CIGRE/EPRI: GRID OF THE FUTURE SYMPOSIUM
Chicago, Illinois, October 11, 2015

Tutorial #2

Design and Implementation of Microgrid in Modern Power Systems

Wanda Reder, Saeed Kamalinia, Paul Pabst, and Michael Higginson
S&C Electric Company

Tutorial Abstract

This tutorial introduces the concepts, fundamental theories, practical design process, and applications of various types of microgrids. The course is intended for engineers, researchers, and industry managers who want to learn more about latest developments of microgrid technologies as well as the design and implementation of microgrid systems. Participants will learn several aspects of the engineering design and analytical studies required for successful integration of modern microgrids. Initial discussion will cover the definition and objectives of microgrids, the current market, challenges and barriers of microgrid development, and real world experiences with microgrid projects will be presented.

Several components are required for successful design and implementation of a microgrid. Proper analytical studies need to be performed for secure and reliable integration of microgrids to the existing robust power systems. Considerations for selecting Distributed Energy Resources (DERs) for optimal integration and utilization will be discussed. A variety of DERs are usually considered for microgrid applications, including conventional generation, renewable generation, energy storage, and demand reduction. Protection of microgrids has unique challenges compared to conventional radial distribution systems, including complex fault current flow and DER fault behavior. Implementation of a microgrid protection scheme, including selection of appropriate switching and protection devices and differences with the protection of conventional power systems will be reviewed in this tutorial. Communication and control systems are integral components of modern microgrids. Communication, media protocols, the process of designing a robust communication system, and control hierarchy in microgrid applications will be presented.

The workshop will also include an overview of an actual industrial-scale microgrid project commissioned by S&C engineers and group exercises for better understanding of the concepts and processes. This project is the recipient of *2015 Smart Grid Project of the Year award from Power magazine*.

About the Instructors

Wanda Reder, is currently the Chief Strategy Officer of S&C Electric Company in Chicago, IL. From 2004 to 2014 she was Vice President of Power Systems Solutions (PSS) Division of S&C, where she led numerous industrial, commercial, and utility projects, including several Smart Grid and Distribution Automation projects. Under her leadership PSS Division design and implemented the first Perfect Power prototype at Illinois Institute of Technology.

Ms. Reder is Fellow of IEEE, the IEEE Division VII Director,Past President of the Power and Energy Society, and founder of IEEE-PES Scholarship Plus Initiative. She received the 2014 IEEE Richard M. Emberson Medal for her distinguished service to the development, viability, advancement, and pursuit of the technical objectives of the IEEE and the IEEE Technical Activities Board (TAB) Hall of Honor Award and IEEE Power & Energy Society Meritorious Service Award in 2013.

Saeed Kamalinia, Ph.D., is a Senior Engineer in Consulting and Analytical Services department of S&C Electric Company. He has extensive experience in various fields of power system analyses including renewable generation planning and interconnection studies, load flow and dynamic stability analysis, transient and switching analyses, harmonic study, and integration of distributed generators into the distribution systems.

Saeed received his Ph.D. in Electrical Engineering, with a focus on Power Systems, from Illinois Institute of Technology, Chicago in 2010. He is author/co-author of more than twenty journal papers and conference articles in various areas of power system including wind generation, power markets security and operation, distributed generation resources, and transmission system design. He is Chair of Awards and Recognition Committee of IEEE-Chicago Section and Technical Activities Coordinator for the Large Sections of IEEE Region 4. He is also member of Cigre Working Groups of "Wind farm interconnection to weak AC networks (WG B4-62)" and "Effects of DG reverse power flow on transmission and distribution transformers (WG A2.50)", and Executive Committee Member of Cigre Next Generation Network (NGN).

Paul Pabst, PE, is Supervisor of SCADA Engineering in the Power Systems Solutions Division of S&C Electric Company with eight years of experience in the electric power industry. His responsibilities include technical lead of protection & control (P&C) systems, SCADA integration design, control enclosure design, field start-up and commissioning of green field and brown field substations, and design and full-scale testing of distribution automation systems.

Paul received his B.S. in Electrical Engineering from Purdue University, West Lafayette, IN in 2007. He is previous Chair of the IEEE PES Chicago Chapter and IEEE PES Region 4 Representative. Paul is a Licensed Engineer (P.E) in Illinois, Florida, California, Georgia, and Alabama.

Michael Higginson, is a Design Engineer with S&C Electric Company in its Consulting and Analytical Services department of the Power Systems Solutions division. Michael is responsible for performing a variety of power systems studies including short circuit analysis, protective device coordination, and arc flash studies. He also presents training on electrical hazards and the performance of arc-flash incident energy analysis.

Michael has a B.S. degree in Electrical Engineering from University of Notre Dame and is currently pursuing his M.S. degree in Electrical Engineering from Illinois Institute of Technology in Chicago. Michael is a member of the IEEE Power and Energy Society and is active in the IEEE Power System Relaying Committee. He is an Enrolled Professional Engineer Intern in the state of Illinois.