ECONOMIC OPERATION OF POWER SYSTEM

- A power system has several power plants. Each power plant has several generating units.
- At any point of time, the total load in the system is met by the generating units in different power plants.
- Economic dispatch control determines thepower output of each power plant and power output of each generating units within a power plant, which will maximize the overall cost of the fuel needed to serve the system load.
- The factors considered by the load dispatcher are when to interchange energy from one station to another station, how much energy to interchange, the cost of supplying energy to the interconnection, the cost of received energy fromthe interconnection.
- The other factors affecting the economy of operation arevariation fuel cost, labour cost, and weather conditions, normal and emergency equipment rating, reserve requirements, voltage limitations, characteristic's of prime moves, transmission losses etc.,
- The main economic factor in power system operation is the cost ofgenerating real power.
- The main factor controlling the most desirable load allocationbetween the various generating units is the total cost.
- Interconnected power system is the more reliable, convenient to operate and offers economical operating cost.
- Forthe purpose of economy interchange so it is necessary to consider not only the incremental fuel cost but also the incremental transmission loss for the optimum economy. The economic system operation is necessary because
- In many cases economic factors and the availability of primary essentials such as coal, water etc., it indicates that new generating plants is located at greater distances from the load Centres
- Power systems are in interconnecting for purpose of economy interchange and reduction of reserve capacity In a number of areas of the country, the cost of fuel is rapidly increasing.

Statement of Economic Dispatch Problem:

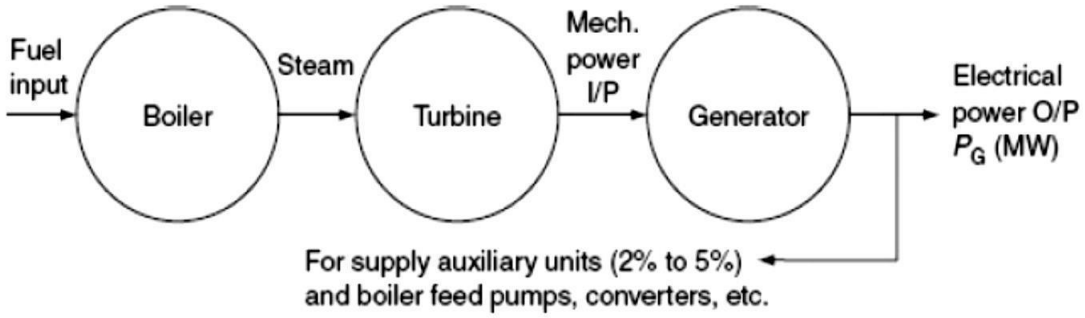
- The complexity of interconnections and the size of the areas of electric power systems that are controlled in a coordinated way is rapidly increasing.
- This entails optimal allocation of the outputs of a large number of participating generators.
- Whether a generator should participate in sharing the load at a given interval of time is a problem of unit commitment.
- Once the unit commitment problem has been solved, it becomes a problem of optimal allocation of the available generations to meet the forecasted load demand for the current interval.
- At a modern-day energy management center, highly developed optimization techniques are used to determine not only the optimaloutputs of the participating generators, but also the optimal settings of various control devices such as the tap settings of load tap changers (LTCs), outputs of VAR compensating devices, desired settings of phase shifters etc.
- The desired objective for such optimization problems can be many, such as the

minimization of the cost of generation, minimization of the total power loss in the system, minimization of the voltage deviations, and maximization of the reliability of the power supplied to the customers.

- One or more of these objectives can be considered while formulating the optimization strategy.
- Determination of the realpower outputs of the generators so that the total cost of generation in the system is minimized is traditionally known as the problem of economic load dispatch (ELD).

Input and Output Characteristics of Thermal Plant

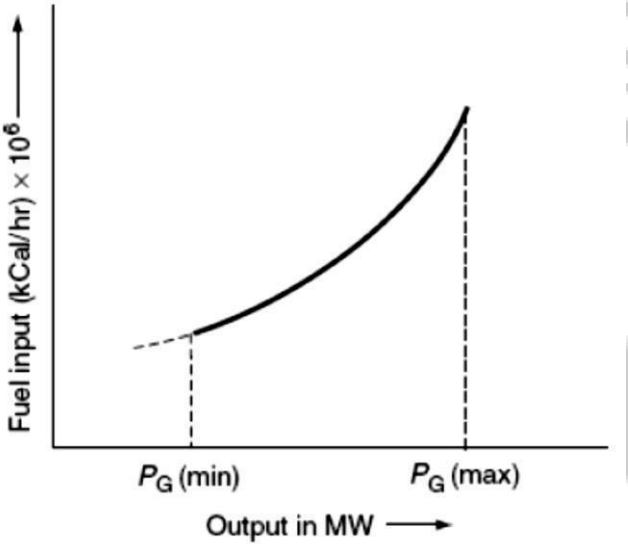
- In analysing the economic operation of a thermal unit, input–output modeling characteristics are significant.
- For this function, consider a single unit consisting of a boiler, a turbine, and a generator as shown in Fig This unit has tosupply power not only to the load connected to the power system but also to the local needs for the auxiliaries in the station, which may vary from 2%to 5%.
- The power requirements for station auxiliaries are necessary to drive boiler feed pumps, fans and condenser circulating water pumps, etc The total input to the thermal unit could be British thermal unit (Btu)/hr or Cal/hr in terms of heat supplied or Rs./hr in terms of the cost of fuel (coal or gas).
- The total output of the unit at the generator bus will be either kW or MW



- To analyze the power system network, there is a need of knowing thesystem variables. They are:
- Control variables - real and reactive-power generations
- Disturbance variables - real and reactive-power demands
- State variables - bus voltage magnitude V and its phase angle δ
- Scheduling is the process of allocation of generation among different generating units.
- Economic scheduling is a cost-effective mode of allocation of generation among the different units in such a way that the overall cost of generation should be minimum.
- This can also be termed as an optimal dispatch
- Let the total load demand on the station = P_D and the total number ofgenerating units = n.
- The optimization problem is to allocate the total load P_D among these ‗n' units

in an optimal way to reduce the overall cost of generation

- Let P_{G1} , P_{G2} , P_{G3} , …, P_{Gn} be the power generated by each individual unit to supply a load demand of P .
- To formulate this problem, it is necessary to know the ‗input–output characteristics of each unit'.
- It establishes the relationship between the energy input to the turbine andthe energy output from the electrical generator.
- The input to the turbine shown on the ordinate may be either in terms of the heat energy requirement, which is generally measured in Btu/hr or kCal/hr or in terms of the total cost of fuel per hour in Rs./hr. The output is normally the net electrical power output of that steam unit inkW or MW.



- The steam turbine-generating unit curve consists of minimum and maximum limits in operation, which depend upon the steam cycle used, thermal characteristics of material, the operating temperature etc.
- To convert the input–output curves into cost curves, the fuel input per hour is multiplied with the cost of the fuel (expressed in Rs./million kCal)