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PROJECT TITLE: ASSESSMENT OF THE UNIVERSAL FEASIBILITY OF USING POWER SYSTEM HARMONICS AS LOSS OF MAINS DETECTION FOR DISTRIBUTED ENERGY RESOURCES

CONTRACT NUMBER: RD3-21 **MILESTONE NUMBER: 13** **REPORT DATE: JULY 31, 2012**

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MILESTONE REPORT

EXECUTIVE SUMMARY

The purpose of this project is to assess the universal applicability of harmonic signatures and/or synchrophasors as a means for detecting unintentional islanding of distributed generation equipment such as photovoltaics. This report covers the time period April 01, 2012 to July 31, 2012, and describes our progress on Milestone 13. Milestone 13 has been completed. Accomplishments in this reporting period include:

- Make a presentation at the 38th IEEE Photovoltaic Specialists Conference, the first of three, and a presentation at the IEEE Power and Energy Society General Meeting, the second of three presentations at major power systems conferences, on the results of this work.

To meet this milestone, NPPT investigators wrote and submitted papers to the two above-named conferences and gave presentations at both.

Project funding is provided by customers of Xcel Energy through a grant from the Renewable Development Fund.

TECHNICAL PROGRESS

Milestone #13 consisted of:

- Make a presentation at the 38th IEEE Photovoltaic Specialists Conference (IEEE PVSC), the first of three, and a presentation at the IEEE Power and Energy Society General Meeting (IEEE PES GM), the second of three presentations at major power systems conferences, on the results of this work.

NPPT's President and the PI on this project, Michael Ropp, wrote and submitted papers to and made presentations at both of the above-named conferences. The paper "Synchrophasors for Island Detection" [1] was presented at the IEEE PVSC in Austin, TX on June 4, 2012. The paper "A Statistically-Based Method of Control of Distributed Photovoltaics Using Synchrophasors" [2] was presented at the IEEE PES GM in San Diego, CA, on July 26, 2012. The papers will be available online by the end of CY 2012 as part of the Proceedings of the respective conferences. They will be accessible through IEEExplore, http://ieeexplore.ieee.org; use the

Advanced Search feature, enter “Ropp” in one field and select to search in the Authors field, and enter “Synchrophasors” in another field and select to search the Document Title field. Abstracts and brief summaries of the PVSC and PES GM papers are presented in Appendices A and B, respectively, at the end of this report.

The PVSC paper on synchrophasor-based island detection [1] was presented as a poster. We received inquiries and high interest from approximately two dozen conference attendees, which is quite good for the PVSC, and our poster was named by the session chairs as one of the five best in our technical area at the conference. The PES GM paper [2] was presented orally, and approximately 38 people were in attendance. Interest in islanding detection in general was very high, and it is clear that the realization that there is a need for a new means of islanding prevention is spreading.

In addition, Dr. Ropp also attended a Distribution System Modeling Workshop that was held right after the IEEE PES GM in the same town. This workshop was held by the Department of Energy, Sandia National Laboratories, the National Renewable Energy Laboratory, and the Electric Power Research Institute. Dr. Ropp’s official talk at this conference was on temporary and transient overvoltage, but a high percentage of the attendees wanted to talk about islanding detection and the connection between islanding detection, fault detection, and grid support. Thus, the results of this Xcel RDF project received a hearing at that workshop as well.

NEXT STEPS

We now turn our attention to Milestone #14, our presentation at the Minnesota Power Systems Conference in November and subsequent submission of our RDF project final report.

PROJECT STATUS

The MiPSyCon paper was accepted, as noted earlier, so there are no obstacles remaining to meeting that portion of Milestone #14. Also, we are on track to submit our Final Report (Milestone #14) in November 2012.

REFERENCES

[1] M. Ropp, S. Perlenfein, D. Joshi, C. Mettler, M. Mills-Price, M. Scharf, K. Gubba Ravikumar, G. Zweigle, “Synchrophasors for Island Detection”, Proceedings of the 38th IEEE Photovoltaic Specialists Conference, June 3-8 2012, 7 pgs.

[2] M. Ropp, D. Joshi, M. Mills-Price, S. Hummel, M. Scharf, C. Steeprow, M. Osborn, K. Gubba Ravikumar, G. Zweigle, “A Statistically-Based Method of Control of Distributed Photovoltaics Using Synchrophasors”, Proceedings of the IEEE Power and Energy Society General Meeting, July 22-26 2012, 7 pgs.

LEGAL NOTICE

APPENDIX A. ABSTRACT OF THE IEEE PVSC PRESENTATION/PAPER (REFERENCE [1]).

Abstract:

Detection and prevention of unintentional islands powered by distributed generators like photovoltaics remains a key concern of utility protection engineers, especially in high-penetration and grid-support environments. These new circumstances dictate that new island detection tools are needed. Synchrophasors are highly promising in this regard, but some in the community remain skeptical about them because of costs. This paper discusses synchrophasors, how they may be used to detect islands, their cost-reducing value-added features, and synchrophasor-based island detection methods.

Summary of Key Results:

The goal of this paper was twofold. First, it discussed synchrophasor-based island detection techniques in general, especially the Wide-Area Method (WAM) and the Correlation Coefficient Based (CCB) method [2], and demonstrated the effectiveness of synchrophasors in this application. Second, it argued that cost concerns regarding synchrophasor-based islanding detection may be inflated because synchrophasors offer an excellent value-added proposition through all of the other functions they facilitate, in addition to islanding detection. Some of these other functions include:

- Feeder optimization and advanced control of distributed generators
- Event diagnosis
- Phase identification (important for maintenance, and for such things as electric vehicle charging optimization)
- Support for intentional islands and microgrids and their seamless integration into the grid

APPENDIX B. ABSTRACT OF THE IEEE POWER AND ENERGY SOCIETY GENERAL MEETING PAPER (REFERENCE [2]).

Abstract:

Despite many years of effort in the distributed energy resources (DER) industry, there remains a need for an islanding detection method that a) facilitates, rather than conflicts with, DER participation in grid support functions; b) does not degrade power quality; and c) reliably detects a loss of mains without nuisance trips. This paper describes a method that can meet this challenge. The method is a communications-based method that uses statistical analysis on synchrophasor data measured in two locations, an upstream reference point and at the DER bus. Simulation results, and laboratory and field test results are presented for one very simple implementation of the method. It is shown that the method works very well, even in its simplest form.

Summary of Key Results:

This paper focused on a new method of islanding detection using synchrophasors. A phasor is a complex vector representation of a voltage or current, and synchrophasors are time-synchronized phasors. Synchrophasors are already used for a variety of system control, monitoring and protection functions at the transmission level, but are not yet widely deployed in distribution. Still, it is clear that if challenges involving cost and speed can be overcome, synchrophasors can be effectively used in distribution to detect island formation. This paper presented a new means for using synchrophasor information for islanding detection based on statistical correlation of frequency. The method, called the Correlation Coefficient Based (CCB) method, is described in the paper, and simulation, laboratory and field test results are presented. The conclusion of the paper is that the CCB has two great advantages;

1. In simulations, lab tests and field experiments, it “always” works in the sense that because of the physical mechanism on which it is based it never fails to detect an island. At the same time, if thresholds are properly set, the CCB exhibited no false trips—in other words, it only tripped when there was an island, and not on local switching events or system-level transients in which ride-through is desired. In simulation, the CCB achieved this level of success on multiple feeders and with many combinations of distributed generation on the feeder.
2. It is computationally efficient and relatively easy to implement in inexpensive hardware.

The paper also identifies two key disadvantages of the method.

1. Because it is a statistical method, the CCB’s time to detect an island is nondeterministic; although it does always detect an island, it is sometimes slower to do so than IEEE 1547 recommends (IEEE 1547 recommends a maximum detection time of 2 sec). Fortunately, it appears that this can be improved through more advanced signal processing and decision criteria.
2. The CCB shares with other synchrophasor-based methods the problem of requiring expensive synchrophasor infrastructure, but the idea is the value-added proposition of the synchrophasors (discussed in [1]) may largely overcome this problem.