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Anti-Islanding Protection in Microgrids
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PROJECT BACKGROUND

Electrical islands take place when a fault occurs on a line and causes generating plants such as solar panels or wind farms to continue generating power when the grid connected to them is offline. These conditions could lead to the power lines being back-fed, equipment failure or damage, and dangerous fluctuations in voltage and frequency. Controllers manage the differences in voltage and frequency and cause the annunciator to indicate when an island has occurred. Anti-islanding software is a form of preventative protection that is implemented onto electrical grids to disconnect the Distributed Energy Resource (DER) when the grid goes offline and ensure safe re-connection when the grid comes back online. The purpose of our research is to learn about current anti-islanding efforts and expand our experience simulating, experimenting, and troubleshooting faults on microgrid networks when connected to a larger grid using software such as PSCAD and ETAP.

RESEARCH

Electrical Islands are dangerous to the personnel working on the system and the machines in it. If an island goes unnoticed for too long, the frequency of the system can deviate and cause immense damage to the devices, therefore standards are created to ensure the safe operation of renewable energy resources (see below).

In Anti-*Islanding for Three-Phase One-Cycle Control Grid Tied Inverter,* the different forms of anti-islanding protections are listed and a proposed method that relies on harmonic injection and is minimally invasive to the system is outlined.

Passive Forms
- Over/under voltage or frequency
- Voltage harmonic monitoring
- Phase Monitoring

Active Forms
- Harmonic Injections
- Positive Feedback

Islanding Protection schemes enforce Renewable Distributed Generators to disconnect from the grid and supply the loads by themselves.

Fig. 1. Typical network configuration with DG and utility grid.

FIGURE 5 – A schematic of the microgrid operating as (a) grid-connected and (b) islanded.

In *A Real MultiTechnology Microgrid in Venice: A Design Review*, a microgrid is designed to operate in several different modes of operation including intentional and unintentional islanding modes. An Energy Management System (EMS) serves as the microgrid controller and can adjust the system to operate in any mode. If an emergency condition arises, the microgrid can operate in unintentional islanding mode and disconnect from the Point of Common Coupling (PCC). If the system is planned to work with the grid, or disconnect, it can adjust parameters of power, voltage, and frequency to work in Grid Connected/Intentional Islanding mode.

In *Testing of anti-islanding protections for grid-connected inverters*, it describes an anti-islanding protection study undertaken by CESI RICERCA. They created a closed-loop control system where the synch-gen V & f is varied to simulate an island.
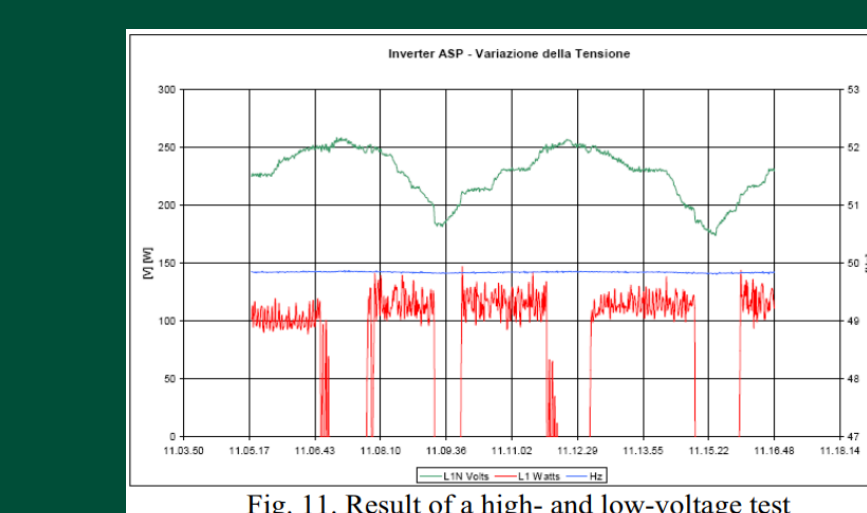

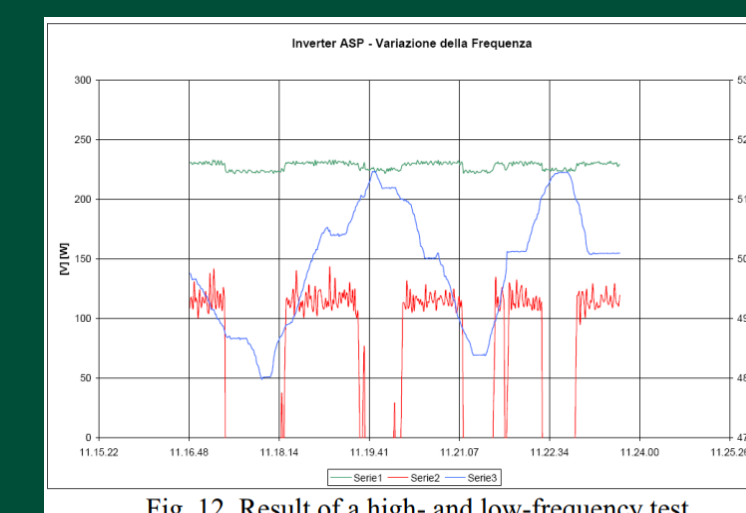Fig. 11. Result of a high- and low-voltage test

Fig. 12. Result of a high- and low-frequency test

In *An Anti-Islanding Technique for Grid-Connected DG and Multi DG System* article, it constructs a test simulation in Simulink of grid connected DG system with set values and can detect when an island occurs in the system through the voltage and current.

IEEE Anti-Islanding Standards
IEEE 1547 - Standard for Interconnection and Interoperability of Distributed Energy Resources (DERs) with Associated Electric Power Systems Interfaces
- Covers requirements for interconnection of distributed energy resources with electric power systems

IEEE 1547a - Amendment 1, May 2014
- 4.1.1 Voltage Regulation - DER allowed to change active & reactive power
- 4.2.3 (Response to abnormal grid...) Voltage - DER & grid operators can mutually agree to other voltage trip & clearing time settings
- 4.2.4 (Response to abnormal grid...) Frequency - DER & grid operators can mutually agree to other frequency trip & clearing time settings.

Scan For More Information

ETAP

Electrical Transient Analyzer Program (ETAP) software offers the capability to simulate, control and analyze a microgrid and other system, and is commonly used in the power industry.

PSCAD

Power System Computer Aided Design (PSCAD) software allows for construction of power systems circuits, running simulations, power flow analysis and management of the data.
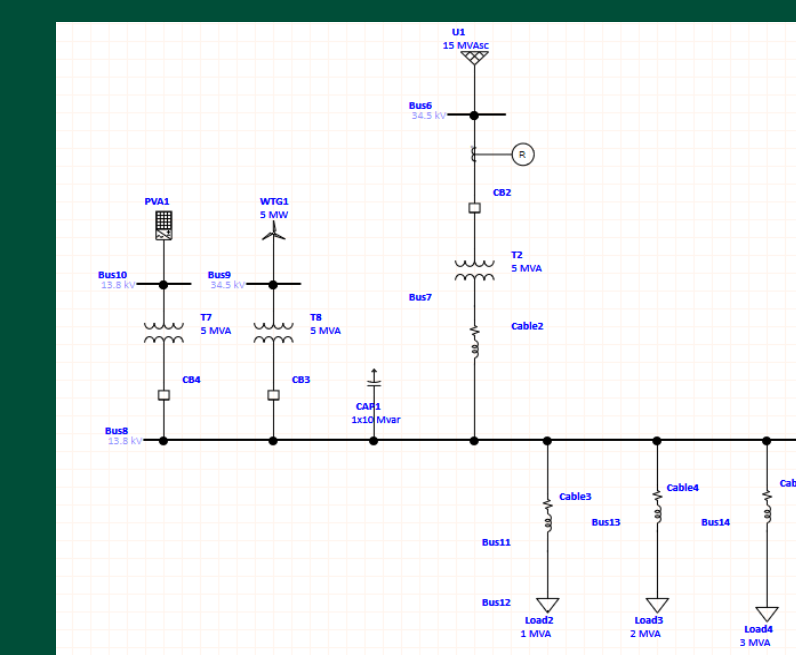

Figure 1. ETAP 20 Simulated circuit.

Questions
- What other protection schemes exists apart from inverters?
- What parameters are used to test new inverters?
- Should anti-islanding and Islanding protection schemes be used together? What logic should dictate how they work in tandem?

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