determine when this method can be used most effectively. To start, this thesis begins with a brief introduction to power systems in North America and the motivation for the use of distributed generation. Further chapters then detail the background and specifics of this technique.

II. ISLANDING

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. As shown in the figure2.1. Traditionally, a distribution system doesn't have any active power generating source in it and it doesn't get power in case of a fault in transmission line upstream but with DG, this presumption is no longer valid.

Current practice is that almost all utilities require DG to be disconnected from the grid as soon as possible in case of islanding. IEEE 929-1988 standard [1] requires the disconnection of DG once it is islanded .Islanding can be intentional or Non intentional. During maintenance service on the utility grid, the shut down of the utility grid may cause islanding of generators. As the loss of the grid is voluntary the islanding is known. Non-intentional islanding, caused by accidental shut down of the grid is of more interest. As there are various issues with unintentional islanding. IEEE 1547-2003 standard [2] stipulates a maximum delay of 2 seconds for detection of an unintentional island and all DGs ceasing to energize the distribution system

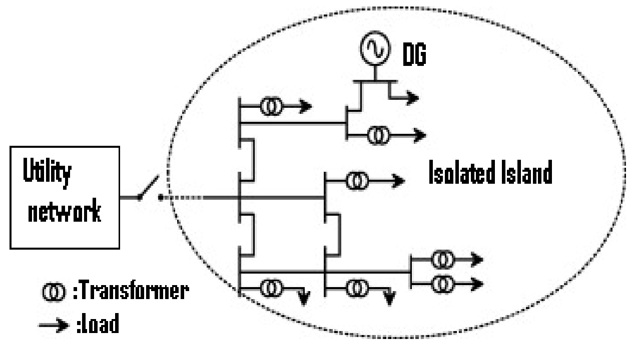

Figure 1 Scenario of Islanding operation.

III. ISSUES WITH ISLANDING

Although there are some benefits of islanding operation there are some drawbacks as well. Some of them are as follows:

Line worker safety can be threatened by DG sources feeding a system after primary sources have been opened and tagged out. The voltage and frequency may not be maintained within a standard permissible level. Islanded system may be inadequately grounded by the DG interconnection. Instantaneous reclosing could result in out of phase reclosing of DG. As a result of which large mechanical torques and currents are created that can damage the generators or prime movers [3] Also, transients are created, which are potentially damaging to utility and other customer equipment. Out of phase reclosing, if occurs at a voltage peak, will generate a very severe capacitive switching transient and in a lightly damped system, the crest over-voltage can approach three times rated voltage. [4] Various risks resulting from this include the degradation of the electric components as a consequence of voltage& frequency drifts. Due to these reasons, it is very important to detect the islanding quickly and accurately.

IV. LITERATURE REVIEW

The use of neural network for identification of parameters has been reported by Chu et al (1990); Narendra et al (1990). Bernieri (1994) has used a dynamic multilayer neural network for parameter estimation in a secondorder lead-lag bandpass filter. The network is trained for normal and different fault conditions based on the parameters obtained from system transfer function during the steady state conditions.

Sorsa et al (1993) have used a bank of neural network models (each for known class of system behaviour) that is similar to observer based schemes. The neural network replaces the analytical model that describes the process and the models are developed with appropriate data for different system behaviour.

Han et al (1997) have proposed a parameter estimation technique using neural networks in which the physical parameters are estimated by applying the neural network universal approximation property with the help of the measured input/output data. The deviations of the parameters from normal values are then used for fault diagnosis. It is assumed that the fault in the mentioned process can be described as changes in the parameter vector and the nominal parameter values are known in advance or can be estimated online. (e.g. via RLS method).

Chen et al (1991) have used neural networks for fault diagnosis through generation of residuals in signal processing application. The fault data are required for all expected faults in terms of residual values or system measurements. A multi-layer feedforward network is trained to represent the relationship between past values of residual data (generated by another neural network) and those identified with some fault condition. The second neural network is used for classification in conjunction with other residual generating methods.

Chandorkar et al. (1993) have worked on the control of inverters in islanded mode alone. Chen et al. (1995) have analysed the combination of voltage and current controlled inverters. Van et al. (1998) have suggested a simple solution to operate the inverters in parallel. In the same way Kawabata et al. (1988) have also advocated the operation of parallel inverters. Hanaoka (2003) presented a method of operating Uninterrupted Power Supply (UPS) in parallel as a redundant unit. Chandrokar et al. (1994) have investigated the method of control of UPS using a new architecture.

Alvaro et al. (1996) have designed an optimal static prefilter for robust performance against Linear Time Invariant (LTI) or Linear Time Variant (LTV) structured uncertainties using the H∞ and Hz performance index. These are convex problems and they fall into the scope of well-known optimization algorithms.

Gomm (1998) has described an adaptive neural network that continuously monitors the process and improves its performance online as new fault information becomes available. New nodes are automatically added to the network to accommodate novel process faults after detection and online adaptation are achieved using recursive linear algorithm to train selected network parameters.

Patton et al (1999) have proposed a model of fault detection without residual generation. A single layer neural network used for fault detection accepts current and past inputs [u(k), u(k-1), u(k-2) …] and current and past values of output [y(k), y(k-1), y(k-2) …]. The network directly indicates the occurrence of fault at the output. As an alternative Bhama et al (1993) have proposed a technique for identifying the parameters A and B of an unknown second-order dynamic system. The author has used a Single Layer Neural Network (SLNN) that uses a gradient descent learning algorithm (also known as instant back propagation) to train and identify the parameters of a linear Single-Input Single-Output system (SISO), where the weights of the network represent the system parameters.

The modified gradient descent learning algorithm proposed by Yadaiah et al (2000) works well in terms of faster convergence irrespective of the initial conditions where online identification can be done. 19 Chi-Sing Leung et al (2001) have Chi-Sing Leung et al (2001) have used RLS based algorithm for online training of the multilayer feedforward neural network. It has been shown through simulation result that the trained network has improved generalization capability. Yong et al (2006) have proposed a generalised RLS model which includes a general decay term in the energy function for the training of feedforward neural network for four different problems. In this work a single layer neural network is used to obtain the system parameters for deaerator which is a Multi-Input Multi-Output system, using the RLS algorithm.

Dalmi et al (1998) have compared the use of BPN, RFBN, Kohonen and counter propagation neural networks for detecting novel events in a vehicle. They have employed the RBFN and counter propagation networks to diagnose faults in actuators and sensors. The effectiveness of feature extraction for fault diagnosis in a gas turbine by seven different types of neural network architectures has been reported by Addison (1999). The performances of different networks are evaluated during training and testing based on a number of features (from turbine sensors) as the input to the networks. The most important observation from these experiments is that combining neural network with linear regression yields compatible performance.

Huang, F.S et al.; 2001 suggests that the last drawback encountered with islanded operation is the safety problems to maintenance crews. Personnel working on the line maintenance work or repairing a fault may mistakenly consider the load side of the line as inactive, where distributed sources are indeed feeding power to utilities.

Yoshida et al. (2001) have suggested a approach to systematically compute the corrective and preventive control strategies to mitigate power system voltage collapse. The approach also avoids an impending immediate voltage collapse due to the loss of system solvability caused by severe contingencies, the corrective control utilizing fast-acting controls is first determined, then the preventive control is further computed by solving the margin sensitivity based optimization problem. Their proposed method significantly reduced the size of the optimization problem by fully utilizing the margin sensitivity information and is very effective in dealing with unsolvable cases and cases with insecure voltage stability margin.

Lu et al. (2002) have advocated a method for enhancing power system security by Thyristor Controlled Series Compensator (TCSC) under single line outages. The enhancement of system security and system performance under network contingencies through an optimal placement and optimal setting of TCSC is focussed.

Jianhong Lu et al (2002) have proposed a multivariable control system for the water levels in the deaerator and the condenser based on fuzzy PID controller. The level control system proposed by the authors has been used continuously with good performance. Earlier attempts on the design of control system for a deaerator system have been made by An (1994), Yuan (1994) and Li (1996).

K Kauhaniemi, L. K.; 2004 suggests that this separation could be due to operation of an upstream breaker, fuse, or automatic sectionalizing switch. Manual switching or "open" upstream conductors could also lead to islanding. In most of the cases this is not desirable as the reconnection of the islanded part becomes complicated, mainly when automatic reclosing is used. Furthermore, the network operator is not able to assurance the power quality in the island (the DG is no more controlled by the utility protection devices and continues feeding its own power island). This increases the probability that DG sources may be allowed to subject the island to out of range voltage and frequency conditions during its existence and the fault level may be too low, so that the over current protection will not work the way it is designed. Therefore, the power quality supplied to customers is worsening.

Yunwei et al. (2004) have presented a unified controller for use with each DG system in a multibusmicrogrid. This controller contains inner current and voltage loops for regulating the grid interfacing inverter and outer real and reactive power loops.These loops are provided for controlling the flow of power within the microgrid with particular attention focused on the proper sharing of power between the DG systems when a utility fault occurs and the microgrid islands. Algorithms are also incorporated for synchronizing the micro and utility grids once the fault is cleared and the microgrid is on the verge of transiting from islanding to grid connected mode.

Farina et al. (2004) have used Model Predictive Control (MPC) approach to control the voltage profiles in Medium Voltage(MV) networks with distributed generation. Their control scheme woul deal with distributed implementations of the controller, for a survey of available distributed MPC methods, or on the use of a larger number of slack variables, one for each voltage constraint, to refine the control logic governing the On-Load Tap Changer (OLTC).

Pecas et al. (2006) have presented the feasibility of control strategies to be adopted for the operation of a microgrid when it becomes isolated. Normally, the microgrid operates in interconnected mode with the medium voltage and it must have the ability to operate stably and autonomously.

Khan, U. N; 2008 narrates that If the DG is located between the utility substation and the fault, a decrease in fault current from the utility substation may be observed. This decrease needs to be investigated for minimum tripping or coordination problems. On the other hand, if the DG source (or combined DG sources) is strong compared to the utility substation source, it may have a significant impact on the fault current coming from the utility substation. This may cause fail to trip, sequential tripping, or coordination problems.

Martin-Arnedo, J. A; 2009 suggests that the nature of the DG also affects the short circuit levels. The highest contributing DG to faults is the synchronous generator. During the first few cycles its contribution is equal to the induction generator and self excited synchronous generator, while after the first few cycles the synchronous generator is the most fault current contributing DG type. The DG type that contributes the least amount of fault current is the inverter interfaced DG type, in some inverter types the fault contribution lasts for less than one cycle. Even though a few cycles are a short time, it may be long enough to impact fuse breaker coordination and breaker duties in some cases.

Brabandere et al. (2007) have presented a new control method for the parallel operation of inverters in an island grid or in a grid connected to an infinite bus. Frequency and voltage control, including mitigation of voltage harmonics, are achieved without the need for any common control circuitry or communication between inverters. Each inverter supplies a current that is the result of the voltage difference between a reference AC voltage source and the grid voltage. The reference AC voltage source is synchronized with the grid, with a phase shift depending on the difference between rated and actual grid frequency.

Yasser et al. (2008) have introduced a fast gridvoltage regulation scheme inverter based DG which employs a hybrid linear with variable structure control approach to increase the disturbance rejection performance and to embed a wide band of frequency modes through an equivalent internal model. As a result, a wide range of voltage perturbations, including capacitor-switching voltage disturbance, has been effectively mitigated.

Salam et al. (2008) have described a micro grid system which is formed to provide reliable electricity and heat delivering services by connecting DGs and loads together within a small area. The microgrid is connected to an electrical distribution network in an autonomous way and it employs various distributed generation technologies such as micro turbine, fuel cell, photo-voltaic system together with energy storage devices such as battery, condenser and flywheel. In the future power system configuration, the microgrid would provide clear economic and environmental benefits compared to traditional power system.

Zhang et al. (2008) have used phase lead compensation RC scheme for constant voltage and constant frequency Pulse Width Modulation (PWM) inverter systems where RC with a well-selected lead step compensate the system phase lag so that more error harmonics are eliminated to achieve a high tracking accuracy. A simple and efficient approach for engineers to design high-performance power converter systems is achieved with faster convergence.

V.PROBLEM DEFINITION

DG system has been conventionally designed as radial systems, and the time coordination of protection devices at the distribution level is a standard practice used by the utilities. The traditionally radial nature of distribution system may need a change in protection strategy. The problems include protection issues, voltage and frequency issues, operational issues and minimizing the need to upgrade the system for accommodating DGs. The DG may have no power export agreement with the utility. In this condition, if a huge load connected to the micro-grid goes off, the DG may not be able to minimize its generation fast and adequate. This may direct to a power export for a period larger than allowable, which would cause the CB at the point of common coupling to trip.

This kind of CB tripping is defined as nuisance tripping. In case the micro-grid is importing a considerable amount of power from the utility, if Islanding occurs, there may not be sufficient installed capability to feed all the loads connected to the micro-grid. In such cases loads have to be selectively reduced to ensure supply of uninterrupted power to critical loads. The IEEE Standard for connecting distributed resources to electric power systems sets the necessities which the DGs have to meet before coupling with the utility. In terms of security, Line worker security can be threatened by DG sources supplying a system after main sources have been opened and tagged out. The voltage and frequency may not be retained within a standard permissible value. Islanded system may be improperly grounded by the DG interconnection. Immediate reclosing could lead in out of phase reclosing of DG.

Consequently huge mechanical torques and currents are formed that can spoil the generators or prime movers. Also, transients are initiated, which are potentially destructive to the utility and other consumer apparatus. Voltage peak initiate out of phase reclosing, it generate a severe capacitive switching transient, and the crest over-voltage can lead three times of rated voltage. Due to these reasons, it is a prime factor to detect the Islanding speedily and precisely. Hence, in this research, Islanding detection techniques and implementation of the same in IEEE 9-bus system with multiple DGs is attempted. This approach is very effective in power quality improvement.

VI. PROBLEM FORMULATION

The aim of the current research is to enable the operation and control of the sources connected in a microgrid in a coordinated and efficient way using proposed controller. The main objectives of the research to overcome the difficulties are listed.
1. Coordinated of inverters for different scenario.
2. Improving the power quality during grid disturbances.
3. Optimal location of Distributed Generation.

All islanding events are not required to end up with DG disconnection. Only when the DGs generation is not sufficient to the local load demands for an islanded microgrid, to avoid power misbalance and equipment / microgrid failure DG disconnection is important. But when DGs generation is sufficient to operate local loads and islanding event is intentional a load management operation can be achieved for uninterrupted supply to prior loads (example: hospitals, computer data accusation centres etc.). During such operation auto reclosing is possible after clearance of contingency at utility side.

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