Frank Mace, Associate Project Manager
New York State Energy Research and Development Authority
Albany, NY

COMBINED HEAT AND POWER

Description:

The New York State Energy Research and Development Authority (NYSERDA) defines Combined Heat and Power (CHP) as the simultaneous generation of two or more forms of energy from a single fuel source. Across the country, this technology is also known as Cogeneration, but more recently has been rebranded Combined Heat and Power. The most common use of this technology is the generation of electricity by means of an engine-driven generator while, at the same time, capturing and recycling the heated combustion exhaust, or thermal energy, to produce domestic hot water.

Thomas Edison's Pearl Station in 1882 is the first commercial recorded use of CHP in the United States. The waste heat produced from the generation of electricity was used to heat the neighboring buildings. With the rural electrification policies of the 1900's, central power plants and regional utilities became the norm. This structure discouraged decentralized power generation until 1978 when the Public Regulatory Policies Act (PURPA) was established. This act promoted renewable technologies and allowed non-utilities to provide power. Today, with concerns about the environment, dependence on foreign fuels, and the escalating cost of energy, efficiency of the fuel being used has become more important than ever.

Although we are beginning to see the deployment of micro-CHP in single family homes, most CHP systems currently available work best in larger facilities or multifamily buildings that have one hundred units or more.

In addition to the engine-driven generator, several variations of CHP technology include micro-turbines, steam turbines, and fuel cells. Natural gas is the most common fuel source; however, other fuels, such as digester gas, landfill gas, or even wood scrap from sawmills have been used when available and cost-effective. All CHP systems rely on the common principle of capturing two or more forms of energy in order to maximize fuel efficiency.

Other uses of CHP technology include recycling waste heat for industrial usage or manufacturing processes or to produce refrigeration by means of an absorption chiller. In the case of an absorption chiller, what was previously considered waste heat is now converted to refrigeration through an absorption process, often providing air conditioning for a large facility. CHP systems can also be configured to provide emergency power during power outages in order to allow occupants to remain where they are (shelter in place) during power outages. Sheltering in place in lieu of evacuation may be the preferred option, especially with frail older people or individuals of any age with disabilities. Dumping of thermal energy during emergency conditions in order to maximize electricity generated is considered an

acceptable practice, but it is not recommended during normal operation as it reduces fuel efficiency.

Traditional fossil-fueled power plant generation often results in the loss or dumping of exhaust heat as a waste product. Thermal dumping, combined with transmission and distribution losses, can greatly reduce overall fuel efficiency to about one-third or less. As CHP systems avoid these losses, they have a significant environmental benefit over utility-based centralized power generation and distribution. The combined increased fuel efficiency results in an overall decrease in harmful emissions of carbon dioxide (CO2), sulfur oxides (SOx), and nitrogen oxides (NOx).

A CHP system is designed to generate energy in close proximity to where it will be used and is therefore not used for long-distance transmission and distribution. As such, CHP is part of a larger group of technologies known as Distributed Generation (DG). CHP is often the most economic DG technology. In order to successfully use this technology, a preliminary assessment or feasibility study can determine if the characteristics of the electrical load can be successfully matched with a corresponding thermal load. This matching of the electrical and thermal loads can demonstrate overall fuel efficiency and thus avoid the costly dumping of the excess thermal energy.

The addition of a CHP system adds to overall generating capacity and can have a significant impact on the utility grid or network by reducing peak demand on the grid. The utility grid system's peak demand usually occurs during the hottest part of the summer when the electric cooling load is running at the maximum. In the past, this peak demand event has been responsible for brown-out or black-out conditions.

Benefits:

For consumers, including older adults and younger people with disabilities—

- The higher fuel efficiency results in a lower operational cost of energy (kWh for electricity and Btu's for thermal), thereby lowering household expenses.

- Investment in CHP provides long-term stabilization of energy rates, making energy rates more predictable and less subject to commodity market fluctuations.

- CHP units can be configured to operate independent of the local utility company, thus providing on-site power generation during emergency conditions and allowing for sheltering in place.

For the community—

- There are environmental benefits of reduced CO2, NOx, and SOx by using the fuel's energy twice and reducing the total amount of fuel consumed. This becomes a more important benefit in areas of poor air quality.

- On-site generation reduces the geographical strain or need for additional transmission and distribution systems.

- Financial incentives are often available.

Impediments or barriers to development or implementation:

- Investment in CHP Technology is a long-term commitment, and the owner is responsible for all maintenance (check with the manufacturer for service agreements and warranties).

- There may be a lack of fuel availability— is natural gas available or another fuel such as landfill gas?

- There may not be adequate space available within a building for the equipment and exhaust flue.

- The building's electrical distribution system and metering needs to be configured to support CHP.

- The cost-effectiveness of the project needs to be determined. The cost comparison of electricity to natural gas is often referred to as the spark spread. CHP becomes more economical the larger the cost differential between electricity and natural gas becomes.

Resource—examples :

- According to the NYSERDA CHP Program Guide, "As of mid-2008, NYSERDA programs support and fund over 110 projects for the installation of CHP at customer sites, and over 150 feasibility studies for CHP technologies, as well as numerous product development projects and technology transfer studies. Collectively, these projects represent a NYSERDA funding contribution of over $85 million, and at full-build these systems will produce 153 MW of electricity. As of mid-2008, 54 projects are operational, producing over 30 MW of electricity."

- Information is available from NYSERDA about specific examples of CHP projects in New York State. For example:
  - Fonda-Fultonville Central School District, where the entire K-12 school is operating independent of the utility grid, producing its own electricity and recycling the heat for hot water and cooling through the absorption process. Located on high ground along the Mohawk River, this self-contained school could also be used as a place of refuge during any community emergency.

  - The Emerling Dairy Farm in Perry, NY, where the manure from 1,100 cows is processed by an anaerobic digester, thus reducing odor and producing the methane used to generate electricity and hot water from the farm's CHP system.

- River Point Towers, a multifamily building in Bronx, NY, which uses a natural gas CHP system to produce electricity, with the waste heat recycled to produce domestic hot water, and with surplus energy used to heat the outdoor swimming pool.

Resource—written and web (taken from NYSERDA's CHP Program Guide):

- **NYSERDA CHP Tutorial Information –** NYSERDA's DGCHP program Web site provides detailed information on all aspects of combined heat and power systems. Including topics ranging from technical detail to siting and permitting issues, this Web site is a one-stop-shop for most combined heat and power questions: http://www.nyserda.org/programs/dgchp.asp.

- **NYSERDA CHP Projects Performance Data –**The Monitored Hourly Performance Data allow users to view, plot, analyze, and compare performance data from one or several different DG/CHP sites in the NYSERDA portfolio: http://chp.nyserda.org/home/index.cfm.

- **Northeast Clean Energy Application Center, U. S. Department of Energy –** The Center serves as a focal point for communication among key stakeholders in seven states within the Northeast (CT, ME, MA, NH, NY, RI, and VT) regarding Combined Heat and Power, Waste Heat Recovery, and District Energy. The Center provides services for Education and Outreach as well as Technical Assistance: http://www.northeastcleanenergy.org/home/home.php.

- **US Environmental Protection Agency CHP Partnership Program –** This program was established as a voluntary program seeking to reduce the environmental impact of power generation by promoting the use of CHP. The Partnership works closely with energy users, the CHP industry, state and local governments, and other clean-energy stakeholders to facilitate the development of new projects and to promote their environmental and economic benefits: http://www.epa.gov/chp/index.html.

- **US Department of Energy Distributed Energy Program –** This program supports cost-effective research and development aimed at lowering costs, reducing program emissions, and improving reliability and performance in order to expand opportunities for the installation of distributed energy equipment today and in the future: http://www.eere.energy.gov/de/.

- **US Clean Heat & Power Association –** USCHPA's mission is to create a regulatory, institutional, and market environment that fosters the use of clean, efficient local energy generation, including but not limited to combined heat and power, recycled energy, bio-energy, and other generation sources that lead to a demonstrable reduction in global greenhouse gas emissions: http://www.uschpa.org/i4a/pages/index.cfm?pageid=1.

- **ASERTTI National DG/CHP Performance and Testing Program –** ASERTTI's purpose is to remove a barrier to the increased use of distributed generation

technologies - namely, the unavailability of uniform and documented information on the electrical, environmental, and mechanical performance of distributed generation (DG) and distributed generation/combined heat and power (DG/CHP) systems: http://www.dgdata.org/.

- **Environment Technology Verification Program Greenhouse Gas Center -** The Greenhouse Gas Technology Center is operated in cooperation with Southern Research Institute (SRI). This center verifies the performance of commercial-ready technologies that produce, mitigate, monitor, or sequester greenhouse gas emissions. This center is also part of the Air Pollution Prevention and Control Division, which is under EPA's National Risk Management Research Laboratory: http://www.epa.gov/nrmrl/std/etv/center-ggt.html.

Resource—technical assistance contact names:

- Frank W Mace, LEED AP, DGCP
  Distributed Generation Certified Professional
  New York State Energy Research and Development Authority (NYSERDA)
  17 Columbia Circle
  Albany, New York 12203-6399
  (518) 862-1090 ext. 3433
  fwm@nyserda.org