Optimizing the Economics and Technical Viability Of Combined Heat And Power Systems For Maximum Reliability, Efficiency, And Environmental Protection

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Purpose Of The Research

Advance distributed power development, deployment and integration by designing ways to extend DG into the physical design and controls of a building . The general approach is to evaluate grid-connected and aggregated distributed power systems using several technologies with dynamic optimization and control of energy use while considering regulatory, integration and interconnection issues .

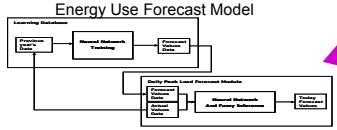
Accomplishments For The Year

- ✓ Investigated DG systems and developed initial DG building control systems using advanced controls and artificial intelligence for the optimal management of energy resources as well as the interface with the grid.
- ✓ Assembled and analyzed detailed data on regulatory and institutional issues associated with interconnection costs in the NiSource territory.
- ✓ Established benchmark requirements for DG system, building interface, and control for various states of interfacing with the utility grid.

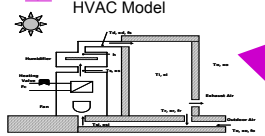
Optimized Model for CHP system using Fuzzy Logic and Neural Networks under development

Test System on Roof of Operating Drug Store

Energy Use Forecast Model



HVAC Model



Optimization Matrix

$$C_{ELEC} = \phi_{kWH}\begin{bmatrix} kWh_{BLDG}(1) - kWh_{GEN}(1) \\ kWh_{BLDG}(2) - kWh_{GEN}(2) \\ \dots \\ kWh_{BLDG}(k) - kWh_{GEN}(k) \end{bmatrix} + \phi_{kW}\begin{bmatrix} kW_{BLDG}(1) - kW_{GEN}(1) \\ kW_{BLDG}(2) - kW_{GEN}(2) \\ \dots \\ kW_{BLDG}(k) - kW_{GEN}(k) \end{bmatrix} + \dots$$

$$\dots + \phi_{GAS}\begin{bmatrix} Btu_{BLDG}(1) - Btu_{GEN}(1) \\ Btu_{BLDG}(2) - Btu_{GEN}(2) \\ \dots \\ Btu_{BLDG}(k) - Btu_{GEN}(k) \end{bmatrix} + \dots$$

$$\dots + \phi_{CRED}\left[\sum kWh_{GEN}\right] + \phi_{O\&M}\left[kW_{INST} + \sum kWh_{GEN}\right]$$

Currently, variability in building codes is a design issue, but situation is improving due to accelerating adoption of International Building Code

Collected and analyzed DR interconnection information provided by the seventeen investor-owned utilities that replied to a survey of 100 utilities. Focus concentrated on the technical and institutional costs related specifically to receiving permission for connection. A widely varying degree of detail with regard to interconnection costs, including the types as well as amount, exists among these electric utilities.

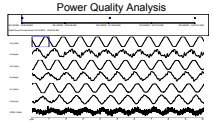
Three CHP test sites considered
- **Small Office Building**
- **Warehouse**
- **Commercial Business**

Interaction between and operation of CHP devices and systems considered to arrive at design recommendations

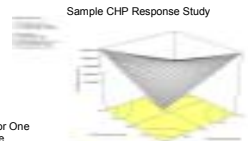
Factorial Experimental Design employed to consider key operating factors and interactions

Absorption Chiller Unit Between Two CHP Modules

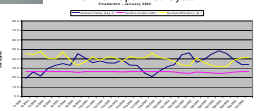
Power Quality Analysis



Sample CHP Response Study



CHP Energy Utilization For Non Optimized System



Test Details For One Test Case

Breeden YMCA Demonstration Site