Distributed Energy Resources

Combined Heat & Power Program for Buildings, Industry and District Energy

Technology Overview

Approximately two-thirds of the fuel used to generate electricity in the U.S. is wasted in the form of discarded heat. Combined heat and power (CHP) systems produce electricity or mechanical power and recapture waste heat for process use. Various technologies are used in generating CHP, including boilers, steam turbines, combustion turbines, spark ignition engines, diesel engines, microturbines, fuel cells, absorption chillers, desiccants, engine-driven chillers, and gasification.

- Boilers convert thermal energy in hot gas from the combustion of a wide range of fuels, or waste heat into steam or hot water.
- Steam turbines convert steam energy from a boiler or waste heat into shaft power.
- Combustion turbines use heat to move turbine blades that produce electricity.
- Spark ignition engines operate on a wide range of liquid and gaseous fuels, including natural gas and gasoline. The reciprocating shaft power can either produce electricity through a generator or drive loads directly.
- Microturbines are small-scale combustion turbines ranging in size from 30-500kW.
- Diesel engines produce shaft power for electricity or direct drive and recover heat in a boiler.
- Fuel cells produce an electric current and heat from chemical reactions rather than combustion.
- Desiccants remove moisture from the air, which can be used to solve indoor air quality problems.
- Absorption chillers use waste heat from CHP systems to produce chilled water, shifting an electric load to a thermal load, allowing for continuing use of CHP systems during the cooling season.
- Engine-driven chillers operate compressors directly for refrigeration with a turbine or reciprocating engine. Heat is recovered from the engine in a boiler, limiting the losses associated with generating electricity and then producing shaft power for the compressor.
- Gasification converts a solid or liquid fuel into a gaseous form that can be used in advanced engine and turbine engine designs. The modern systems incorporate cleaning subsystems that can remove pollutants prior to combustion. Possible fuel inputs include biomass, coal, and a number of waste materials.

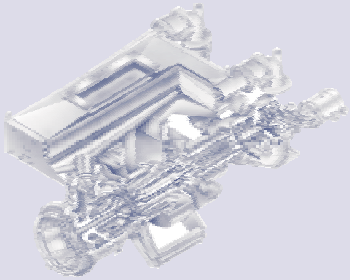
Market Potential

Combined heat and power technologies provide efficient and reliable sources for electricity generation. By productively using waste heat that is vented in conventional power plants, CHP will improve overall energy efficiency levels to 70% or greater. CHP systems can operate on site at an industrial plant or building and in district energy systems satisfying power needs and thermal loads. The waste heat from CHP systems can be used to distribute thermal energy to provide heating and cooling, mechanical power, and dehumidifying systems for buildings, or compressed air, steam or hot water, for industrial and commercial applications.

- Small Industrial Systems - Thousands of boilers provide process steam to a broad range of U.S. manufacturing plants. This offers a large potential for adding new electricity generation between 50 kW and 25 MW by either modifying boiler systems to add electricity generation, or replacing the existing boiler with a new CHP system. Small manufacturers represent an important growth segment over the coming decade.
- Smaller Commercial and Institutional Systems - With the arrival of reliable reciprocating engines and smaller combustion turbines, microturbines and fuel cells, CHP is becoming feasible for small commercial buildings. This involves the installation of a system that generates part of the building's electricity requirement and provides heating and/or cooling. Packaged systems with capacities starting at around 25 kW could be installed at fast food restaurants and in larger commercial buildings. Though an important long-term market, this segment's total capacity is expected to be modest for the next few years.

Engines

Microturbines



Gas Turbines

Fuel Cells

DISTRIBUTED ENERGY RESOURCES

Cooling / Heating

Dehumidification

Humidification

Thermal Storage

U.S. DEPARTMENT OF ENERGY PROGRAM

The U.S. Department of Energy (DOE) Office of Power Technologies is currently leading programs to promote the development and installation of combined heat and power technologies for distributed energy resource (DER) applications in industry, buildings, federal facilities and district energy. DER refers to local energy systems that generate electric, thermal, or mechanical energy on or near the customers' site. In addition to power generation systems, DER includes energy storage, grid interconnection, and demand management systems, which are important components in power quality, availability, and reliability.

Program Activities

- Designing and testing packages and modular cooling, heating, and power for building systems.
- Integrating mechanical equipment systems with overall building design-performance targets for the next generation CHP building systems include 30% efficiency improvements, 45% CO_2 emissions reductions, and 10% installation and maintenance cost reductions.
- 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.
- Develop and operate an equipment testing facility at the University of Maryland to assist manufacturers and packagers to design the next generation system, and evaluate performance.
- Form a Regional Applications Center at the University of Illinois, Chicago to help the building owning, operating and engineering communities to successfully apply CHP systems. This first center will be the model for other similar centers.
- Address the issue of integrating distributed generation equipment within manufacturing processes with the greatest opportunity to use waste heat.
- Promoting Distributed Generation equipment and CHP in New York State industrial sector.
- Integration of CHP in the fluid heating processes in the chemical and refining sectors.
- Install a CHP system at 29 Palms Marine Air Ground Combat Center.

The goal of the CHP program is to double the capacity of CHP in the U.S. to 92 GW by the year 2010 and create integrated mechanical equipment in overall building system design. The program will use the National CHP roadmap to guide their activities in order to achieve the CHP goal.

Raising CHP Awareness

Strengthen efforts to build a more effective industry coalition dedicated to CHP; intensify federal coordination; and expand existing awareness efforts by regional and state groups.

Eliminating Regulatory and Institutional Barriers

Implement uniform interconnection standards; develop effective and fair utility policies and practices for utility-CHP interconnections; develop output-based emissions standards; develop streamlined siting and permitting processes; develop uniform building codes and standards that address CHP systems and components; and develop equitable tax provisions for CHP equipment.

Developing CHP Markets and Technologies

Install 27 GW of additional industrial CHP capacity; install 8 GW of additional buildings cooling, heating, and power capacity; install 8GW of additional district energy capacity; and install 5 GW of additional CHP capacity in federal facilities.

For More Information:

DOE Combined Heat and Power Program
http://www.eren.doe.gov/der/chp

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