Description of integrated pilots/demonstrations/field tests/existing practices

1. Name of the case:

System Integration of Distributed Power for Complete Building Systems

2. What is integrated with DSM

DG	X
Energy storage	X
Smart grid technologies	X

3. What is the level of commercialization

Research project	
Demonstration	
Field test	
Existing practice	X

4. Where to find more information?
   - Contact persons: R. Kramer / NiSource Energy Technologies
H. Thomas / NREL
   - web-site: http://www.nrel.gov/docs/fy04osti/35054.pdf

5. Objectives of the case

This project's long-term goal is to design ways to extend distributed generation (DG) into the physical design and controls of buildings. The approach was to evaluate grid-connected and aggregated distributed power systems using technologies with dynamic optimization and control of energy use to identify regulatory, integration, and interconnection issues.

6. Business rationale/model

Distributed energy resources hold great potential for meeting future energy needs. This is especially true when aspects of sustainable development and environmental compatibility are considered. Currently there are many distributed generation (DG) sources in operation, primarily for standby or emergency purposes. DG devices tend to have higher proportionate capital costs and lower efficiencies when compared to central stations for the production of electricity.

However, when operated in an optimized combined heat and power (CHP) mode these devices provide many operational and economic advantages over conventional energy supply options.

7. Technologies used

Distributed generation power generators considered in this study include biomass-based generators; combustion turbines; concentrating solar power and photovoltaic systems; fuel cells; wind turbines; microturbines; diesel generator sets; hybrid systems and electrical power storage. These alternative sources can produce electric power that range from 5 kW to 50 MW and either be grid connected or operate independent of the grid (stand-alone).

Combined heat and power (CHP) systems as DG hold the promise of providing electric power as well as economic, operational, and environmental benefits. CHP systems located at the customer's facility generate electricity and can more than double the efficiency of energy utilization by making use of excess heat from combustion. Heat can be utilized for thermal equipment, such as: heat exchangers, active/passive thermal storage or heating ventilating and air conditioning (HVAC) systems. By using CHP, consumers also lower greenhouse gas emissions and reduce energy costs.

The following was to be designed and installed by the customer at the customer's expense: connection, transformation, switching, protective relaying, metering, and safety equipment—including a disconnect switch and all other outlined requirements.

The installation of the following equipment may have been necessary, depending on the results of the review: supervisory control and alarms, telemetering, and associated communications channels—all at the customer's expense. Some or all of these functions may have been available utilizing existing energy management systems (EMS). Additionally, all meters and metering cabinets were installed in accordance with utility rules.

8. Short description of the case

NiSource Energy Technologies Inc. (NET) has completed an effort to address research and development to significantly advance distributed power development, deployment, and integration. Its long-term goal was to design ways to extend distributed generation (DG) into the physical design and controls of buildings. The NET approach was to evaluate grid-connected and aggregated distributed power systems using technologies with dynamic optimization and control of energy use to identify regulatory, integration, and interconnection issues. In addition, DG, and specifically combined heat and power (CHP), holds promise to greatly improve energy efficiency and reduce environmental emissions. NET worked to meet these goals through advances in the implementation and control of CHP systems in end-user environments and a further understanding of electric interconnection and siting issues.

9. Achieved/expected results (operational savings, CO_2, efficiency enhancement)

A major goal of this work was to develop concepts that will advance the penetration of IES technology into the marketplace and increase its use as a resource for meeting future national energy needs. In Task 4, system design issues were considered to increase the overall efficiency of the system. This is important to make the technology competitive with other energy options such as conventional grid power. Optimization and testing were performed on IES components and building integration concepts to increase efficiency, reliability, and applicability. Issues relating to how an IES might be connected to the grid for a particular location and purpose were considered.

The systems performed as designed and reliably for a variety of conditions. Issues of power quality and grid interaction did not seem significant for the current installation. As the penetration of DG systems increases, these aspects will become more noticeable. Essentially, there should be no concern with low levels of penetration on a particular distribution feeder. It was found that 120 kW of microturbine generation had no influence on the operation of the distribution feeder in Gary. As the penetration level increases, inductive transients first surface as a concern. This will restrict those applications in which there is significant motor starting, including such devices as refrigeration and process handling equipment.

10. Lessons learned

This paper demonstrates a new strategy for the integrated applications of distributed generation, HVAC system, active/passive thermal storage and electrical grid interconnection for a building system. Although this research project is still under development, this paper has been able to describe the elements that need be incorporated into an intelligent building system from the energy usage point of view. Two commercial building sites have been equipped with CHP units and formed test-beds for the NET DG-based energy optimization analysis.

A three-level hierarchical control system for the integration of distribution generation, HVAC and thermal storage provides benefits in terms of:
• Integration of utility rate structures and other relevant information databases into the control strategy
• Improved optimization of comfort/energy usage
• Operational simplicity for the end-user
• Reduction in the equipment capacity required
• The ability to shed load from unoccupied zones when demand cannot be met