Chapter 01

Conventional Generation, Load Curves and Tariffs:

Lecture : 09

TOPIC:

1. Gas turbine power plant
2. Schematic arrangement of gas turbine power plant
3. Comparison of Various Power Plants.

Chapter: 01
Conventional Generation, Load Curves and Tariffs:

- Generation scenario in India and Gujarat
- Steam power station, Schematic arrangement of steam power station, Equipment's of steam power station,
- Hydroelectric power station, Schematic arrangement of hydro-electric power station, Constituents of hydro-electric plants,
- Nuclear power station, Schematic arrangement of nuclear power station, Nuclear reactor,
- Gas turbine power plant, Schematic arrangement of gas turbine power plant,
- Comparison Of Various Power Plants.
- Load curves, Important terms and factors, Load duration curve, Examples. Tariff, Desirable characteristics of tariff, Types of tariff, Examples.

Gas turbine power plant

A generating station which employs gas turbine as the prime mover for the generation of electrical energy is known as a **gas turbine power plant**

In a gas turbine power plant, air is used as the working fluid. The air is compressed by the compressor and is led to the combustion chamber where heat is added to air, thus raising its temperature. Heat is added to the compressed air either by burning fuel in the chamber or by the use of air heaters. The hot and high pressure air from the combustion chamber is then passed to the gas turbine where it expands and does the mechanical work. The gas turbine drives the alternator which converts mechanical energy into electrical energy.

It may be mentioned here that compressor, gas turbine and the alternator are mounted on the same shaft so that a part of mechanical power of the turbine can be utilised for the operation of the compressor. Gas turbine power plants are being used as standby plants for hydro-electric stations, as a starting plant for driving auxiliaries in power plants etc.

Advantages

(*i*) It is simple in design as compared to steam power station since no boilers and their auxiliaries are required.

(*ii*) It is much smaller in size as compared to steam power station of the same capacity. This is expected since gas turbine power plant does not require boiler, feed water arrangement etc.

(*iii*) The initial and operating costs are much lower than that of equivalent steam power station.

(*iv*) It requires comparatively less water as no condenser is used.

(*v*) The maintenance charges are quite small.

(*vi*) Gas turbines are much simpler in construction and operation than steam turbines.

(*vii*) It can be started quickly form cold conditions.

(*viii*) There are no standby losses. However, in a steam power station, these losses occur because boiler is kept in operation even when the steam turbine is supplying no load.

Disadvantages

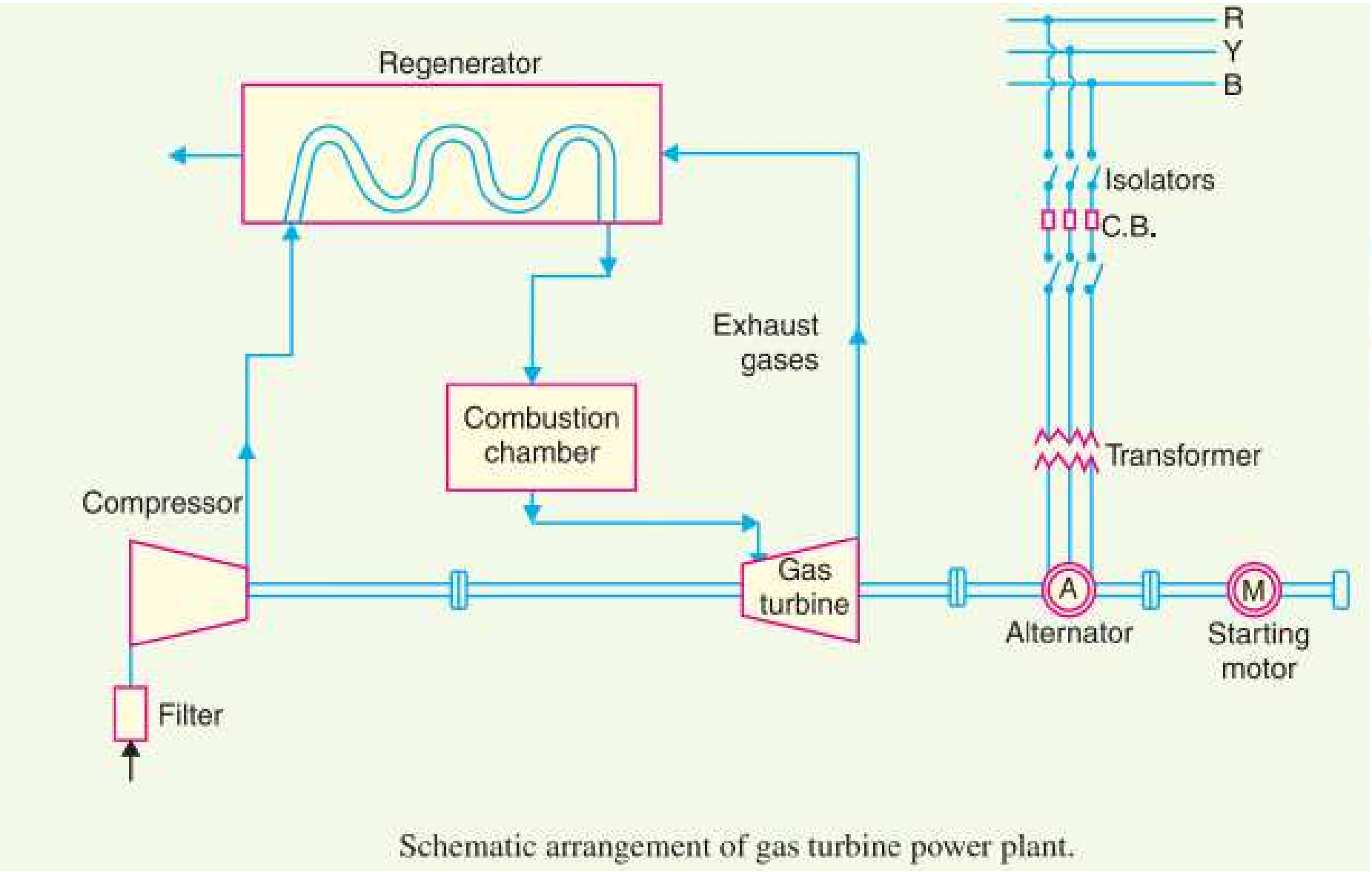
(*i*) There is a problem for starting the unit. It is because before starting the turbine, the compressor has to be operated for which power is required from some external source. However, once the unit starts, the external power is not needed as the turbine itself supplies the necessary power to the compressor.

(*ii*) Since a greater part of power developed by the turbine is used in driving the compressor, the net output is low.

(*iii*) The overall efficiency of such plants is low (about 20%) because the exhaust gases from the turbine contain sufficient heat.

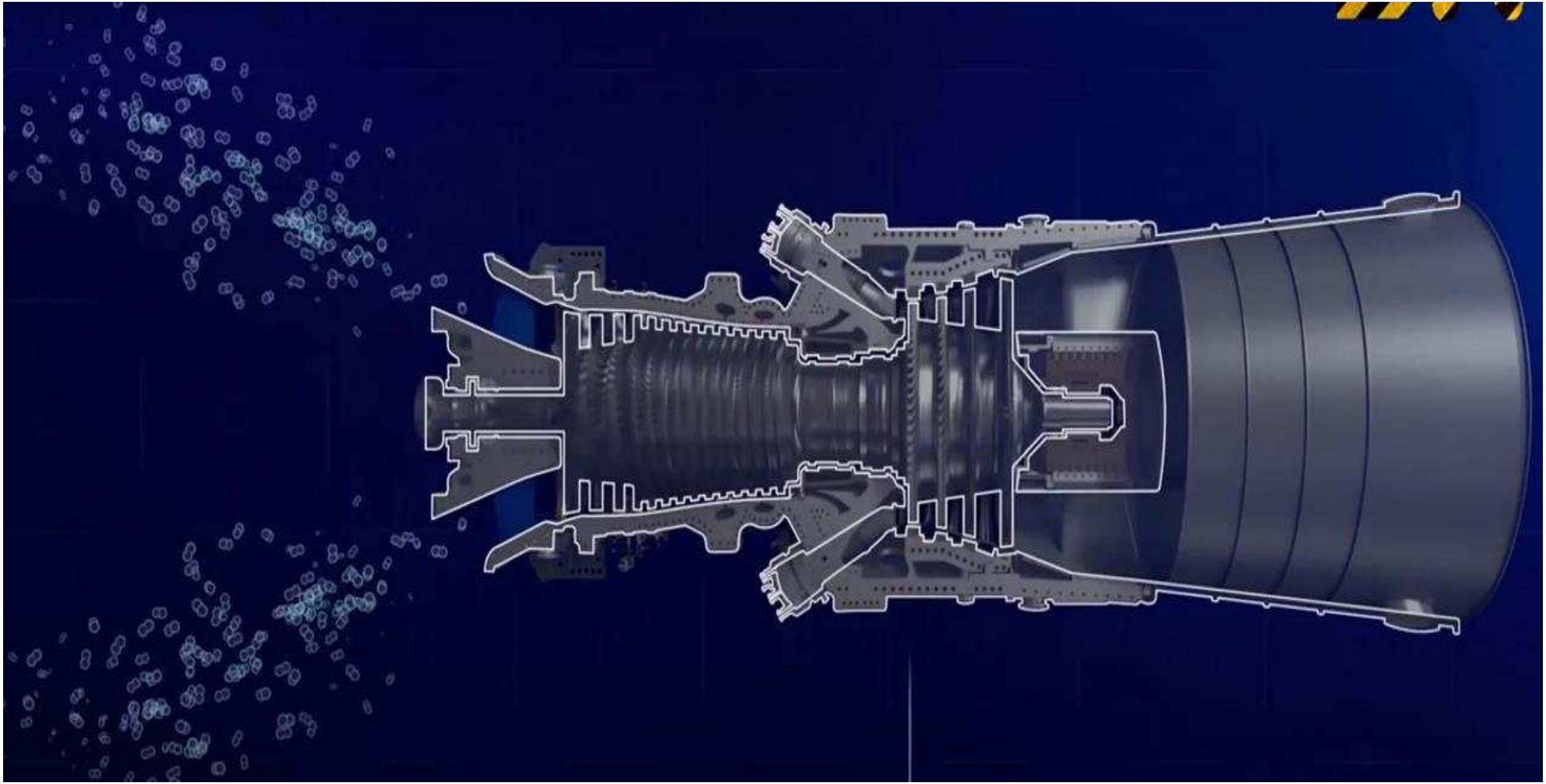
(*iv*) The temperature of combustion chamber is quite high (3000°F) so that its life is comparatively reduced.

Schematic arrangement of gas turbine power plant



Schematic arrangement of gas turbine power plant.

(*i*) Compressor
(*iii*) Combustion chamber
(*v*) Alternator
(*ii*) Regenerator
(*iv*) Gas turbine
(*vi*) Starting motor



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(*i*) **Compressor.** The compressor used in the plant is generally of rotatory type. The air at atmospheric pressure is drawn by the compressor *via* the filter which removes the dust from air. The rotatory blades of the compressor push the air between stationary blades to raise its pressure. Thus air at high pressure is available at the output of the compressor.

(*ii*) **Regenerator.** A regenerator is a device which recovers heat from the exhaust gases of the turbine. The exhaust is passed through the regenerator before wasting to atmosphere. A regenerator consists of a nest of tubes contained in a shell. The compressed air from the compressor passes through the tubes on its way to the combustion chamber. In this way, compressed air is heated by the hot exhaust gases.

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(*iii*) **Combustion chamber.** The air at high pressure from the compressor is led to the combustion chamber *via* the regenerator. In the combustion chamber, heat* is added to the air by burning oil. The oil is injected through the burner into the chamber at high pressure to ensure atomisation of oil and its thorough mixing with air. The result is that the chamber attains a very high temperature (about 3000°F). The combustion gases are suitably cooled to 1300°F to 1500°F and then delivered to the gas turbine.

(*iv*) **Gas turbine.** The products of combustion consisting of a mixture of gases at high temperature and pressure are passed to the gas turbine. These gases in passing over the turbine blades expand and thus do the mechanical work. The temperature of the exhaust gases from the turbine is about 900°F.

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(*v*) **Alternator.** The gas turbine is coupled to the alternator. The alternator converts mechanical energy of the turbine into electrical energy. The output from the alternator is given to the bus-bars through transformer, circuit breakers and isolators.

(*vi*) **Starting motor.** Before starting the turbine, compressor has to be started. For this purpose, an electric motor is mounted on the same shaft as that of the turbine. The motor is energised by the batteries. Once the unit starts, a part of mechanical power of the turbine drives the compressor and there is no need of motor now.

Comparison of Various Power Plants

S.No.	Item	Steam Power Station	Hydro-electric Power Plant	Diesel Power Plant	Nuclear power Plant
1.	*Site*	Such plants are located at a place where ample supply of water and coal is available, transportation facilities are adequate	Such plants are located where large reservoirs can be obtained by constructing a dam *e.g.* in hilly areas.	Such plants can be located at any place because they require less space and small quantity of water.	These plants are located away from thickly populated areas to avoid radioactive pollution.
2.	*Initial cost*	Initial cost is lower than those of hydroelectric and nuclear power plants.	Initial cost is very high because of dam construction and excavation work.	Initial cost is less as compared to other plants.	Initial cost is highest because of huge investement on building a nuclear reactor.
3.	*Running cost*	Higher than hydroelectric and nuclear plant because of the requirement of huge amount of coal.	Practically nil because no fuel is required.	Highest among all plants because of high price of diesel.	Except the hydroelectric plant, it has the minimum running cost because small amount of fuel can produce relatively large amount of power.

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S.No.	Item	Steam Power Station	Hydro-electric Power Plant	Diesel Power Plant	Nuclear power Plant
4.	*Limit of source of power*	Coal is the source of power which has limited reserves all over the world.	Water is the source of power which is not dependable becuase of wide variations in the rainfall every year.	Diesel is the source of power which is not available in huge quantities due to limited reserves.	The source of power is the nuclear fuel which is available in sufficient quantity. It is because small amount of fuel can produce huge power.
5.	*Cost of fuel transportation*	Maximum because huge amount of coal is transported to the plant site.	Practically nil.	Higher than hydro and nuclear power plants	Minimum because small quantity of fuel is required.
6.	*Cleanliness and simplicity*	Least clean as atmosphere is polluted due to smoke.	Most simple and clean.	More clean than steam power and nuclear power plants.	Less cleaner than hydro-electric and diesel power plants.

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S.No.	Item	Steam Power Station	Hydro-electric Power Plant	Diesel Power Plant	Nuclear power Plant
7.	*Overall efficiency*	Least efficient. Overall efficiency is about 25%.	Most efficient. Overall efficiency is about 85%.	More efficient than steam power station. Efficiency is about 35%.	More efficient than steam power station.
8.	*Starting*	Requires a lot of time for starting.	Can be started instantly.	Can be started quickly.	Can be started easily.
9.	*Space required*	These plants need sufficient space because of boilers and other auxiliaries.	Require very large area because of the reservoir.	Require less space.	These require minimum space as compared to any other plant of equivalent capacity.
10.	*Maintenance cost*	Quite high as skilled operating staff is required.	Quite low.	Less	Very high as highly trained personnel are required to handle the plant.
11.	*Transmission and distribution cost*	Quite low as these are generally located near the load centres.	Quite high as these are located quite away from the load centres.	Least as they are generally located at the centre of gravity of the load.	Quite low as these are located near load centres.
12.	*Standby losses*	Maximum as the boiler remains in operation even when the turbine is not working.	No standby losses.	Less standby losses.	Less.

Precape

- Load curves
- Important terms and factors
- Load duration curve


Thank You