Modeling and Simulation of a DG-Integrated Intelligent Microgrid

Background

The electric power system is an enabling infrastructure that supports the continuous operation of various mission critical facilities, both at the component and the systems levels. For example, a reliable, efficient and secure power system is necessary for the operation of critical buildings in a base or the whole base itself. This is also applicable for deployed force in forward bases, which have to be put into service quickly and reliably. At present, there is a need to design a distributed and autonomous subset of a larger grid or a microgrid to increase the security and reliability of electricity supply in such facilities. This microgrid must be capable of intelligently controlling and networking a variety of local distributed energy resources (DERs) that include renewable energy technologies to reduce the use of fossil fuels.

Objective

The objective of the proposed work is to model and simulate a specialized microgrid called an Intelligent Distributed Autonomous Power Systems (IDAPS), which will play a crucial role in building a scalable power grid that facilitates the use of renewable energy technologies.

Process and Technology

The technical approach for modeling and simulation of an IDAPS microgrid consists of the following five steps: (1) the development of IDAPS physical components in Matlab/Simulink – which include a distribution network, DERs and loads; (2) the development of local control algorithms to control each DER and loads in an IDAPS microgrid; (3) the development of an IDAPS energy management system based on multi-agent technologies that follow the IEEE standard on Foundation for Intelligent Physical Agents (FIPA); (4) the demonstration of how a connection between the IDAPS physical components and the IDAPS decision support system can be established using addressable IP-based communication interfaces; and lastly, (5) the simulation and evaluation of the IDAPS microgrid in both parallel and islanded operations using data from Virginia Tech Electric Services to ensure that the IEEE 1547 standard for interconnecting distributed resources with electric power systems are followed.

Benefits

The implementation of an IDAPS microgrid in a mission-critical facility optimizes the operation of internal generation and loads during normal conditions and increases the security of energy supply to critical loads by shedding non-critical loads during emergencies. The IDAPS control agents have an embedded intelligence that works in collaboration with local controllers to coordinate both DERs and loads to achieve any mission-based environmental, operational and economic performance criteria. The proposed approach once validated is believed to help remove certain barriers in the interconnection and control of DER units in a microgrid environment. As a result, the IDAPS model will help facilitate the use of cleaner, greener and more efficient distributed energy resources, including renewable energy technologies, microturbines, fuel cells, storage devices and plug-in hybrid electric vehicles.

Contact Information:

Lead PIs:
Dr. Saifur Rahman (srahman@vt.edu)
Dr. Manisa Pipattanasomporn (mpipatta@vt.edu)
Virginia Tech
Advanced Research Institute
4300 Wilson Blvd., Suite 750
Arlington, VA 22203

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