ABSTRACT OF THE DISSERTATION

DEVELOPMENT OF HARDWARE IN THE LOOP REAL-TIME CONTROL

TECHNIQUES FOR HYBRID POWER SYSTEMS INVOLVING DISTRIBUTED DEMANDS AND SUSTAINABLE ENERGY SOURCES

by

Ali Mazloomzadeh

Florida International University, 2014

Miami, Florida

Professor Osama A. Mohammed, Major Professor

The future power grid will effectively utilize renewable energy resources and distributed generation to respond to energy demand while incorporating information technology and communication infrastructure for their optimum operation.

This dissertation contributes to the development of real-time techniques, for wide-area monitoring and secure real-time control and operation of hybrid power systems.

To handle the increased level of real-time data exchange, this dissertation develops a supervisory control and data acquisition (SCADA) system that is equipped with a state estimation scheme from the real-time data. This system is verified on a specially developed laboratory-based test bed facility, as a hardware and software platform to emulate the actual scenarios of a real hybrid power system with the highest level of similarities and capabilities to practical utility systems. It includes phasor measurements at hundreds of measurement points on the system. These measurements were obtained from especially developed laboratory based Phasor Measurement Unit (PMU) that is utilized in addition to existing commercially based PMU’s. The developed PMU was used in conjunction with the interconnected system along with the commercial PMU’s. The tested studies include a new technique for detecting the partially islanded micro grids in addition to several real-time techniques for synchronization and parameter identifications of hybrid systems.

Moreover, due to numerous integration of renewable energy resources through DC microgrids, this dissertation performs several practical cases for improvement of interoperability of such systems. Moreover, increased number of small and dispersed generating stations and their need to connect fast and properly into the Ac grids, urged this work to explore the challenges that arise in synchronization of generators to the grid and through introduction of a Dynamic Brake system to improve the process of connecting distributed generators to the power grid.

Real time operation and control requires data communication security. A research effort in this dissertation was developed based on Trusted Sensing Base (TSB) process for data communication security. The innovative TSB approach improves the security aspect of the power grid as a cyber-physical system. It is based on available GPS synchronization technology and provides protection against confidentiality attacks in critical power system infrastructures.