



TES SYSTEMS AND CHP SYSTEMS

CEM REFRESHER TRAINING

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FOR ENERGY MANAGEMENT AND EFFICIENCY PROFESSIONALS





BENEFITS OF CHP SYSTEMS

FOR ENERGY PROFESSIONALS

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ENERGY SPECIALIST CURRICULUM



WHAT SHOULD YOU LEARN





- What Is CHP?
- Benefits of CHP Systems
- Need for Cogeneration
- Principle of cogeneration
- Classification of Cogeneration Systems



WHAT IS CHP?

CHP is a technology that produces electricity and thermal energy at high efficiencies using a range of technologies and fuels. With on-site power production, losses are minimized and heat that would otherwise be wasted is applied to facility loads in the form of process heating, steam, hot water, or even chilled water.

CHP can be located at an individual facility or building or it can be a district energy, micro-grid, and/or utility resource that provides power and thermal energy to multiple end-users. CHP equipment can provide resilient power 24/7 in the event of grid outages, and it can be paired with other distributed energy technologies like solar photovoltaics (PV) and energy storage.

Conventional power generation plants cannot always utilise the waste heat they produce. In contrast, CHP systems recover that waste heat and use it to operate industrial processes, heat domestic hot water, or provide space heating and cooling.

BENEFITS OF CHP

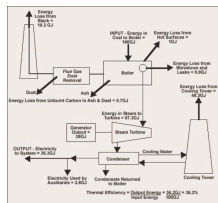
CHP systems offer many benefits when appropriately matched to a building's use and size. The use of CHP is growing due to increasing demand for energy efficiency, operating flexibility, grid outage resiliency, and the potential reduction of greenhouse gas emissions.

CHP systems are more fuel efficient than centralized (or grid-based) power generation in that CHP recycles valuable heat to produce power where it can be used. In contrast, although minimal, there are some losses when grid-based electricity is transmitted over long distances.

Designed to operate every day, CHP systems may be more reliable than traditional emergency back-up generators during grid outages. This resiliency might make them a good option for multifamily buildings. The ability to produce electricity and heat during grid outages is also advantageous for critical care facilities including nursing homes and hospitals. A site-specific, detailed analysis should be conducted before committing to purchase a CHP system.

NEED FOR COGENERATION

Thermal power plants are a major source of electricity supply in India. The conventional method of power generation and supply to the customer is wasteful in the sense that only about a third of the primary energy fed into the power plant is actually made available to the user in the form of electricity (Figure 7.1).



BALANCE IN TYPICAL COAL FIRED POWER STATION

In conventional power plant, efficiency is only 35% and remaining 65% of energy is lost. The major source of loss in the conversion process is the heat rejected to the surrounding water or air due to the inherent constraints of the different thermodynamic cycles employed in power generation. Also further losses of around 10-15% are associated with the transmission and distribution of electricity in the electrical grid.

PRINCIPLE OF COGENERATION

Cogeneration or Combined Heat and Power (CHP) is defined as the sequential generation of two different forms of useful energy from a single primary energy source, typically mechanical energy and thermal energy. Mechanical energy may be used either to drive an alternator for producing electricity, or rotating equipment such as motor, compressor, pump or fan for delivering various services. Thermal energy can be used either for direct process applications or for indirectly producing steam, hot water, hot air for dryer or chilled water for process cooling.

Cogeneration provides a wide range of technologies for application in various domains of economic activities. The overall efficiency of energy use in cogeneration mode can be up to 85 per cent and above in some cases.

CLASSIFICATION OF COGENERATION SYSTEMS

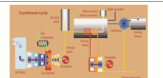
Cogeneration systems are normally classified according to the sequence of energy use and the operating schemes adopted.

A cogeneration system can be classified as either a topping or a bottoming cycle on the basis of the sequence of energy use. In a topping cycle, the fuel supplied is used to first produce power and then thermal energy, which is the by-product of the cycle and is used to satisfy process heat or other thermal requirements. Topping cycle cogeneration is widely used and is the most popular method of cogeneration.

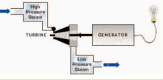
TOPPING CYCLE

The four types of topping cycle cogeneration systems are briefly explained in Table 7.2.

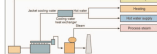
A gas turbine or diesel engine producing electrical or mechanical power followed by a heat recovery boiler to create steam to drive a secondary steam turbine. This is called a combined-cycle topping system.



The second type of system burns fuel (any type) to produce high-pressure steam that then passes through a steam turbine to produce power with the exhaust provides low-pressure process steam. This is a steam-turbine topping system.



A third type employs heat recovery from an engine exhaust and/or jacket cooling system flowing to a heat recovery boiler, where it is converted to process steam / hot water for further use.

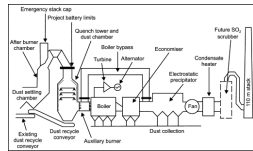


The fourth type is a gas-turbine topping system. A natural gas turbine drives a generator. The exhaust gas goes to a heat recovery boiler that makes process steam and process heat.



BOTTOMING CYCLE

In a bottoming cycle, the primary fuel produces high temperature thermal energy and the heat rejected from the process is used to generate power through a recovery boiler and a turbine generator. Bottoming cycles are suitable for manufacturing processes that require heat at high temperature in furnaces and kilns, and reject heat at significantly high temperatures. Typical areas of application include cement, steel, ceramic, gas and petrochemical industries. Bottoming cycle plants are much less common than topping cycle plants.



The Figure 7.3 illustrates the bottoming cycle where fuel is burnt in a furnace to produce synthetic rutile. The waste gases coming out of the furnace is utilized in a boiler to generate steam, which drives the turbine to produce electricity.

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