

# Gas Turbine And Ccgt Conceptual Plant Design A Refresher

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1 Gas turbines and combined cycle gas turbine CCGT plants play a crucial role in modern power generation Offering high efficiency low emissions and quick startup capabilities these technologies contribute significantly to global energy demands This document serves as a refresher on the key principles of gas turbine and CCGT plant design focusing on the conceptual aspects

2 Gas Turbine Basics A gas turbine is a type of internal combustion engine that converts the chemical energy of fuel into mechanical energy through a series of stages involving compression combustion and expansion

2.1 Components

- Compressor Compresses ambient air increasing its density and temperature
- Combustion Chamber Combusts fuel typically natural gas with the compressed air generating high temperature high pressure gases
- Turbine Extracts energy from the expanding combustion gases driving the compressor and an external load
- Exhaust System Discharges the remaining combustion gases to the atmosphere

2.2 Operating Principles

Brayton Cycle Gas turbines operate on the Brayton cycle which involves four thermodynamic processes: adiabatic compression, constant pressure heat addition, adiabatic expansion, and constant pressure heat rejection

Efficiency The efficiency of a gas turbine is primarily determined by its pressure ratio (ratio of outlet to inlet pressure of the compressor) and the turbine inlet temperature Higher pressure ratios and higher temperatures generally result in higher efficiencies

3 Combined Cycle Gas Turbine CCGT Plants

2 CCGT plants combine the high efficiency of gas turbines with the heat recovery potential of steam turbines significantly improving overall efficiency

3.1 Components

- Gas Turbine As described in Section 2
- Heat Recovery Steam Generator (HRSG) Recovers heat from the gas turbine exhaust to generate steam
- Steam Turbine Extracts energy from the steam to generate electricity
- Condenser Condenses the steam after it has passed through the steam turbine

3.2 Operating Principles

Combined Cycle The exhaust gases from the gas turbine are used to heat water in the HRSG producing steam This steam drives the steam turbine generating additional power

Higher Efficiency The CCGT cycle achieves higher efficiency due to the utilization of waste heat from the gas turbine improving the overall energy conversion process

4 Conceptual Plant Design

4.1 Plant Layout

Site Selection Factors considered include proximity to fuel sources, transmission lines, and water resources

Layout Optimization Designing a layout that minimizes piping runs, maximizes equipment accessibility, and ensures safe operation is crucial

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