DER DISTRIBUTED ENERGY RESOURCES

Thermally Activated Technologies: Integrated Energy Systems

Tech Brief

Distributed Energy Resources (DER) are a suite of onsite, grid-connected or stand-alone technology systems that can be integrated into residential, commercial, or institutional buildings and/or industrial facilities. These energy systems include distributed generation, renewable energy, and hybrid generation technologies; energy storage; thermally activated technologies that use recoverable heat for cooling, heating, or power; transmission and delivery mechanisms; control and communication technologies; and demand-side energy management tools. Such decentralized resources offer advantages over conventional grid electricity by offering end users a diversified fuel supply; higher power reliability, quality, and efficiency; lower emissions; and greater flexibility to respond to changing energy needs.

Roughly one-third of the energy contained in the fuel for conventional electrical generation is used to make usable power-the other two-thirds is discarded as waste heat into the atmosphere, adjoining lakes, rivers, and streams; further losses occur in electrical power transmission and distribution. Integrated Energy Systems (IES) can recover waste heat from distributed generation and use it to provide additional power, cooling, heating, water heating, steam heating and humidity control for buildings—with overall system efficiency approaching 80 percent.

IES technology is not routinely employed in commercial buildings, primarily because of a lack of pre-packaged, pre-engineered, or modular systems that can plug and play into a building's existing energy system. Typically, specialists in controls, chillers, desiccants, storage tanks, cooling towers, heat exchangers, and electrical connection equipment engineer these systems in the field after consulting with multiple vendors—adding cost, time, and complexity. So, the first level of integration includes making individual IES components work more efficiently as one system.

Microturbine, Exhaust Gas Fired Absorption Chiller, and Cooling Tower at the University of Maryland's IES for Buildings Integration Test Center

The second level of integration involves connecting an IES into a building's existing energy system. component manufacturers need to offer building owners pre-engineered, packaged IES systems that can be seamlessly integrated into building energy systems. Universal connection standards would greatly simplify installation and maintenance—and encourage acceptance of the technology by the architectural and engineering community. Simplified, pre-engineered, skid-mounted IES equipment would make building owners responsible only for connecting power, piping, or ducting. Controls may be connected to a local network, permitting onsite personnel to operate the equipment directly from a desktop PC.

This advanced technology integration requires a new application of existing technical expertise and cooperation between government, academia, and industry. The IES Integration Test Center at the University of Maryland will test IES that have been engineered in the field, right outside the building. DOE, Oak Ridge National Laboratory (ORNL), and the University of Maryland will work together to learn how to integrate existing IES systems into a commercial building more effectively, test those systems, and transfer their expertise to other building owners.

Applications

- **Smaller Commercial and Institutional Systems** — With the arrival of reliable reciprocating engines and smaller combustion turbines, microturbines, and fuel cells, IES is becoming feasible for small commercial, residential, and institutional buildings. This involves the installation of a system that generates part or all of the building's electricity/thermal requirements.

The Test Center is located in College Park, Maryland, where winters tend to be mild and summers fairly hot and humid. The center is housed in the Chesapeake Building at the edge of the University of Maryland campus. The 200-employee administration building is an ideal test site because it represents a typical commercial building. At 52,700 square feet, the building qualifies as a medium-sized office building, a group comprising 23 percent of U.S. buildings.

Controls and communications hardware and software programs enable CHP equipment to work in concert, facilitating integration of the individual components. Once all the new equipment is up and running, the engineering team will use the Whole-Building Diagnostician (WBD), developed by Pacific Northwest National Laboratory, to identify and immediately diagnose common problems in the HVAC system and equipment, track a building's energy use, monitor the performance of air-handling units, and detect problems with outside air control.

To assess how much improvement in energy efficiency, emissions, and indoor air quality the building has achieved, the engineering team characterized the Chesapeake Building's baseline energy use in late 1999. This characterization included an examination of load profiles, energy distribution, HVAC controls, and mechanical equipment design.

By working together on the Test Center, industry, government, and academia will benefit by learning how to take advantage of recoverable heat with IES equipment. The ultimate outcome is to give building owners a plethora of affordable, energy saving, easy-to-install packaged systems that can take advantage of "waste" heat with advanced thermally-activated technologies.

Program Goals and Activities

Program activities include:

- Design of test packages and modular IES systems to assist manufacturers and packagers in designing the next generation system and evaluating performance
- Integrate mechanical equipment systems with overall building design.
- Effectively integrate desiccant dehumidification/enthalpy exchange devices with thermal cooling, heating, and storage devices.
- Accelerate humidity control in buildings to significantly improve indoor air quality, productivity, and occupant health.
- Form the Midwest CHP Applications Center at the University of Illinois at Chicago to help the building owning, operating, and engineering communities to successfully apply CHP systems.

Research goals include:

- Absorption cooling equipment can be adapted to use recovered heat from power generation equipment, maximizing fuel efficiency. Distributed power generation sites can benefit from integration with absorption chillers, especially for gas turbine inlet cooling, process cooling, and air conditioning in buildings.
- Desiccant humidity control equipment is used to mitigate IAQ problems and improve humidity control in buildings. Advanced ventilation air conditioning designs, using recovered energy, are the key to efficiently controlling IAQ.
- Energy recovery systems are generally the purview of installers, rather than part of a well-thought-out integration design or strategy.
- Using IES in buildings requires optimizing the electric and thermal generation capabilities of systems with the building's thermal and electric load profiles, requiring a new understanding of these load profiles and the ability of emerging IES equipment to heat and cool, while controlling humidity.

For further information:

Distributed Energy Resources:
www.eren.doe.gov/der/

IES for Buildings:
www.bchp.org/home.html

Oak Ridge National Laboratory:
www.ornl.gov

U.S. Combined Heat and Power Association:
www.nemw.org/uschpa/

American Council for an Energy-Efficient Economy:
www.aceee.org

Northeast Midwest Institute:
www.nemw.org/energy.htm

Partners:

ATS
Baltimore Aircoil
Broad
Brookhaven National Laboratory
Capron
Daikin
EPRI
Honeywell
Goettl
Kathabar
National Renewable Energy Laboratory
Oak Ridge National Laboratory
Pacific Northwest National Laboratory
PEPCO
RMF
Tridium
Trion
University of Maryland

Contact:

Ronald Fiskum
U.S. Department of Energy
1000 Independence Avenue
Washington, DC 20585
Tel: (202) 586-9130
ronald.fiskum@hq.doe.gov

OFFICE OF POWER TECHNOLOGIES
CLEAN POWER FOR THE 21ST CENTURY

DER
DISTRIBUTED ENERGY RESOURCES

EFFICIENTLY POWERING A HEALTHIER AMERICA
INTEGRATED ENERGY SYSTEMS