NiSource Energy Technologies

Optimizing Combined Heat and Power Systems

Goals

NiSource Energy Technologies is conducting research and development to evaluate grid-connected and aggregated distributed power systems and combining several technologies with dynamic optimization and control of energy use to identify regulatory, integration, and interconnection issues. Its long-term goal is to develop approaches to incorporate distributed generation (DG) systems into the physical design and controls of buildings.

Two-turbine CHP installation

The degree to which DG systems penetrate electricity markets is dependent on several factors. DG systems must provide reliable and quality power, safely operate paralleled to utility grids, and meet local electric and building codes. And all of this must be done in a manner that provides economic benefit to the customer. Because combined heat and power (CHP) DG systems have the potential to greatly improve energy utilization efficiency and reduce environmental emissions nationally, NiSource is working to advance implementation and control of CHP systems in grid-connected commercial applications.

Current Results

Interconnection Issues in Small DG Systems

As part of its work, NiSource has detailed the issues related to connecting distributed power systems to the grid and examined approaches and solutions. The approaches are divided into technical, institutional, and regulatory issues and include the following:

a) Determining the state of the art in interconnection technology and methods

b) Describing the architecture and pertinent electrical characteristics of the utility distribution system and identifying any characteristics that affected the interconnection

c) Describing the physical interconnection with the utility grid, the equipment providing interconnection (including a description of this equipment), and other software and hardware required for safety, reliability, or power quality

d) Identifying required interconnection tests (e.g., interconnection equipment, type of test, field test, and others.)

e) Determining and documenting the costs and any delays incurred because of technical interconnection requirements

f) Determining the effect of utility rates, fees, business practices, utility experience, and regulatory practices on the cost of interconnection.

Zoning and Permitting of Distributed Power 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 as identified within the NiSource service area. These requirements include environmental permitting and municipal building, electrical, safety, and mechanical code requirements. It was generally noted that there are few consistent codes for the implementation of DG.

System Integration and Performance

NiSource has established three CHP test sites and one recreational installation within its service territory. The purpose of these test sites is to establish and benchmark requirements for system performance of CHP systems when interfaced with the utility grid. NiSource studied utility interface power electronics performance, interoperability between the DG system and utility, and real-time tracking and control systems.

Packaged CHP system that includes a 30-kW microturbine, heat recovery system, and desiccant dehumidification system

Site 1 is a NiSource-designed pre-packaged system consisting of a 30-kW microturbine, heat recovery, desiccant dehumidification, and controls. Site 2 is a small office building where it was possible to accurately characterize the building as well as the occupancy patterns for several modeling studies. Various CHP systems were installed in the building to gather data about the relative merit and interaction of the systems with one another as well as with a conventional HVAC system.

Packaged CHP system incorporating desiccant dehumidification system

Site 3 is a warehouse for evaluating characteristics of this type of application to determine the most relevant factors for improvements.

The most recent installation is a 2-microturbine (60-kW each) CHP system at a YMCA. In addition to electricity, the system supplements heat for the water supply, swimming pool, and space heating. It is expected to generate approximately 25% of the facility's summer electrical load and up to 70% of the winter load and save the YMCA approximately 10% of its overall energy costs.

Each of these systems is unique in its application and will be a platform for testing the opportunities to optimize the DG operation.

From its testing to date, NiSource has come to several conclusions, including:

- The 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 much more than the CHP system influences the grid.
- Surge suppression and lightning arrestors are essential.
- In most stand-alone 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.

Distribution and Interconnection R&D (Formerly Distributed Power Program)

DOE's Distribution and Interconnection R&D supports the development of technologies and policies that enable distributed generation (e.g., photovoltaic systems, wind turbines, fuel cells, and microturbines), storage, and direct load control technologies to be integrated into the electric system. Through a collaboration of national laboratories and industry partners, DOE's Distribution and Interconnection R&D pursues activities in: (1) strategic research, (2) technical standards, (3) distribution system technology, (4) interconnection technology, and (5) mitigation of regulatory and institutional barriers.

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Additional Distributed Power Information
http://www.eren.doe.gov/distributedpower

Produced for the U.S. Department of Energy, 1000 Independence Avenue, SW Washington, DC 20585 by the National Renewable Energy Laboratory, a DOE National Laboratory.

DOE/GO-102003-1683 January 2003

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste.