**Introduction to Combined Heat and Power**

**What is combined heat and power?**

Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of two forms of useful energy from a single fuel source. Energy from a fuel source, such as natural gas, is converted to mechanical and thermal energy. The mechanical energy generates electricity, while the thermal energy or heat produces steam or hot water. Unlike power, which is produced from a central station, CHP is a form of distributed generation which is located near the point of use. Instead of separately pursuing electricity from the power grid and burning fuel in a boiler to produce thermal energy, CHP provides these energy sources in one efficient, integrated step.

**How does CHP work and what are the key CHP technologies?**

CHP systems capture and use waste heat generated during the production of electricity. It consists of individual components assembled into a system which can be modified to meet a facility's specific energy needs. Components include a prime mover, generator, heat recovery exchanger and electrical interconnection. Prime movers may be reciprocating engines, combustion turbines, steam turbines, microturbines and fuel cells.

**Where does CHP make sense?**

CHP makes sense for facilities having high coincident thermal and electric power needs in areas where electricity costs are expensive. CHP has been successfully installed in a wide variety of energy-intensive facility types and sizes including:

- Industrial manufacturers - chemical, refining, ethanol, pulp and paper, food processing, glass manufacturing
- Institutions - colleges and universities, hospitals, prisons, military bases
- Commercial buildings - hotels and casinos, airports, high-tech campuses, large office buildings, nursing homes
- Municipal - district energy systems, wastewater treatment facilities, K-12 schools
- Residential - multi-family housing, planned communities

**What are the benefits of CHP?**

1. **Benefits of CHP—Energy Efficiency:**

   CHP requires less fuel to produce a given electrical and thermal output. This occurs because the overall CHP energy generation cycle is more efficient than producing electricity and thermal energy separately. The average overall efficiency of generating electricity and heat by conventional systems is around 50%.
Conventional Generation vs. CHP: Overall Efficiency

On the right is an illustration depicting efficiency gains of a typical 5-mW natural gas-fired CHP system compared to using separate heat and power systems.

As shown in the above diagram, to produce 30 units of electricity and 45 units of thermal energy, a separate heat and power system requires 147 units of energy - 91 for electricity production and 56 to produce heat - resulting in an overall efficiency of 51%. However, the CHP system needs only 100 units of energy to produce the same quantity of electric and thermal energy - all from a single fuel source, resulting in a total system efficiency of 75%. For more information, go to this EPA link - http://www.epa.gov/chp/basic/efficiency.html

2. Benefits of CHP—Economic:
The increased efficiency of a CHP system translates into a lower operating cost for meeting a facility's electrical and thermal energy requirements. Customers can lower the CHP system payback period by applying for federal depreciation and tax incentives, electric utility energy efficiency incentives and the Massachusetts Alternative Energy Portfolio Standard Alternative Energy Credits.

3. Benefits of CHP—Reliability:
One option for increasing electric power reliability is to design a CHP system with a synchronous generator which can operate independently of the electric power grid during an outage.

4. Benefits of CHP—Environmental:
Since CHP systems require less fuel than separate heat and power systems, there are fewer greenhouse gas emissions, such as carbon dioxide (CO₂), as well as criteria air pollutants like nitrogen oxides (NOₓ) and sulfur dioxide (SO₂) emitted into the environment.

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