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Innovative research to achieve water efficient and environmentally friendly solar power

SOLAR ENERGY-WATER-ENVIRONMENT NEXUS PROJECT

Microgrid - A Test Bed for Future Smart Grids with Distributed Energy Generation

Introduction and goal

Microgrids – also called minigrids – are local power networks that use distributed energy resources and manage local energy supply and demand. They can operate connected with the bulk power transmission and distribution system, or they can function in island mode (pull themselves off the grid) when necessary to increase reliability for the local load. Microgrids are among the major technical cornerstones in the Department of Energy's vision of the future "smart" electric power infrastructure. It is envisioned that future "smart" grid will have the ability to break down into small autonomous "micro-grids" that continue to serve customer loads in case of major outages.

Our goal is to test new "smart" devices that will be deployed in the future smart grid and to build a strong education and research program in modern electric power systems with distributed energy resources.

Where does this research fit within the NEXUS project?

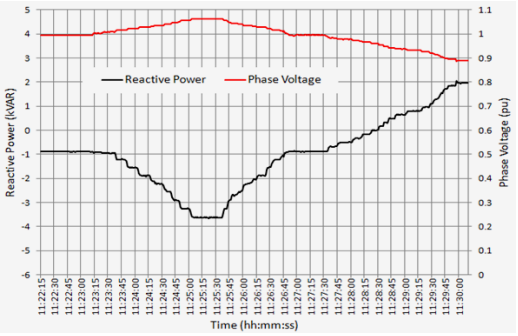
The microgrid research will help to improve the development and reliability of renewable and solar energy supply, which is Objective 4 within Goal 1 of the NEXUS project.

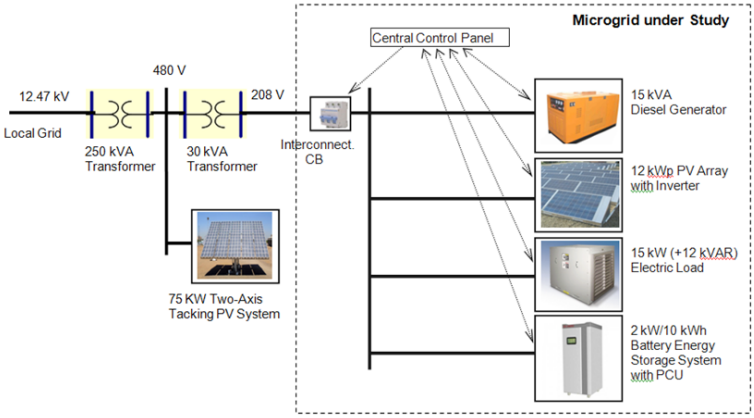
Why is this research important and what knowledge gap does it fill?

The microgrid is a valuable outdoor facility to conduct field tests on new concepts pertaining to grid modernization. The research will lead to more solar photovoltaic penetration into the electrical grid by minimizing its interference with grid operation. It also contributes to the ability of the power grid to adapt to short- and long-term changes. Potential impacts include transforming the operation of utilities throughout the nation with higher level of efficiency, reliability and green energy.

What is the originality of the approach?

Unlike the common methods utilized when testing modern smart electrical devices (i.e., by using grid and photovoltaic simulators), the microgrid employs real power sources including a synchronous generator and a photovoltaic system.





Key results to date

Experiments have been completed on advance functionalities, islanding detection, and current distortion of smart inverters. The results show that smart inverters can (a) provide valuable ancillary services to electric utilities, (b) still detect islanded situations without interference from these advanced functions, and (c) generate harmonic currents that are well within the recommended limits specified in interconnection standards.

The results have been presented in the following publications:

W. Peng, C. Hicks, O. Gonzalez, B. Blackstone and Y. Baghzouz, "Experimental Test on Some Autonomous Functions of Advanced PV Inverters", IEEE PES General Meeting, Boston, MA, July 17-21, 2016

C. Hicks, W. Peng, and Y. Baghzouz, "Experimental Test on the Islanding of an Advanced PV Inverter", IEEE/SPEEDAM, Capri, Italy, June 22-24, 2016

T. Taylor, O. Gonzalez and Y. Baghzouz, "Harmonic Analysis of a 'Smart' 3-Phase PV Inverter", IEEE/ICHQP, Belo Horizonte, Brazil, October 16-19, 2016

How is the research and/or equipment fostering collaboration now, and in the future?

The microgrid is currently being used for the research described above by the following:

- Graduate Students: Chris Hicks, Brandon Blackstone, Wenxin Peng
- Undergraduate Students: Octavio Gonzalez, Travis Taylor
- Research Engineers: Rick Hurt, Paolo Ginobbi

Future use and collaboration planned include:

- M. Etezadi, H. Livani, S, Fadali (UNR) – remote monitoring and controls
- Eric Wilcox (DRI) and Brendan Morris (UNLV) – solar forecasting
- Y. Baghzouz and R.F. Boehm (UNLV) – energy storage
- Paulo Márcio da Silveira (Unifei, Brazil) – Synchronous generator anti-islanding

Future plans

- Conduct tests on PV with energy storage systems.
- Develop controls schemes for seamless transfer between on-grid and off-grid.
- Acquire and test other smart grid devices (e.g., static switches) under different operating conditions.
- Increase collaboration with national and international research institutions.

Contact us

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