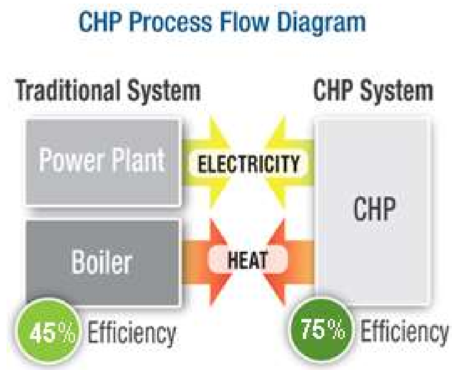
# COMBINED HEAT AND POWER: FREQUENTLY ASKED QUESTIONS

**What is combined heat and power (CHP)?**
CHP is an energy efficient technology that generates electricity and 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. CHP can be located at an individual facility or building, or be a district energy or utility resource. CHP is typically located at facilities where there is a need for both electricity and thermal energy.




**Source:** Oak Ridge National Laboratory, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future*, 2008.

Nearly two-thirds of the energy used by conventional electricity generation is wasted in the form of heat discharged to the atmosphere. Additional energy is wasted during the distribution of electricity to end users. By capturing and using heat that would otherwise be wasted, and by avoiding distribution losses, CHP can achieve efficiencies of over 80 percent, compared to 50 percent for typical technologies (i.e., conventional electricity generation and an on-site boiler).

**How does CHP work?**
- Every CHP application involves the recovery of otherwise-wasted thermal energy to produce useful thermal energy or electricity. CHP can be configured either as a topping or bottoming cycle.
- In a typical topping cycle system, fuel is combusted in a prime mover such as a gas turbine or reciprocating engine to generate electricity. Energy normally lost in the prime mover's hot exhaust and cooling systems is instead recovered to provide heat for industrial processes (such as petroleum refining or food processing), hot water (e.g., for laundry or dishwashing), or for space heating, cooling, and dehumidification.
- In a bottoming cycle system, also referred to as "waste heat to power," fuel is combusted to provide thermal input to a furnace or other industrial process and heat rejected from the process is then used for electricity production.

**Why is CHP more efficient than conventional electricity generation?**
CHP is a form of distributed generation, which is located at or near the energy-consuming facility, whereas conventional generation takes place in large centrally-located power plants. CHP's higher efficiency comes from recovering the heat normally lost in power generation or industrial processes to provide heating or cooling on site, or to generate additional electricity. CHP's inherent higher efficiency and elimination of transmission and distribution losses from the central power plant results in reduced primary energy use and lower greenhouse gas (GHG) emissions.

**Is CHP widely used in the United States?**
- The existing 82 GW of CHP capacity at almost 3,600 industrial and commercial facilities represents approximately 8 percent of current U.S. generating capacity and over 12 percent of total electricity generated.
- CHP is used in every state, and is primarily found in areas with high concentrations of industrial and commercial activity, high electricity prices, and policies favorable to CHP.

**What kinds of facilities use CHP?**
CHP can be utilized in a variety of applications that have significant electric and thermal loads. Eighty-eight percent of existing CHP capacity is found in industrial applications, providing electricity and steam to energy-intensive industries such as chemicals, paper, refining, food processing, and metals manufacturing. CHP in commercial and institutional applications is currently 12 percent of existing capacity, providing electricity, steam, and hot water to hospitals, schools, university campuses, hotels, nursing homes, office buildings and apartment complexes.

**What are the benefits of CHP for the energy user?**

- CHP reduces energy costs for the user.
- CHP reduces the risk of electric grid disruptions and enhances energy reliability for the user. This is particularly useful for hospitals, research institutions, or industrial facilities where electric power outages are particularly disruptive and costly.
- CHP provides predictability in the face of uncertain electricity prices.

**What are the benefits of CHP for the United States?**

- CHP reduces emissions of GHGs and other air pollutants by as much as 40 percent or more.
- CHP consumes essentially zero water resources in generating electricity (a typical coal fired power plant consumes 0.2 to 0.6 gallons of water per kWh[1]).
- CHP offers a low-cost approach to adding new electricity generation capacity.
- On-site electric generation reduces grid congestion and improves the reliability of the electricity distribution system.
- CHP defers the need for investments in new central generating plants and new transmission and distribution infrastructure, helping to minimize increases in electricity costs.
- CHP uses highly-skilled local labor and American technology.

**How do the benefits and costs of CHP compare to other clean energy technologies?**

| Category | 10 MW CHP | 10 MW Wind | 10 MW PV | 10 MW Natural Gas Combined Cycle |
|---|---|---|---|---|
| Annual Capacity Factor | 85% | 34% | 25% | 70% |
| Annual Electricity | 74,446 MWh | 29,784 MWh | 21,900 MWh | 61,320 MWh |
| Annual Useful Heat | 103,417 $MWh_t$ | None | None | None |
| Footprint Required | 6,000 sq ft | 76,000 sq ft | 1,740,000 sq ft | N/A |
| Capital Cost | $20 million | $24.4 million | $60.5 million | $9.8 million |
| Cost of Power* | 7.6 ¢/kWh | 7.5 ¢/kWh | 23.5 ¢/kWh | 6.1 ¢/kWh |
| Annual Energy Savings | 316,218 MMBtu | 306,871 MMBtu | 225,640 MMBtu | 163,724 MMBtu |
| Annual $CO_2$ Savings | 42,506 Tons | 27,546 Tons | 20,254 Tons | 28,233 Tons |
| Annual NOx Savings | 87.8 Tons | 36.4 Tons | 26.8 Tons | 61.9 Tons |

**Table Assumptions**: 10 MW Gas Turbine CHP-28% electric efficiency, 68% total efficiency, 15 PPM NOx; Electricity displaces National All Fossil Average Generation (eGRID 2010)-9,720 Btu/kWh, 1,745 lbs $CO_2$/MWh, 2.3078 lbs NOx/MWh, 6% T&D loss; Thermal displaces 80% efficient on-site natural gas boiler with 0.1 lb/MMBtu NOx emissions; NGCC NOx emissions = 9 ppm; DOE EIA Annual Energy Outlook 2011 assumptions for Capacity Factor, Capital cost, and O&M cost of 7 MW utility scale PV, 100 MW utility scale Wind (1.5 to 3 MW modules) and 540 MW NGCC; Capital charges based on: 7% interest, 30 year life for PV, Wind and NGCC, 9% interest, 20 year life for CHP; CHP and NGCC fuel price = $6.00/MMBtu.
*The cost of power for CHP is at the point of use; the cost of power for PV, wind and central station combined cycle is at the point of generation and would need to have transmission and distribution costs added to the totals in the table (2 to 4 ¢/kWh) to be comparable.

**What can CHP contribute in the future?**

An additional 50 GW of capacity—equal to about half of current U.S. nuclear generation capacity—could be cost-effectively deployed by 2020 and would produce annual savings of $77 billion.[2] The EPA CHP Partnership and the Department of Energy's CHP Technical Assistance Partnerships offer information on policies that promote clean energy generation technologies such as CHP. See [https://www.epa.gov/chp/dchpp-chp-policies-and-incentives-database](https://www.epa.gov/chp/dchpp-chp-policies-and-incentives-database) and [http://www.midwestchptap.org/policy/](http://www.midwestchptap.org/policy/).

[1] EPRI, *Water & Sustainability: U.S. Water Consumption for Power Production – The Next Half Century,* 2002
[2] McKinsey & Company, *Unlocking Energy Efficiency in the U.S. Economy,* 2009.