How Combined Heat and Power Saves Money, Reduces Emissions and Improves Energy Security

CHP Overview

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Over Two Thirds of the Fuel Used to Generate Electrical Power in the United States Is Lost as Heat

More than two-thirds of the fuel used to generate power in the U.S. is lost as heat.
What Is Combined Heat and Power?

CHP is an *integrated energy system* that:

- Generates electrical and/or mechanical power
- Recovers waste heat for:
  - Space heating
  - Water heating
  - Space cooling
  - Dehumidification
- Is located at or near a factory or building that can use the energy output
- Can utilize a variety of technologies and fuels
- CHP is also known as *cogeneration*
Defining Combined Heat & Power (CHP)

The on-site simultaneous generation of two forms of energy (heat and electricity) from a single fuel/energy source

Conventional CHP
(also referred to as Topping Cycle CHP or Direct Fired CHP)

- Simultaneous generation of heat and electricity
- Fuel is combusted/burned for the purpose of generating heat and electricity
- Normally sized for thermal load to max. efficiency – 70% to 80%
- HRSG can be supplementary fired for larger steam loads
- Normally non export of electricity
- Low emissions – natural gas

Recip. Engine
**Gas Turbine**
Micro-turbine
Fuel Cell
Boiler/Steam Turbine

Heat recovery steam boiler
Prime Mover & Generator
Steam
Electricity
Fuel
Defining Combined Heat & Power (CHP)

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Waste Heat to Power CHP
(also referred to as Bottoming Cycle CHP or Indirect Fired CHP)

- Fuel first applied to produce useful thermal energy for the process
- Waste heat is utilized to produce electricity and possibly additional thermal energy for the process
- Simultaneous generation of heat and electricity
- No additional fossil fuel combustion (no incremental emissions)
- Normally requires high temperature (> 800°F) (low hanging fruit in industrial plants)
CHP in the U.S. Represents a Variety of Fuels, Technologies, Sizes and Applications

- Industrial
- Institutional
- Residential
- Commercial
- Utility Scale
What Are the Benefits of CHP?

- CHP is more efficient than separate generation of electricity and thermal energy
- Higher efficiency translates to lower operating cost
- Higher efficiency reduces emissions of all pollutants, including CO$_2$, NO$_X$ and SO$_2$
- CHP can increase power reliability and enhance power quality
- On-site electric generation can help reduce grid congestion
CHP is a Clean, Efficient Method of Providing Energy Services

Source: EPA CHP Partnership - 2012
CHP’s Increased Efficiency Generally Results in Lower Emissions

Source: EPA CHP Partnership - 2012
How Much CHP is Operating in the U.S. Today?

- **82 GW** of installed CHP at 4,100 industrial and commercial facilities (2012)
  - 87% of capacity in industrial applications
  - 71% of capacity is natural gas fired
- Avoids more than **1.8 quadrillion Btus** of fuel consumption annually
- Avoids **241 million metric tons of CO₂** compared to separate production

Source: ICF CHP Installation Database
CHP Is Used at the Point of Demand

Source: ICF CHP Installation Database
CHP Annual Additions since 1960

Annual Capacity Additions by Size

Source: ICF CHP Installation Database
Emerging Drivers for CHP

• Benefits of CHP recognized by Federal and State policymakers
  • *White House Executive Order:* 40 GW by 2020
  • *Increasing state interest* (Ohio, Maryland, New Jersey, etc.)

• Game changing outlook for natural gas supply and price in North America

• Opportunities created by environmental drivers
  • *ICI Boiler MACT*
  • *Pressures on utility coal and oil capacity*
Recent CHP Market Activity

Source: ICF CHP Installation Database
CHP Provides Energy Reliability and Resiliency Benefits

- Traditional backup generators do not always perform during emergencies, a system operating on a daily basis (CHP) is more reliable.

- CHP provides continuous benefits to host facilities, rather than just during emergencies.

- CHP systems kept running during Sandy:
  - South Oaks Hospital - Amityville, NY, 1.25 MW
  - The College of New Jersey - Ewing, NJ, 5.2 MW
  - Public Interest Data Center - New York, NY, 65 kW
  - Bergen County Wastewater Plant – Little Ferry, NJ
  - New York University – New York, NY
  - Sikorsky Aircraft Corporation – Stratford, CT
New Report on CHP in Critical Infrastructure

  - Provides context for CHP in critical infrastructure applications
  - Contains 14 case studies of CHP operating through grid outages
  - Policies promoting CHP in critical infrastructure
  - Details how to design CHP for reliability

The Potential for Additional CHP Is Nationwide
Where is the Remaining Potential for CHP

Existing CHP vs Technical Potential

- CHP Technical Potential
- CHP Existing Capacity

Source: ICF internal estimates
CHP Supports Industrial and National Goals

Benefits for U.S. Industry

- Reduces energy costs for the user
- Reduces risk of electric grid disruptions
- Provides stability in the face of uncertain electricity prices

Benefits for the Nation

- Provides an immediate path to increased energy efficiency and reduced GHG emissions
- Offers a low-cost approach to new electricity generation capacity and lessens need for new T&D infrastructure
- Uses abundant, domestic energy sources
- Uses American highly skilled local labor and technology
Questions?

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