Cogeneration

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Energy Portal

Cogeneration (also **combined heat and power**, **CHP**) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.

Conventional power plants emit the heat created as a byproduct of electricity generation into the environment through cooling towers, as flue gas, or by other means. CHP or a bottoming cycle captures the byproduct heat for domestic or industrial heating purposes, either very close to the plant, or —especially in Scandinavia and eastern Europe—for distribution through pipes to heat local housing.

In the United States, Con Edison produces 30 billion pounds of steam each year through its seven cogeneration plants (which boil water to 1,000°F/538°C) before pumping it to 100,000 buildings in Manhattan—the biggest commercial steam system in the world.[1][2]

Byproduct heat at moderate temperatures (212-356°F/100-180°C) can also be used in absorption chillers for cooling. A plant producing electricity, heat and cold is sometimes called **trigeneration** or more generally: **polygeneration** plant.

Cogeneration is a thermodynamically efficient use of fuel. In separate production of electricity some energy must be rejected as waste heat, but in cogeneration this thermal energy is put to good use.

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Overview

Masnedø CHP power station in Denmark. This station burns straw as fuel. The plant heats adjacent greenhouses.

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Thermal power plants (including those that use fissile elements or burn coal, petroleum, or natural gas), and heat engines in general, do not convert all of their available energy into electricity. In most heat engines, a bit more than half is wasted as excess heat (see: Second law of thermodynamics). By capturing the excess heat, CHP uses heat that would be wasted in a conventional power plant, potentially reaching an efficiency of up to 89%, compared with 55%[3] for the best conventional plants. This means that less fuel needs to be consumed to produce the same amount of useful energy. Also, less pollution is produced for a given economic benefit.

Some tri-cycle plants have utilized a combined cycle in which several thermodynamic cycles produced electricity, and then a heating system was used as a condenser of the power plant's bottoming cycle. For example, the RU-25 MHD generator in Moscow heated a boiler for a conventional steam powerplant, whose condensate was then used for space heat. A more modern system might use a gas turbine powered by natural gas, whose exhaust powers a steam plant, whose condensate provides heat. Tri-cycle plants can have thermal efficiencies above 80%.

An exact match between the heat and electricity needs rarely exists. A CHP plant can either meet the need for heat (*heat driven operation*) or be run as a power plant with some use of its waste heat.

CHP is most efficient when the heat can be used on site or very close to it. Overall efficiency is reduced when the heat must be transported over longer distances. This requires heavily insulated pipes, which are expensive and inefficient; whereas electricity can be transmitted along a comparatively simple wire, and over much longer distances for the same energy loss.

A car engine becomes a CHP plant in winter, when the reject heat is useful for warming the interior of the vehicle. This example illustrates the point that deployment of CHP depends on heat uses in the vicinity of the heat engine.

Cogeneration plants are commonly found in district heating systems of big towns, hospitals, prisons, oil refineries, paper mills, wastewater treatment plants, thermal enhanced oil recovery wells and industrial plants with large heating needs.

Thermally enhanced oil recovery (TEOR) plants often produce a substantial amount of excess electricity. After generating electricity, these plants pump leftover steam into heavy oil wells so that the oil will flow more easily, increasing production. TEOR cogeneration plants in Kern County, California produce so much electricity that it cannot all be used locally and is transmitted to Los Angeles.

Types of plants

Topping cycle plants produce electricity first, then the exhausted steam is used for heating. Flames naturally produce heat suitable for a boiler. The hot water from condensed steam is well-suited for space and water heating.

Bottoming cycle plants produce high heats for an industrial process, then a waste heat recovery boiler feeds an electrical plant. Bottoming cycle plants are only used when the industrial process requires very high temperatures, such as furnaces for glass and metal manufacturing, so they are rarer.

Large cogeneration systems provide heating water and power for an industrial site or an entire town. Common CHP plant types are:

- Gas turbine CHP plants using the waste heat in the flue gas of gas turbines
- Combined cycle power plants adapted for CHP
- Steam turbine CHP plants that use the heating system as the steam condenser for the steam turbine.
- Molten-carbonate fuel cells have a hot exhaust, very suitable for heating.

Smaller cogeneration units may use a reciprocating engine or Stirling engine. The heat is removed from the exhaust and the radiator. These systems are popular in small sizes because small gas and diesel engines are less expensive than small gas- or oil-fired steam-electric plants.

Some cogeneration plants are fired by biomass [4], or industrial and municipal waste (see incineration).

MicroCHP

"Micro cogeneration" is a so called distributed energy resource (DER). the installation is usually in a house or small business[1] (http://www.cogen.org/about/workinggroup_microcogeneration.htm) . Instead of burning fuel to merely heat space or water, some of the energy is converted to electricity in addition to heat. This electricity can be used within the home or business, or (if permitted by the grid management) sold back into the electric power grid.

Current (2007) MicroCHP installations use five different technologies: microturbines, internal combustion engines, stirling engines, closed cycle steam engines and fuel cells.

See also

- Biogas Powerplant
- Decentralized energy (more general term that encompasses CHP)
- Distributed Generation (more general term that encompasses CHP)
- Geothermal power in Iceland
- New York City steam system
- Proposed oil phase-out in Sweden
- Trigeneration (using waste heat for cooling during the summer)
- District heating
- Organic Rankine Cycle

References

1. **^** Newsroom: Steam (http://www.coned.com/newsroom/energysystems_steam.asp) . ConEdison. Retrieved on 2007-07-20.
2. **^** Bevelhymer, Carl (2003-11-10). Steam (http://www.gothamgazette.com/article/issueoftheweek/20031110/200/674) . Gotham Gazette. Retrieved on 2007-07-20.
3. **^** Coolkeeragh ESB & the Environment (http://www.coolkeeraghesb.co.uk/about/index.htm) .
4. **^** http://www.opet-chp.net/download/wp3/iisalmifinland.pdf]

External links

- Energy Policy Act of 2005 - sec. 1817 "Study of Cogeneration" (http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/E6-1096.htm)
- www.mccree.com (http://www.mccree.com/airproducts.html) - Air Products and Chemicals Cogeneration Plant (Orlando, Florida)
- www.co-generationsystems.com (http://www.co-generationsystems.com/) - Industrial Co-generation Equipment Provider
- Stirling Denmark Aps (http://www.stirling.dk) - Small-scale CHP systems based on Stirling technology and renewable fuels.
- CHP in Finland:
  - High cogeneration performance by innovative steam turbine for biomass-fired CHP plant in Iisalmi, Finland (http://www.opet-chp.net/download/wp3/iisalmifinland.pdf) (URL accessed on 30 March 2006)
- CHP in Belgium :
  - Experimental study and modeling of a low temperature Rankine Cycle for small scale cogeneration (http://www.labothap.ulg.ac.be/cmsms/Staff/QuoilinS/TFE_SQ010607.pdf)
- UK micro CHP schemes:
  - CHP at DEFRA (http://www.defra.gov.uk/environment/climatechange/uk/energy/chp)
  - BBC News: Power from the people (http://news.bbc.co.uk/2/hi/programmes/working_lunch/3231549.stm)
  - Powergen WhisperGen (http://www.powergen.co.uk/At-Home/Products/Technology-And-Initiatives/WhisperGen.htm)
  - M.I.T. algae reactor (http://cogen.mit.edu/powermit/)
  - Stirling/ Oven (http://www.hoval.com/english/contents/presse/agrolyt_stirling.pdf)
- Associations:
  - U.S. Combined Heat and Power Association (http://www.uschpa.org/)
  - COGEN Europe The European Association for the Promotion of Cogeneration (http://www.cogen.org/)
  - The World Alliance for Decentralized Energy (http://www.localpower.org/)

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