

# EE3101 - Power Systems-I

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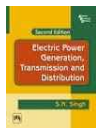
# Overview

- 1 Syllabus
- 2 Books
- 3 Course Mechanics
- 4 Power Systems
- 5 Indian Power Sector - An Overview

- Power Generation
- Basic Concepts
- Per unit calculation
- Line Parameter Calculation
- Performance of Transmission lines
- Distribution

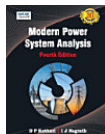
- Text Book

- ① S. N. Singh: Electric Power Generation, Transmission and Distribution, Prentice-Hall, 2007



- Reference Book

- D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, Tata McGraw-Hill, 4e, 2011.



- Lab/Quizzes - 33 %
- Mid Sem & End Sem- 67 %

## Grading

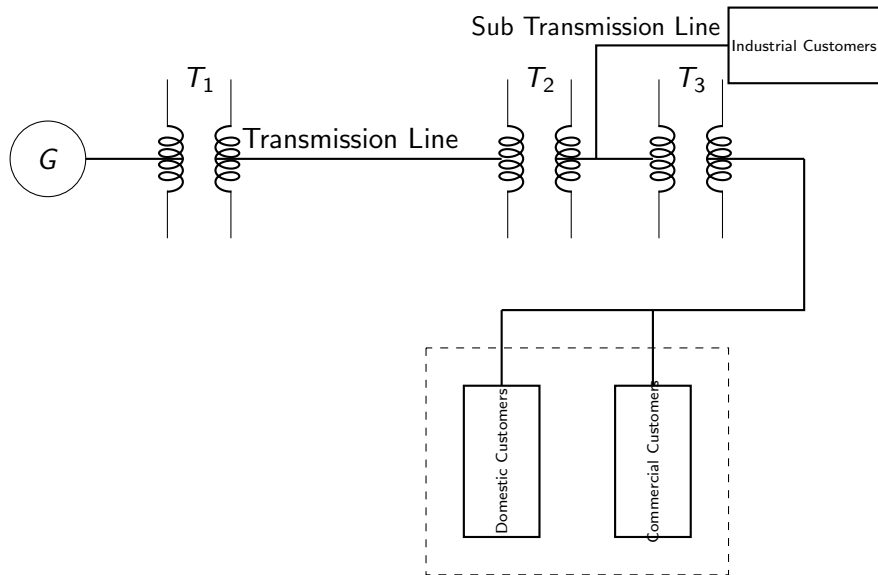
- It is absolute.
- Marks scored less than 30 out of 100 shall be given "F" Grade.

Power systems have the following three components.

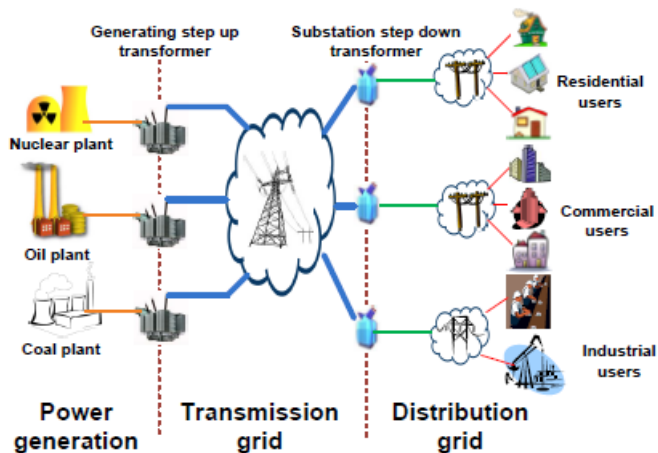
- ① Generation - Source of Energy
- ② Transmission - Transmission of Energy over long distance (close to the speed of light)
- ③ Distribution - Consumption of Energy

- Electric Energy is seldom used in its form.
- It is easy to convert from other forms and transmit from sources to loads.
- Power system is the most complex system on earth.
- In interconnected systems, the frequency has to be the same. In India, it is 50 Hz. In some countries, it is 60 Hz.

# Structure of a Power System



# Practical System

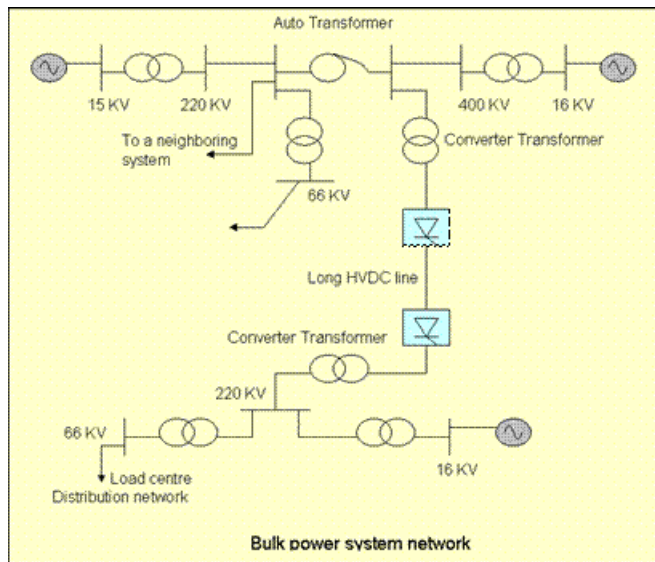




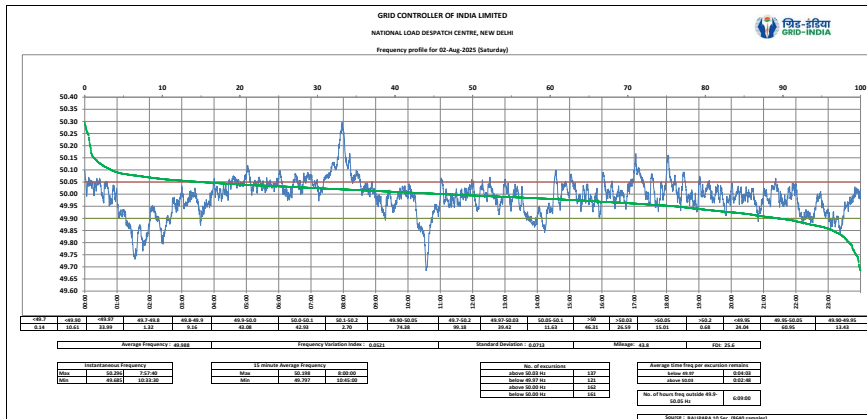
## Reasons for interconnections

- ① To improve reliability
- ② To improve economy
- Several power systems are interconnected to form a grid.
- Several regional grids are interconnected to form a national grid.
- Interconnections are done at Transmission networks.
- In interconnected systems, the frequency of generation must be the same.

# Power System



# Grid Frequency



# Indian Power Sector - An Overview

- India is the third largest producer of electricity (more than 1 TU<sup>1</sup> a year) in the world.
- India is also the third largest consumer of electricity in the world.
- T& D losses are 18 %.
- However , the per capita energy consumption is 1,395 kWh per person per year.
- It is low compared to many countries. For example, US : 12,440 & China : 6,640
- It is even lower than the world average (3,700 kWh).

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<sup>1</sup>1 TU = 1,000,000,000,000 kWh

# Installed Capacity

The installed capacity as on June 30, 2025 is **485 GW**.

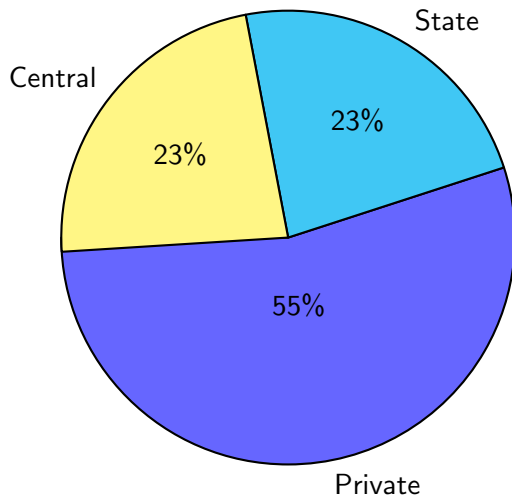
Type	Capacity (GW)	% of Total
Thermal <sup>2</sup> (Coal, Oil & Gas)	242	50 %
Hydro	49	10 %
Nuclear	9	2 %
RES	185	38 %
<b>Total</b>	<b>485</b>	

Source : Central Electricity Authority, Ministry of Power, Gol

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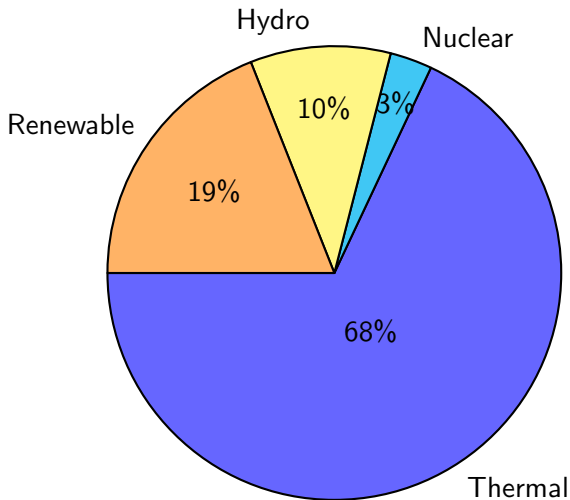
<sup>2</sup>Coal based power plants account for 90 %

# Installed Capacity - Sector Wise



# Electricity Generation in June 2025

Total electricity generation in June 2025 was 160.88 BU.



Most of the energy is still from Thermal.

# Load Curve

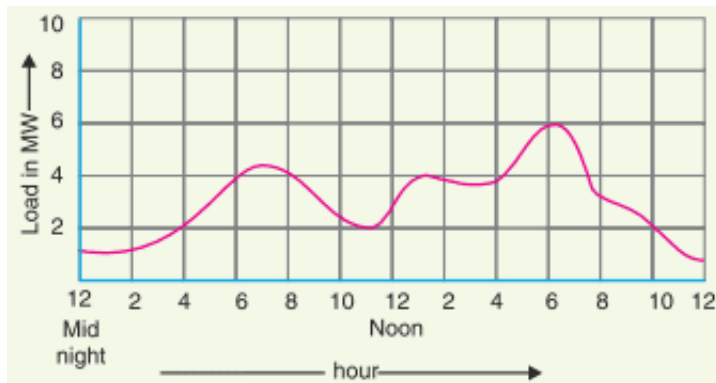


Figure: Typical Daily Load Curve

Source : Internet



# Definitions

## Load Factor

$$\text{Load factor} = \frac{\text{Average Load}}{\text{Maximum Demand}}$$

It is always less than unity.

## Diversity Factor

$$\text{Diversity factor} = \frac{\text{Sum of Individual Maximum Demands on the Consumers}}{\text{Maximum Demand on the System}}$$

It is greater than unity.

# Definitions

## Demand Factor

$$\text{Demand Factor} = \frac{\text{Maximum Demand}}{\text{Connected Load}}$$

It is between 0.5 and 0.8.

## Plant Capacity Factor

$$\begin{aligned} &= \frac{\text{Actual Energy Produced}}{\text{Maximum possible energy that could have been produced}} \\ &= \frac{\text{Average Demand}}{\text{Installed Capacity}} \end{aligned}$$

It is also known as plant load factor (PLF).

## Plant Use Factor

$$= \frac{\text{Actual Energy Produced}}{\text{plant capacity in kW} \times \text{Time in hours the plant has been in operation}}$$

The general form of tariff is

$$a + b \times \text{kW} + c \times \text{kWh}$$

$a$ ,  $b$ , and  $c$  are constants.

The different types of tariffs are as follows:

- 1 Flat rate tariff -  $a$  and  $b$  are zero.
- 2 Two-part tariff -  $a$  is zero.
- 3 Block rate tariff - Different slabs based on energy consumption.

The tariff should consider the power factor of the consumers.

The other alternatives to avoid low power factor are

- to charge the consumers based on kVAhr rather than kWhr.
- to penalize the consumers.

# Availability Based Tariffs (ABT)

ABT is mainly for generating companies and consists of three components.

- ① Capacity Charge
- ② Energy Charge
- ③ Charges for deviation from schedule