Combined Heat and Power

Energy Savings and Energy Reliability for Data Centers

Combined heat and power (CHP), also known as cogeneration, can be an excellent solution for controlling energy costs while improving the reliability of power and thermal energy supplies for data centers. CHP applied in data centers can provide benefits to the facility operator in the form of:

- Reduced energy-related costs and enhanced economic competitiveness.
- Increased reliability and decreased risk from outages.
- Increased ability to meet facility expansion timelines.
- Reduced emissions of greenhouse gases and criteria air pollutants, including carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_X), and sulfur dioxide (SO_2). (See Figure 1 on page 2)

What Is CHP?

CHP is the production of both power and heat from a single fuel source. By making use of the waste heat from onsite electricity production for heating or cooling, CHP increases fuel efficiency and decreases energy costs.

What Can CHP Do for Data Centers?

Reduce Energy Costs

Due to their very high electricity consumption, data centers have high power costs. Installing CHP systems with absorption cooling[1] can often reduce energy costs by producing power more cheaply onsite than can be purchased from the utility supplier. In addition, waste heat from the generation of power can drive absorption chillers and replace electric air conditioning load. By reducing operating costs and providing other economic value to a facility such as reduced outage costs, the facility can become more economically competitive.

Increase Reliability

Data centers require both high-quality and extremely reliable power. Power outages or lapses in power quality can cost as much as $30 million per minute for data center operations during peak periods.[2] Onsite power generation, whether in the form of an engine, fuel cell, microturbine, or other prime mover, supports the need for reliable power by protecting against long-term outages beyond what uninterruptible power supply (UPS) and battery systems can provide.

For detailed information on the opportunities for additional benefits of CHP at data centers, see the CHP Partnership's report, *The Role of Distributed Generation and Combined Heat and Power (CHP) Systems in Data Centers*, at *www.epa.gov/chp/documents/datactr_whitepaper.pdf*

[1] Absorption cooling incorporates absorption chillers that utilize a heat source to provide the energy needed to drive the cooling system, rather than being dependent on electricity from a compressor.

[2] Digital Realty Trust, 2007.

CHP systems that operate continuously provide additional reliability compared to emergency backup generators that must be started up during a utility outage. The increase in reliability produced by continuously operating CHP can be used to reduce the amount of battery backup that is typically designed into premium secure power systems.

Enhance Facility Expansion

Developing onsite power sources provides data center operators with increased flexibility in both the expansion and design of new facilities. Upgrading older, smaller data centers with new equipment can require a large increase in power demand to the facility that might not be able to be met by the utility in the near term. By adding a CHP system to provide continuous prime power, it may be possible for data centers with expansion plans to proceed on a more rapid schedule than can sometimes be possible by relying solely on the existing utility grid. Minimizing external power demand also reduces additional utility infrastructure requirements and associated costs that might be required for new or expanded facilities.

Reduce Emissions

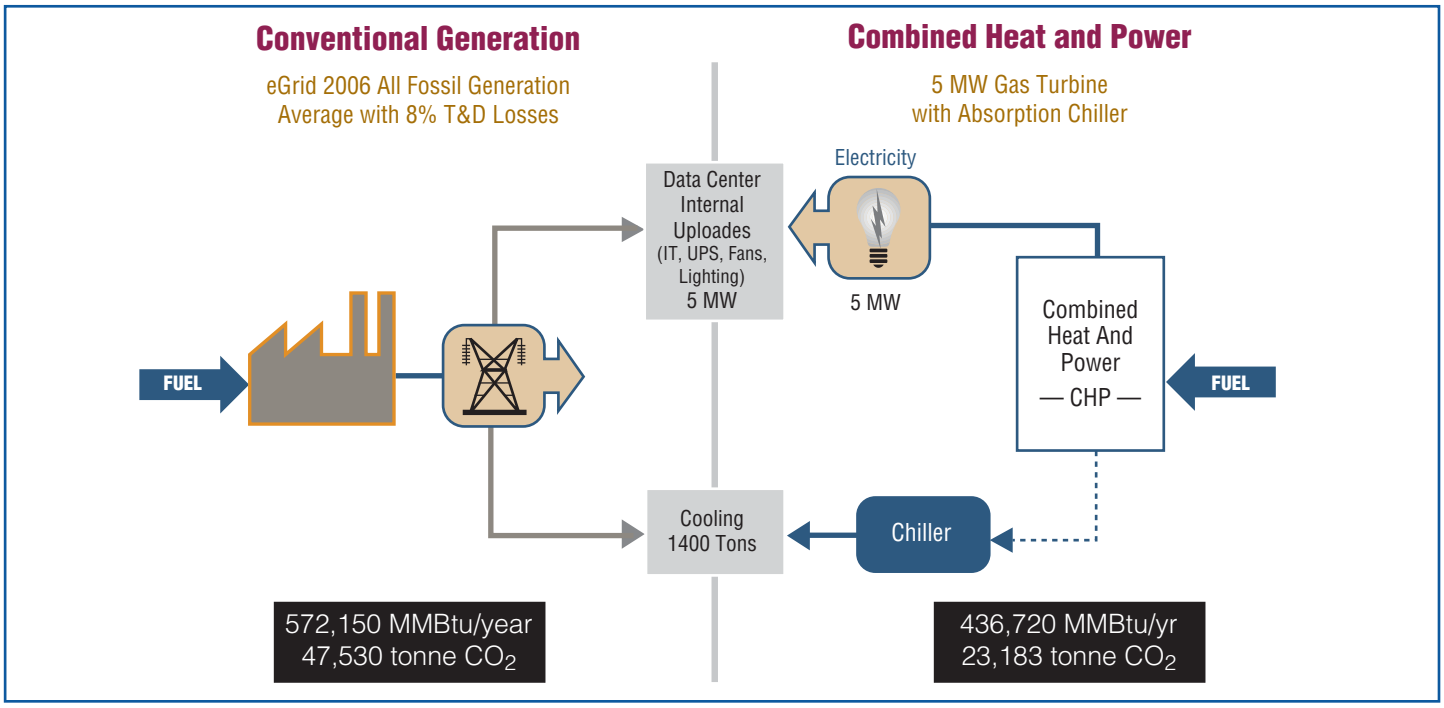
Data centers have very low site emissions, but their high energy intensity results in large emissions from the utility that produces electricity for the data center. CHP systems reduce emissions of criteria air pollutants—CO, NO_X, and SO_2—through increased efficiency and the use of cleaner technologies. The increased efficiency of fuel use with CHP allows facilities to achieve the same levels of output with lower levels of total fossil fuel combustion, thereby reducing emissions of CO_2.

How Is CHP Used at Data Centers?

Data centers have much higher energy utilization intensities (20 to 100 watts per square foot [W/s.f.]) than typical commercial buildings. Data centers require so much power—all of it converted to heat as it is used within the facility—that the most useful CHP thermal configuration is one that utilizes absorption chillers for air conditioning.

Heat recovered from the onsite power generation unit in the form of steam or hot water can be utilized in an absorption chiller. High-temperature hot water near or above the boiling point (under pressure) can power a single- or double-effect absorption chiller. Absorption chillers are used in a data center with computer room air handlers, or less commonly, the chilled water is fed to water cooled racks. A variety of technologies have been used successfully, including fuel cells, reciprocating engines, gas turbines, and microturbines.

Figure 1: Efficiency and Emissions Benefits of CHP for Data Centers



Where Is CHP Being Used at U.S. Data Centers?

As of October 2008, 16 commercial data centers in the United States are using CHP, representing a total capacity of more than 16 MW. The mix of technologies used for CHP at data centers includes microturbines, fuel cells, and reciprocating engines.

Qualcomm Cogeneration Projects
San Diego, California

Qualcomm, a wireless technology innovator, is a company with a strong sense of environmental stewardship. Since 1993, Qualcomm has completed more than 130 projects targeted at improving energy efficiency and reducing greenhouse gas (GHG) emissions from its operations. The company owns and operates two cogeneration facilities in San Diego, California.

Qualcomm has maintained and operated its "P" cogeneration plant since 1995. The "P" cogeneration plant supports a campus of more than 2 million square feet, which includes Qualcomm's corporate headquarters, lecture hall, cafeteria, medical center, engineering and research offices, labs, data center, network operations center, satellite communications hub, prototype manufacturing, and three parking structures. In 1995, Qualcomm installed a 2.4 megawatt (MW) gas turbine CHP system, consisting of three 800 kilowatt (kW) Solar Turbine Saturn generators. The 800 kW turbines run on natural gas but can be switched to run on jet fuel if the natural gas supply is interrupted. The waste heat from the turbines is sent to a heat recovery unit producing hot water used to power absorption chillers. Based on a positive experience with the original gas turbine system, Qualcomm increased its reliance on CHP when it initiated a campus expansion in 2005. As part of the expansion, Qualcomm added a 4.5 MW Solar Mercury 50 gas turbine and a Broad 1,400 ton absorption chiller driven directly by turbine exhaust gas to help support growing site power and cooling requirements. The "P" campus cogeneration plant results in annual operating cost savings of $500,000. An additional $100,000 is saved annually through a heat recovery unit that supplies hot water to the facility. Onsite power generation also reduces demand for utility electricity by over 14 million kilowatt-hours (kWh) per year, saving another $122,000. Total annual savings achieved by the CHP system have been as high as $775,000.

In 2007, Qualcomm installed a second CHP system, known as the "W" cogeneration plant, to support a new 1 million square foot campus consisting of another data center, engineering offices, labs, a chip test floor, a cafeteria, and a parking structure. This Leadership in Environmental and Energy Design (LEED) Gold-certified campus requires 8 MW of electricity, with 4 MW classified as critical load to support the 12,000 square foot data center. The CHP system consists of a second Solar Mercury 50 gas turbine with a waste heat recovery boiler. The system provides up to 4.5 MW of power for the building, and recovers high temperature water from the turbine exhaust to drive a 1,200 ton Trane absorption chiller that provides cooling for the data center and building. The CHP system supplies approximately 85 percent of the building's power and cooling loads, resulting in significant carbon dioxide (CO_2) and nitrogen oxide (NO_X) emissions reductions.

Qualcomm estimates that their CHP systems reduce overall carbon emissions by 12 percent and NO_X emissions by 91 percent on an annual basis. The combined energy savings from the "P" cogeneration plant expansion and the "W" cogeneration plant result in an estimated payback period of four years.

What Resources Are Available?

Technical Assistance

The CHP Partnership has developed tools and resources to assist those considering implementing CHP at their facilities. Visit the Streamlining Project Development pages of the Partnership's Web site at *www.epa.gov/chp/project-development/index.html* to learn more about the CHP project development process, whom to involve on your CHP project team, typical options for system financing, and other services EPA provides.

Project Resources

Take advantage of the Partnership's up-to-date lists of state and federal incentives (e.g., rebates, tax credits, environmental revenue streams) for CHP, along with lists of regulatory rules and rates that are advantageous to clean distributed generation. This information is updated bi-monthly at *www.epa.gov/chp/funding/index.html*.

Public Recognition

EPA recognizes highly efficient CHP projects that achieve fuel and emission savings over comparable state-of-the-art separate heat and power with ENERGY STAR® CHP Awards. The Partnership accepts Award applications continuously and presents these awards at key events. For more information on applying for an ENERGY STAR CHP Award for your data center, visit *www.epa.gov/chp/public-recognition/index.html*.

Is My Data Center a Good Candidate for CHP?

- Do you pay more than $0.07/kilowatt-hours on average for electricity?
- Are you concerned about the impact of current or future energy costs on your business?
- Are you concerned about power reliability?
- Do you anticipate a facility expansion or new construction project within the next 3-5 years?
- Have you already implemented energy efficiency measures and still have high energy costs?
- Are you interested in reducing your facility's impact on the environment?

If the answer is "yes" to two or more of these questions, CHP can benefit your facility.

CHP technologies are flexible, providing a wide range of sizing options. The right CHP system for your data center will be determined through consultations and analyses, which will include a site-specific evaluation of your facility's electricity and thermal loads.

What's the Next Step?

EPA is available to answer your questions and provide specific technical support for your project. For information on how EPA can support your evaluation and implementation of CHP, contact Felicia Ruiz at (202) 343-9129 or *ruiz.felicia@epa.gov*.

About the EPA CHP Partnership

The CHP Partnership is a voluntary program designed to foster cost-effective CHP projects. Through the Partnership, EPA engages energy users, the CHP industry, state and local governments, and other stakeholders in cooperative relationships to expand the use of CHP. Information about the Partnership's services and program offerings is available on its Web site: *www.epa.gov/chp*.

EPA CHP COMBINED HEAT AND POWER PARTNERSHIP

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