

For gas-fired combustion plants, the application of gas turbine combined cycles and the co-generation of heat and power (CHP) are technically the most efficient means of increasing the energy efficiency (fuel utilisation) of an energy supply system. A combined cycle operation and co-generation of heat and power is, therefore, to be considered as the first BAT option, i.e. whenever the local heat demand is great enough to warrant the construction of such a system. The use of an advanced computerised control system in order to achieve a high boiler performance with increased combustion conditions that support the reduction of emissions are also considered as BAT.

Improvement of the efficiency can also be obtained by preheating the natural gas, before its supply to the combustion chambers or burners. The heat can be obtained from low temperature sources, such as the exhaust gases from cooling from other regenerative processes.

Gas engine driven power plants are suited for both decentralised heat and power production (CHP) as well as for bigger base load applications. The BAT associated total efficiencies are up to 60 – 70 % in low pressure steam generation. With supplementary firing (i.e. when the oxygen content of the engine flue-gas acts as the main ‘combustion air’ in the burner) a large amount of low pressure or high pressure steam can be generated in an efficient way. In hot water production (with outlet temperatures typically in range of 80 – 120 °C), a total efficiency (fuel utilisation) of up to 90 % in gas fuel mode can be seen as BAT, although highly depending on the portion of the engine cooling water energy recovered in the application. Hot water of up to 200 °C can, of course, be produced by utilising the energy in the flue-gas and part of the engine cooling energy. Another advantage is the high thermal efficiency (i.e. low fuel consumption, and consequently low specific CO₂ emissions) of the engines. The BAT electrical efficiency (at alternator terminals) ranges from about 40 to 45 % (depending on the engine size) and is calculated on the lower heating value of the fuel.

For existing plants, a number of retrofit and repowering techniques can be applied to improve the thermal efficiency. The technical measures described in Section 2.7.8 should be taken into account as part of BAT options to improve the efficiency of existing plants. By applying the techniques and the measures listed in Section 7.4.2, to improve the thermal efficiency such as double reheat, and using the most advanced high temperature materials for gas turbines and boilers, energy efficiencies associated with the use of BAT can be achieved as summarised in Table 7.35.

In addition, the following measures also needs to be taken into consideration to increase the efficiency:

- combustion: minimising the heat loss due to unburned gases
- the highest possible pressure and temperature of the working medium gas or steam
- the highest possible pressure drop in the low pressure end of the steam turbine through the lowest possible temperature of the cooling water (fresh water cooling) for boilers and CCGT plants
- minimising the heat loss through the flue-gas (utilisation of residual heat or district heating)
- minimising the heat loss through conduction and radiation with isolation
- minimising the internal energy consumption by taking appropriate measures, e.g. scorification of the evaporator, greater efficiency of the feed water pump, etc.)
- preheating the fuel gas and or the boiler feed water with steam
- improved blade geometry of the turbines.

There was a split view from industry about the efficiency measures applied to CCGT plants, because the proposed measures will only have a marginal improvement of the total combined cycle efficiency. It should be noted that improvements of the gas turbine efficiency may result in a decrease of efficiency of the steam cycle. Therefore, the improvement of efficiency of the total cycle will be less than the improvement of the efficiency of the gas turbine only. Based on the above given rationale, industry is of the opinion that the proposed measures shall not be incorporated in the final draft of the BREF LCP.

Plant type	Electrical efficiency (%)		Fuel utilisation (%)	Remarks
	New plants	Existing plants	New and existing plants	
Gas turbine				
Gas turbine	36 – 40	32 – 35	-	
Gas engine				
Gas engine	38 – 45		-	
Gas engine with HRSG in CHP mode	>38	>35	75 – 85	The wide range of energy efficiency in CHP plants is very much dependent upon the specific situation and the local demand of electricity and heat
Gas-fired boiler				
Gas-fired boiler	40 – 42	38 – 40		
CCGT				
Combined cycle with or without supplementary firing (HRSG) for electricity generation only	54 – 58	50 – 54	-	
Combined cycle without supplementary firing (HRSG) in CHP mode	<38	<35	75 – 85	The wide range of the electrical and energy efficiency of CHP plants very much depends on the specific local demand for electricity and heat. By operating the CCGT in the CHP mode, the energy efficiency includes the amount of the electrical efficiency and should always be seen together to achieve the best overall exergetic efficiency.
Combined cycle with supplementary firing in CHP mode	<40	<35	75 – 85	

Table 7.35: Efficiency of gas-fired combustion plants associated to the use of BAT (based on ISO conditions)

It should be borne in mind that these BAT levels are not achievable in all operation conditions. The energy efficiency is at its best at the design point of the plant. The actual energy efficiencies throughout the operational period of the plants may also be lower due to changes, for instance changes in the load during the operation, quality of the fuel, etc. The energy efficiency also depends on the cooling system of the power plant, and on the energy consumption of the flue-gas cleaning system. It should also be recognised that high efficiency gas turbine systems may generate problems such as vibration and higher short term NO_x emissions.

7.5.3 Dust and SO₂ emissions from gas fired combustion plants

For gas-fired combustion plants using natural gas as a fuel, emissions of dust and SO₂ are very low. The emission levels of dust by using natural gas as a fuel are normally well below 5 mg/Nm³ and SO₂ emissions are well below 10 mg/Nm³ (15 % O₂), without any additional technical measures being applied.

If other industrial gases are used as a fuel such as refinery gas or blast furnace gas, pre treatment gas cleaning measures (such as fabric filters) needs to be applied and considered as BAT, in order to reduce the dust content and the amount of SO₂ in the flue-gas, which may otherwise damage the gas turbines or engines. As mentioned in the Refinery BREF, BAT is to limit the H₂S content of the refinery gas to 20 – 150 mg/Nm³ leading to an emission of 5 – 20 mg of SO₂/Nm³. Such gas do not create particulate emissions. In the case of natural gas refineries, also refer to the Mineral Oil and Gas Refinery BREF.