Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 05, May-2019

Analyse the Influences of Islanding on the Operation of Distribution Grid in Vietnam's Islands

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Abstract **– Distributed generation (DG) in simple term can be defined as a small-scale generation. It is an active power generating unit that is connected at distribution level. IEEE defines the generation of electricity by facilities sufficiently smaller than central plants, usually 10 MW or less, so as to allow interconnection at nearly any point in the power system, as Distributed Resources [1]. The advancement in new technology like fuel cell, wind turbine, photo voltaic and new innovation in power electronics, customer demands for better power quality and reliability are forcing the power industry to shift for distributed generations. There is a renewed interest in the distributed generation mainly due to the environmental concern and electricity market liberalization. Many utilities around the world already have a significant penetration of DG in their systems. But there are many issues to be resolved before DG becomes an integral part of the utilities around the world. One of the main issues with DG is islanding. Islanding occurs when a portion of the distribution system becomes electrically isolated from the remainder of power system yet continues to be energized by distributed generators. This paper analyzes the influences of islanding on the operation of distribution grid in Vietnam's islands.**

Keywords - Islanding; islanding operation; distributed generation; power quality

I. INTRODUCTION

Distributed generations have been broadly used and are expected to be an important element in the future electric power systems. These generation systems have characteristics which are different from those of conventional large capacity fossil and nuclear generation systems. Distributed generations are relatively small and many of them make use of renewable energy such as a wind power or a hydraulic power. And, when the distributed generation systems are operated in parallel with utility power systems, especially with reverse power flow, the power quality problems become significant. Power quality problems include frequency deviation, voltage fluctuation, harmonics and reliability of the power system.

DG systems are often smaller systems that are locally integrated into the low voltage distribution system which conflicts with the existing power network design paradigm. Adding DG to the existing electric power distribution system can lead to a reduction of protection reliability, system stability and quality of the power to the customers. More specifically, the technical challenges that the installation of distributed generation face have been reviewed in various studies [2] [3] [4] [5] [6] [7] [8] [9] where the findings of the various studies are listed below:

- Voltage Regulation and Losses
- Voltage Flicker
- DG Shaft Over - Torque During Faults
- Harmonic Control and Harmonic Injection
- Increased Short Circuit Levels
- Grounding and Transformer Interface
- Transient Stability
- Sensitivity of Existing Protection Scheme
- Coordination of Multiple Generators
- High Penetration Impacts are Unclear
- Islanding Control

When a distributed generation system with some loads is disconnected from the utility power system, the distributed generation is going to supply the loads and this is an islanded operation of power system. Islanding affects issues as safety for maintenance man and power quality of distributed grids.

II. ISLANDING AND ISLANDING OPERATION

A. What is an islanding?

A fault occurring in the power distribution system is generally cleared by the protective relay that is located closest to the faulty spot (B1 opens). As a result, a distributed generation tries to supply its power to part of the distribution system that has been separated from the utility's power system.

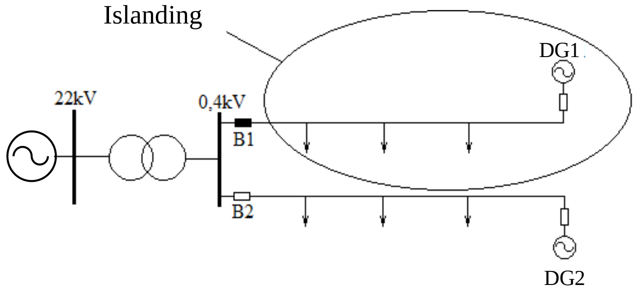

Figure 1. A part of the grid is islanded when the B1 opens

In most cases, this distributed generation assumes an overloaded condition, where its voltage and frequency are lowered and it is finally led to stoppage. However, though this is a rare case, a generator (or a group of generators) connected to this islanded system is provided with a capacity that is large

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 05, May-2019

enough to feed power to all the loads accommodated in the islanded system. When the loads are fed power only from the distributed generations even after the power supply is suspended from the power company, such a situation is called an "islanded operation" or "islanding".

B. The influences of islanding on the operation of distribution grid

If a condition of islanded operation is continued, there can be concern about physical injury because of the inspection and restoration personnel or the public coming in contact with the live parts. In addition, when the power is supplied from the distributed generations, the quality of the fed power may be lowered as compared with the cases when the power is fed from the power company. It is often considered that the lowered quality may affect the loads adversely. At the power company, programs have been established so that the relevant circuit breaker or a switch is automatically closed at the substation after the lapse of the predetermined time period, in order to achieve prompt restoration from a service interruption. However, if the above-mentioned islanded operation is continued longer, a condition of asynchronous closure is assumed and the fault may be evolved further. This results in a further delay in the restoration from the failure.

Integrations of Distributed Generations (DGs) in the distribution grid are expected to play an increasingly important role in the electric power system infrastructure and market. As more DG systems become part of the power grid, there is an increased safety hazard for personnel and an increased risk of damage to the power system.

After the main power source being cut off, the grid is still supplied by DGs. This operational case can be dangerous for the line workers when troubleshooting or maintaining the line.

Technical Challenges Associated with DG Islanding:

- In general, a distributed generator is a “weak” supply that does not have the stability and momentum of the typically strong utility system to effectively control transients.
- A distributed generator’s behavior may be unpredictable if loads are mismatched to the supply characteristics.
- Upon reclosure from a fault, distributed generators will not be synchronized with the utility system. The result would be potential damage to the distributed generator, the utility, or even the customer.
- Uncontrolled islands may pose a threat for unaware utility workers.
- The utility’s liability for the customer’s electricity quality can not be effectively managed with the current mismatch in utility vs. Independent Power Producer’s objectives.

In the case of small grids that consume a significant amount of power from the Utility, if the fault occurs, DGs may not have enough power to supply all loads connected to this grid. In such cases, some loads must be sacked selectively to ensure the quality of power supply to the important loads. On the other hand, if this small grid has DGs generating extra power to, the voltage and frequency of this small grid may increase after occuring the islanding. In such a case, the reduction of power generated by the DGs will be required.

III. SIMULATION MODEL

In order to investigate the performance of the different techniques during various contingencies a simulation model was implemented. It is important that the model reflects a real system in all vital parts. The behavior of the simulated system must be similar to what happens in a real situation. How this achieved is described in the following.

The grid presented in figure 2 include 110 kV power transmission system and 50 Hz short circuit capacity of 100 MVA is illustrated by a voltage source and resistor. The Grid shown in figure 2 is in the CuLaoCham's island of Vietnam. Grid system is connected to a distribution system through a transformer 110/22 kV. DGs is scattered source, including 3 generator has a capacity total of 0.590 MW. Capacitors have a capacity of 0.12 MVAr. Load: P = 1 MW, Q = 0.6 MVAr. L is the submarine cable under the sea. It is 15.444 km long.

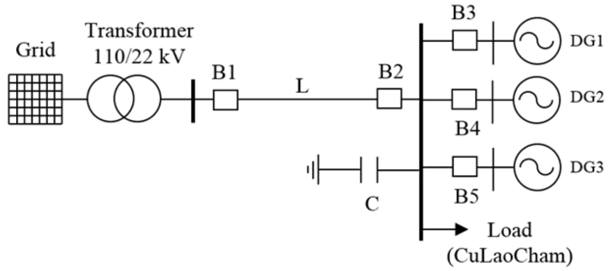

Figure 2. The studied Power Distribution network with multiple DG

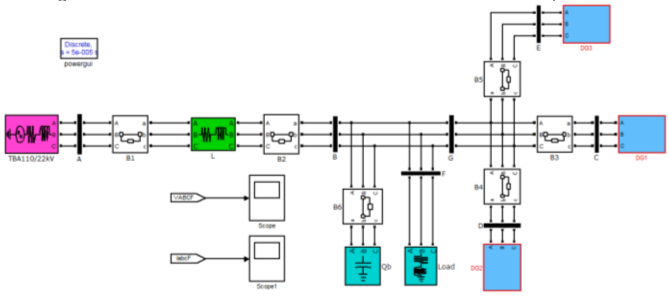

Figure 3. MATLAB/SIMULINK MODEL

To see the influences of the islanding, we simulate the distribution grid of CuLaoCham's island in Vietnam.

Simulation results

1. Phases Voltage on the grid

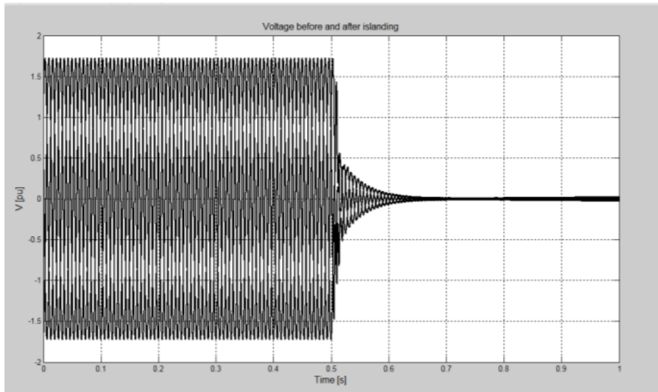

Figure 4. Phases voltage before and after islanding

International Journal of Engineering Research & Technology (IJERT)
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From figure 4, at the time of 0.5 seconds, disconnect the main power (opens B2), at this time this isolation grid is only powered by DGs. We found that the voltage at the load terminal droped very low as soon as the distribution grid occured isolation problem.

2. Phases current on the grid

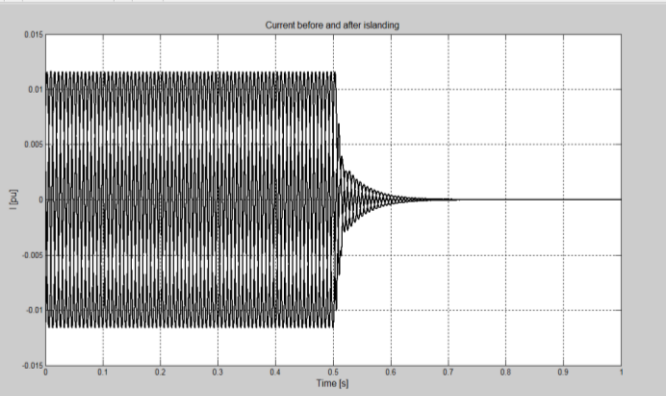

Figure 5. Phases current before and after islanding

From figure 5, at the time of 0.5 seconds, disconnect the main power (opens B2), we found that the currents on the grid also decreased very low as soon as the distribution grid occured isolation problem.

From figure 4 and figure 5, we found that, when occurs the isolation problem, the distribution grid connecting the distributed generation will not ensure the power quality to supply power to the load.

Therefore, when occurs an islanding, the system must immediately detect this situation in order to have quick solutions ensuring the power quality for the isolated grid.

An unintended islanding is not expected because it can cause a large variation in voltage and frequency in the isolated area. At this moment, electrical power supplied to the customer under unnormal conditions can lead to complete collapse of the power system. In order to operate the electrical system safely when connecting to DG, the islanding must be detected accurately. This function is referred to as the "islanding detection" or "loss-of-mains protection."

When the unintended islanding (UI) occurs, it must be detected within 2 seconds [10]. Once this happens, islanding or a small grid is formed, in which part of the grid is only provided by the DGs. The basic thing is that the frequency and voltage of this small grid need to be restored quickly after disconnection from the grid. Transfering the frequency and voltage in the limits as quickly as possible and remain them is a technological challenge being studied globally.

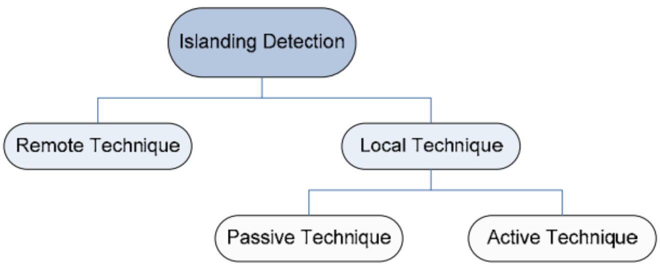

Figure 6. Islanding detection techniques

The main philosophy of detecting an islanding situation is to monitor the DG output parameters and system parameters and decide whether or not an islanding situation has occurred from changes in these parameters. Islanding detection techniques can be divided into remote and local techniques and local techniques can further be divided into passive, active techniques as shown in Figure 6 [11].

Through the above methods of detecting the islanding, the isolated grid will be detected as soon as the main power is disconnected. From this, electrical companys will propose a plan to the most reasonable operate an isolated grid ensuring the quality of electricity for electricity consumers. Specifically, the operator must plan to cut off the less important loads and priority provides the electricity to important electricity consumers.

IV. CONCLUSION

The article analyzed the effects of islanding on distribution grid. Through it, they help operators to make plans to reasonably operate the isolated grid ensuring the quality of electricity for electricity consumers in this grids.

The author of the article also proposed a solution to operate the distribution grid when connected to the distributed generations. That is the use of islanding detection methods to quickly detect the isolated state of the grid. From this, help us operate the distribution grid safely and efficiently.

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