Office of
ELECTRIC TRANSMISSION & DISTRIBUTION
ELECTRIC DISTRIBUTION TRANSFORMATION PROGRAM

NiSource Energy Technologies Inc.

System Integration of Distributed Power for Complete Building Systems

Goals

Several factors affect the degree to which distributed generation (DG) systems will penetrate electricity markets. DG systems must provide reliable, quality power, safely operate parallel to utility grids, and meet local electric and building codes. All of this must be done in a manner that provides economic benefit to the customer. Nationally, combined heat and power (CHP) DG systems have the potential to improve energy efficiency and reduce environmental emissions. NiSource is working to advance the state of the art of implementation and control of CHP systems in grid-connected commercial applications.

Approach

NiSource is developing approaches to incorporate DG systems into the physical design and controls of buildings. It is conducting R&D to evaluate grid-connected and aggregated distributed power systems and combining multiple technologies with dynamic optimization and control of energy use to identify regulatory, integration, and interconnection issues.

Results

Interconnection Issues in Small DG Systems

NiSource surveyed utilities to determine the state of the art of interconnection technology and methods. It documented the architecture and electrical characteristics of the utility distribution system and identified factors that affected interconnection. It detailed the physical interconnection and equipment and the hardware and software required. NiSource identified all tests needed for interconnection and specified requirements for each. It quantified costs and delays incurred because of technical interconnection requirements. In addition, it determined the effects of utility rates, fees, business practices, experience, and regulatory practices on interconnection cost.

Zoning and Permitting of Distributed Generators

To ensure the viability of DG systems, it is important to identify zoning and permitting requirements and assess the associated costs of installing systems. NiSource investigated the effects of zoning and permitting requirements within its service area. These included environmental permitting as well as municipal building, electricity, safety, and mechanical code requirements. Codes for the implementation of DG are not yet consistent. Standards development is under way but not yet universal.

Microturbine CHP installation

System Integration and Performance

NiSource has established four CHP test sites to establish and benchmark requirements for the performance of CHP systems under various conditions—especially when interfaced with the utility grid. Data are gathered through comprehensive field-testing and used to validate computer models. NiSource studied utility interface power electronics performance, interoperability between the DG and the utility, and real-time tracking and control systems.

Each site and its systems are unique in application and a different platform for testing opportunities to optimize CHP DG operation in buildings.

- Site 1 is a NiSource-designed prepackaged system consisting of a 30-kW microturbine, heat recovery, desiccant dehumidification, and controls.
- Site 2 is a small office building for which NiSource can accurately characterize the building and occupancy patterns for modeling studies. Various CHP systems were installed in the building to gather data about the interactions of the systems with one another and with a conventional HVAC system.
- Site 3 is a warehouse.
- Site 4, a YMCA, includes a two-microturbine (60 kW each) CHP system. In addition to providing electricity, the system supplements heat for the water supply, swimming pool, and space heating.

Modular system power controls

From its testing, NiSource has concluded:

- Market penetration of CHP DG systems will depend on integrating the system with the building's controls and low maintenance costs.
- At low penetration levels, the grid influences the CHP system more than the CHP system influences the grid.
- Surge suppression and lightning arrestors are essential.
- In most standalone and some grid-connected applications, it is necessary to sequence starting inductive loads.
- The type of heat-driven devices used in the CHP system can greatly affect the overall efficiency and economic viability of the CHP application.

Related Research

NiSource is conducting research in several areas. It is developing a conceptual design and model of a portion of the NiSource system to determine the ability of a controllable inverter to directly improve local power quality. The model will be able to change its operating mode to provide ancillary services such as VAR support and wave shape correction. NiSource is also modeling an electric distribution network to evaluate the stability and interaction of inverters, synchronous generators, and induction generators with loads and system components.

NiSource has baselined the state of the art in transfer switching and is working to evaluate alternatives for power reliability and power quality during the transitions to and from grid-connected operation.

A meeting in late 2003 will explore advances in technology and operations that could be incorporated into the future distribution system.

Continuing its efforts to characterize how distributed generators interact with the electric distribution network, NiSource is developing an integrated model of a portion of its system. It is studying the dynamic and steady-state interactions of two microturbine installations and the local utility distribution network.

Continued Testing and Analysis

NiSource continues testing how these systems work with the whole building model and studying interrelationships with the grid and surrounding communities. Current testing includes configuring the systems for grid isolation and ascertaining how the systems perform under complete isolation. Power quality and performance data are being collected under all conditions. A database of test data has been developed. Failures are analyzed and repaired.

Publications

Kramer, R. "System Integration of Distributed Power for Complete Building Systems: Phase 1 Report." NREL/SR-560-34966.

Kramer, R. "System Integration of Distributed Power for Complete Building Systems: Phase 2 Report." NREL/SR-560-35054.

Publications are available on the NREL publications database, http://www.nrel.gov/publications/.

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