Combined Heat and Power

Combined heat and power (CHP), also known as cogeneration, is:

- The concurrent production of electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy.
- A type of distributed generation, which, unlike central station generation, is located at or near the point of consumption.
- A suite of technologies that can use a variety of fuels to generate electricity or power at the point of use, allowing the heat that would normally be lost in the power generation process to be recovered to provide needed heating and/or cooling.

Source: U.S. Department of Energy, Combined Heat and Power Basics

Typically, nearly two-thirds of the energy used to generate electricity is wasted in the form of heat discharged to the atmosphere. Additional energy is wasted during the distribution of electricity to end users. CHP is on-site electricity generation that captures the heat that would otherwise be wasted to provide useful thermal energy—such as steam or hot water—that can be used for space heating, cooling, domestic hot water and industrial processes. In this way, and by avoiding distribution losses, CHP can achieve efficiencies of over 80 percent, compared to 50 percent for conventional technologies (i.e., grid-supplied electricity and an on-site boiler).
Source: U.S. Environmental Protection Agency, Combined Heat and Power Partnership

CHP technologies provide reliable electricity, mechanical power, or thermal energy by capturing heat that is wasted during electricity generation. District energy takes heat from a CHP system to heat or cool entire complexes such as a university campus, office park, or downtown area.

CHP Technologies

CHP technology can be deployed quickly, cost-effectively, and with few geographic limitations. CHP can use a variety of fuels, both fossil- and renewable-based. It has been employed for many years, mostly in industrial, large commercial, and institutional applications. CHP may not be widely recognized outside industrial, commercial, institutional, and utility circles, but it has quietly been providing highly efficient electricity and process heat to some of the most vital industries, largest employers, urban centers, and campuses in the United States. It is reasonable to expect CHP applications to operate at 65-75% efficiency, a large improvement over the national average of ~50% for these services when separately provided.
Source: U.S. Department of Energy, Combined Heat and Power Basics

The U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy recognizes five of the most common CHP technologies as fuel cells, gas turbines, microturbines, reciprocating engines, and steam turbines. The DOE summaries and factsheets below provide an analysis on each respective CHP technology. The factsheets address the technologies’ (1) attributes, (2) combined heat and power applications, (3) technology description, (4) performance characteristics, (5) capital, and operation and maintenance costs, and (6) emission characteristics.

Fuel Cells – *Link:* Factsheet Fuel cells use an electrochemical process to convert the chemical energy in a fuel to electricity. For stationary power, fuel cells are used for distributed generation (electricity only) and are also configured for CHP. There are 126 fuel cells installed in the United States that are configured for CHP operation, accounting for a combined capacity of 67 MW. The majority of these fuel cells are used in commercial and institutional buildings—such as universities, hospitals, nursing homes, hotels, and office buildings—where there is a relatively high coincident demand for electricity and thermal energy.

Gas Turbines – *Link:* Factsheet Gas turbines are available in sizes ranging from approximately one to more than 300 megawatts (MW) and are used to meet diverse power needs, including propulsion, direct drive, and stationary electricity generation. For CHP applications, gas turbines typically have favorable economics in sizes greater than 5 MW. Gas turbines account for 52 GW of installed CHP capacity in the United States, representing 64% of the total installed CHP capacity. Gas turbines are well suited for industrial and institutional CHP applications because the high temperature gas turbine exhaust can either be used to generate high pressure steam or used directly for heating or drying.

Microturbines – *Link:* Factsheet Microturbines are relatively small combustion turbines that can use gaseous or liquid fuels. They emerged as a CHP option in the 1990s. Individual microturbines range in size from 30 to 330 kilowatts (kW) and can be integrated to provide modular packages with capacities exceeding 1,000 kW. There are over 360 sites in the United States that currently use microturbines for CHP, accounting for over 8% of the total number of CHP sites and 92 MW of aggregate capacity. In CHP applications, thermal energy from microturbine exhaust is recovered to produce either hot water or low pressure steam.

Reciprocating Engines – *Link:* Factsheet Reciprocating internal combustion engines are a mature technology used for power generation, transportation, and many other purposes. For CHP installations, reciprocating engines have capacities that range from 10 kW to 10 MW. Reciprocating engines for distributed power generation, which are most often fueled with natural gas, are well suited for CHP service. There are nearly 2,400 reciprocating engine CHP installations in the United States, accounting for 54% of the entire population of installed CHP systems and nearly 2.4 gigawatts (GW) of total capacity. Common applications for reciprocating engine CHP systems include universities, hospitals, water treatment facilities, industrial facilities, commercial buildings, and multi-family dwellings.

Steam Turbines – *Link:* Factsheet Steam turbines are a mature technology and have been used since the 1880s for electricity production. Most of the electricity generated in the United States is produced by steam turbines integrated in central station power plants, and steam turbines are also commonly used for CHP installations. There are 699 sites in the United States that are using steam turbines for CHP operation. These steam turbine CHP installations have an average capacity of 37 MW and a combined capacity of 26 GW, representing 32% of the total installed CHP capacity. The majority of these CHP steam turbines are at industrial plants, commercial buildings with high thermal loads, and district heating sites.