INFORMATION SHEET
RENEWABLE DEVELOPMENT FUND

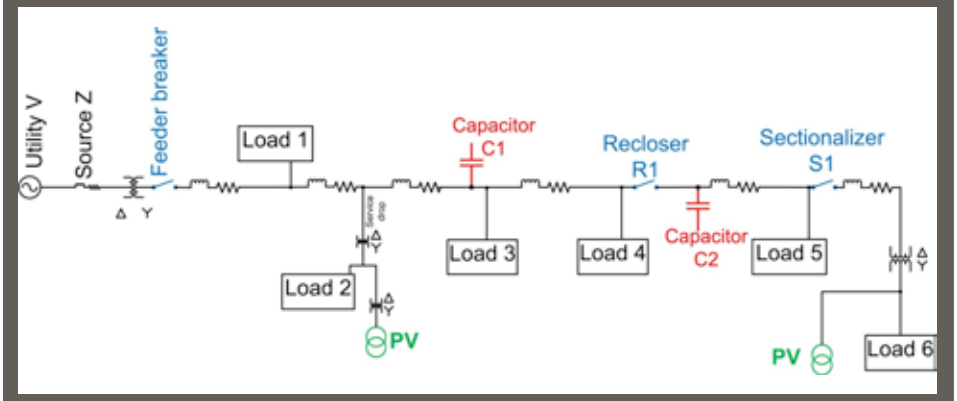
Investing in Renewable Energy

LOSS OF MAINS DETECTION AND ASSESSMENT FOR DISTRIBUTED GENERATION

Executive Summary

Loss of Mains (LOM) is a condition in which a section of a distribution system is isolated from a centralized power plant but continues to be energized by a local distributed generation facility, essentially forming a stranded subsystem, or "island". Small renewable energy generators, such as small wind power and photovoltaic systems, can be a source for potential LOM disturbances. If not correctly detected, LOM can result in a dangerous situation for utility workers or limit system reliability. Although current technology can address this problem, it causes distributed generators to take actions that are harmful to the larger system during disturbances.

What is islanding?



This is a generic distribution feeder. If part of the feeder is isolated by any of the blue switches from the "Utility V" at the left ("loss of mains"), any distributed generators, such as the PV plants shown in green, need to stop energizing the isolated part of the grid. If they don't, that section of the grid that's still energized is an unintentional island.

Project Description

Northern Plains Power Technologies (NPPT) built and tested highly detailed loss-of-mains detection (LOMD) models for two islanding detection methods:

1) Harmonic signature-based LOMD (HS-LOMD) which uses sophisticated signal processing for detection;
2) Synchrophasor-based LOMD (SB-LOMD) which uses differences in local and remote synchrophasor measurements for detection.

The models simulated LOM disturbances and the results were analyzed to ascertain signs that can be monitored for detection.

Benefits

- Elimination of a barrier to higher penetration levels of small renewable electric generation systems by improving grid operation and safety.
- Enables distributed generation assets to participate in system frequency support, local voltage regulation, and a variety of other system integrity protection schemes, collectively referred to as "grid support functions".

Grantee: Northern Plains Power Technologies
Project Dates: 6/11/2009 – 11/11/2012
RDF Funding Cycle: 3
Project Funding: $493,608 RDF Grant (Total project cost $734,273)
Project ID: RD3-21
RDF Mission: To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.

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Methodology

- In year one a computer model for a distribution system and portions of a transmission system was created and verified.
- In year two, the model simulated two system characteristics. One characteristic was the voltage harmonic spectra under steady-state and transient conditions to identify unique harmonic signatures and power line carrier communications signals. The second characteristic pertained to the relationships between synchrophasors at the generation location and a reference location higher in the system.
- In year three the computer modeling work was completed and the results disseminated to the energy industry regarding modification of applicable codes as well as describing standards and test procedures to facilitate commercial use of the technology.

Outcomes

- Two new LOM detection methods were invented and characterized.
- Four presentations were made before policy peer groups.
- Four publications were produced.
- Harmonic signature-based LOM detection feasibility can be achieved if in addition to sensitivity and selectivity, the speed (how quickly the condition is detected) is also used as a parameter.
- Synchrophasor-based LOM detection is highly effective in islanding prevention, compatible with grid support functions, and able to ride though grid events successfully.

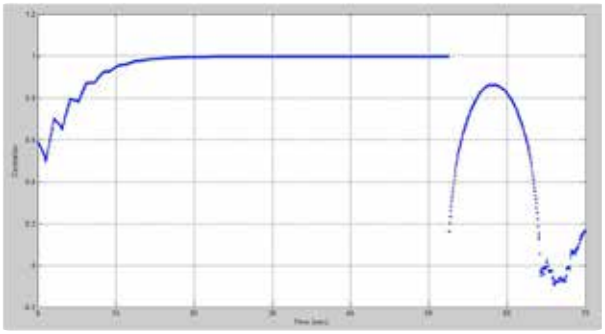
Lessons Learned

- Current LOM detection technologies must pass through a lengthy and expensive certification process, which increases the levelized energy cost from a distributed generator. Policy developed may improve the certification process.
- New loss-of-mains detection technologies based on harmonic signatures or synchronized phasors can provide a grid support role for distributed generation.
- Detection of unintentional islanding to enable distributed generation deployment is possible without compromising safety and security.
- When the required speed of response is reduced then selectivity and sensitivity can be simultaneously improved.

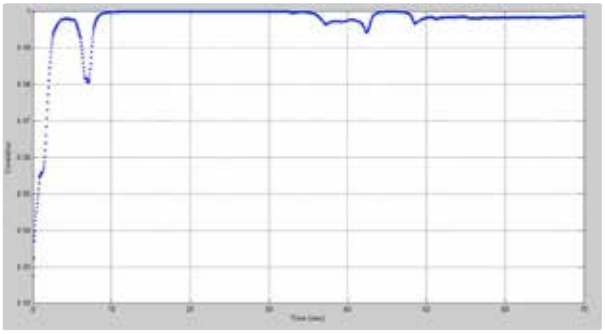
RDF Mission:

To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.

Example SB-LOMD project result



Island event. Island is clearly detected less than a half-second after it forms.



System event in which DG ride-through is desired. Here, SB-LOMD does not trigger a "trip"; DG stays online and supports the grid, as desired.