

# Introduction to Power System

Comprehensive Course on Power System

Ajay Gupta • Lesson 1 • May 16, 2021

Gate → 9-12 Marks (Moderate)  
100%

ESE - 104 Marks. (Tough)

AE/JE/BARC/ISRO (Tough)

## Books

- Stevenson.
- C.L. Wadwa.
- Nagrath Kotari
- B.R Gupta [Generation  
Transmission]
- J.B. Gupta

## POWER SYSTEM.

SYSTEM → It is collection of component for an certain objective.

POWER → Electrical power.

OBJECTIVE → To provide quality & reliable power to consumer at minimum cost.

Total study of power system is divided into 3 parts.

- (I) Generation of electrical power
- (II) Transmission of electrical power
- (III) Distribution of electrical power.

## Generation of electric power :-

Conventional energy source  
(Thermal, hydro, Nuclear).

Non conventional energy source.

(Wind, solar, Biomass, tidal, Geothermal).

## Thermal power plant. →

Coal energy → Steam energy → Mechanical energy → Electrical energy.

Total installed capacity → 2,33,171 MW  
(1.5%)

300 RPM

## Hydro Power Plant. →

Potential energy → Kinetic energy → Mechanical energy. → Electrical energy.

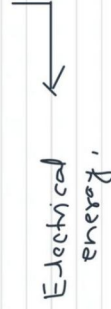


Installed capacity → 46,209 MW  
(12.2%)

300 RPM

## Nuclear power plant. →

Nuclear energy → Steam energy → Mechanical energy



Installed capacity = 6750 MW  
(1.8%)

## Non conventional energy source →

→ Wind. (Vara varata)

→ Solar.

→ Biomass

→ Tidal

- Geothermal.

Installed capacity - 46,209 MW.

(12.2%)

Total Installed capacity  $\rightarrow$  3,79, 130 MW.

Central govt: 91, 187 MW 25.4%.

State govt 1,03, 628 MW 27.4%.

Private sect 1,79, 315 MW 47.3%.

Approximately 1330 BU.

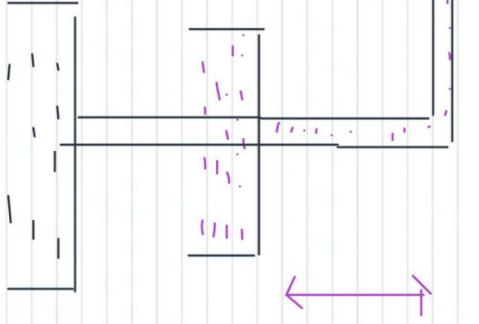
(Billion units)

## Transmission of electrical power.

$\rightarrow$  it is network of cables which carries bulk power from generating station to sub-station.

$\rightarrow$  3 phase 3 wire system is used.

$\rightarrow$  Power is transmitted at high voltage to reduce the loss.



$$V_1 I_1 = V_2 I_2$$

$$I_2 = \frac{V_1}{V_2} \cdot I_1$$

$$I_2 = \frac{11}{400} \cdot I_1$$

$$I_2 < I_1$$

$$P = I^2 R$$

$$11/33/132/220/400 / 745/1200$$

- Short T.L
- Medium T.L
- Long T.L

→ High length tower is used for power transmission.

### Distribution of electrical power. →

→ it is a network of conductor, which carries power from substation to end user.

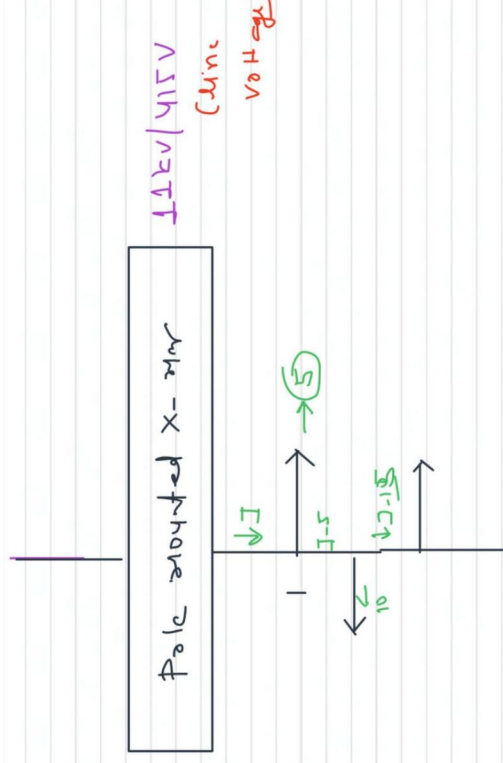
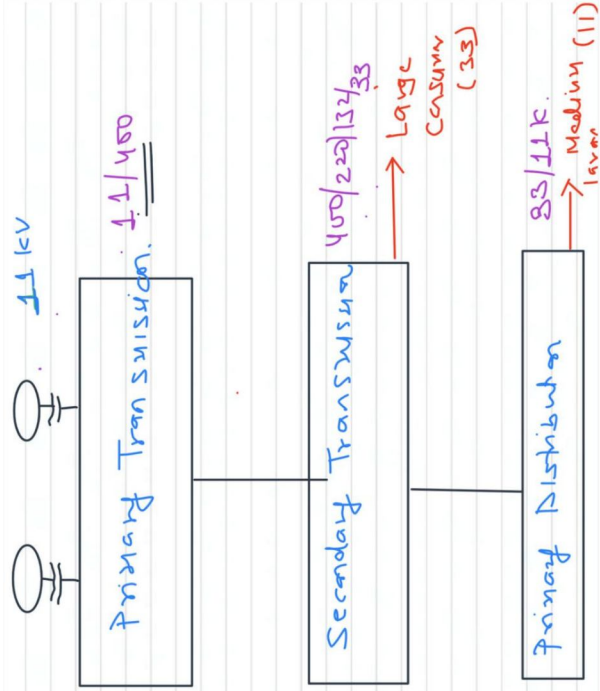
→ 3 Ph y wire is used. to supply Δp power to end user.

→ it carries power at low voltage.  
→ Current carrying capacity is low.

→ Radial distribution system

Ring distribution system

Interconnected distribution system.





Feeder → The current density of feeder is constant every where. (No tapping is done from feeder)

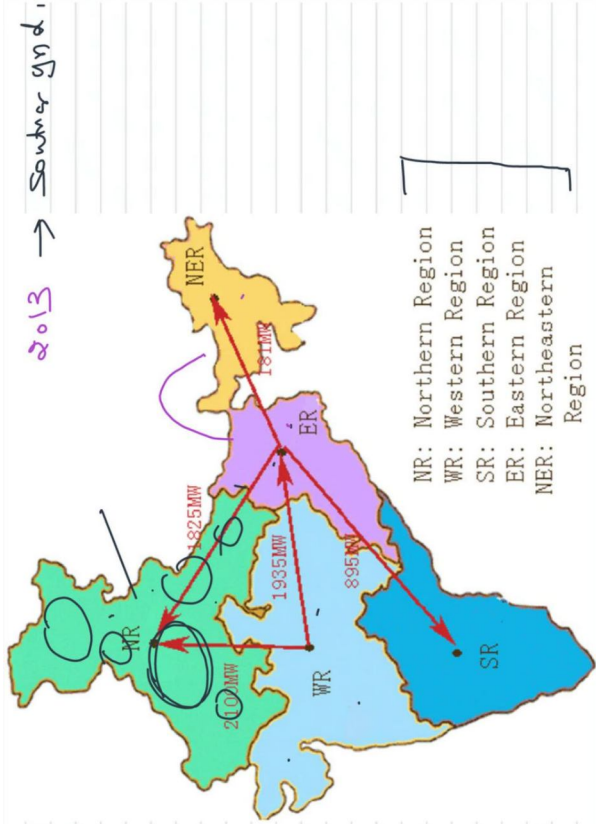
Distributor → The current density of distributor are not same every where.

GRID → The transmission system of a area is known as grid. The different grid are inter connected to form a Regional grid. And different regional grid is further connected to form the national grid.

1951 → N.E  
+  
Eastern.

2003 → Western.

2004 → Northern grid



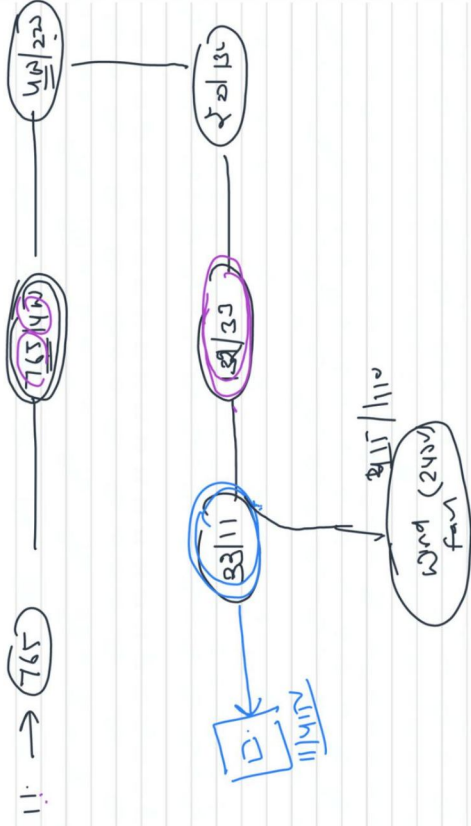


## Sub-station: →



The Main Role of Sub Station.

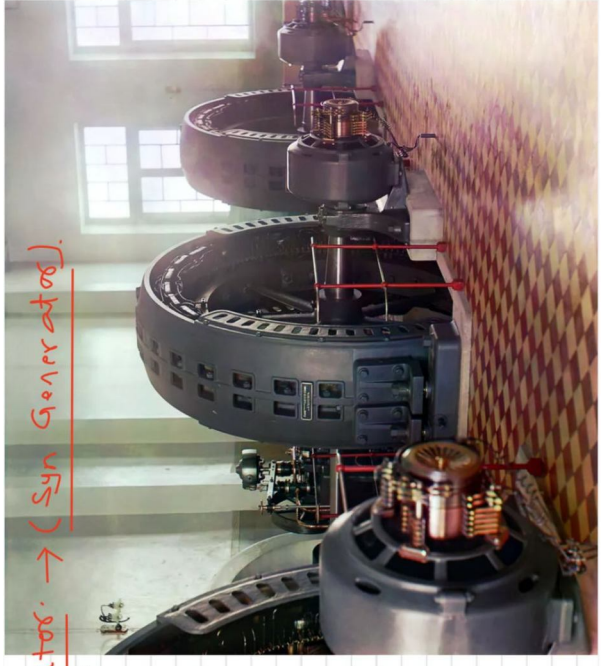
- To step down the voltage. ✓
- Protection of transmission system.
- Maintaining the voltage level (Reactor, cap Bank)
- To control the freq. (By load shedding)  
→ Data transmission for purpose of control & protection.



Type of substation. →

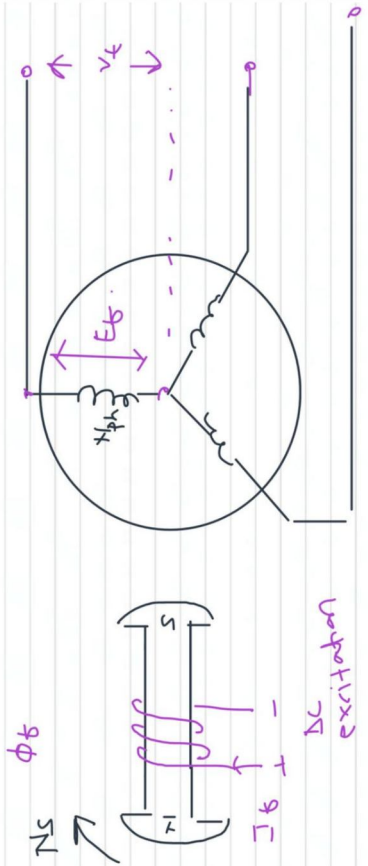
- 1) Primary Transmission S/S
- 2) Secondary Transmission S/S
- 3) Distribution S/S
- 4) Converter S/S. (HVDC)
- 5) Switching station. (S/S without transformer) (it operates at single voltage level).

- 6) Railway S/S
- 7) Collector S/S [wind farm/ solar farm]



Alternator. → (Syn Generator).





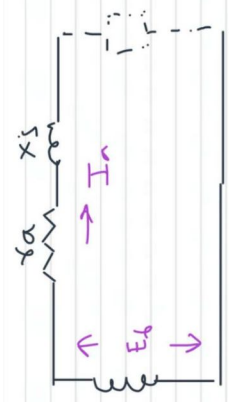
$$E_b (ph) = \sqrt{2} \pi f N_{ph} \phi_b k_w$$

$$\phi_b \propto I_f$$

$$k_w = \text{wdf factor}$$

→ By increasing field current ( $I_f$ )

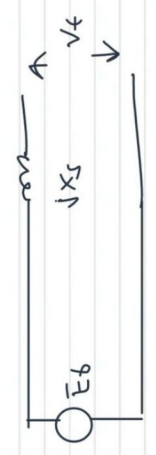
$I_f \uparrow$   
 $\downarrow$   
 $\phi_b \uparrow$   
 $\downarrow$   
 $E_b \uparrow \rightarrow V_t \uparrow$



$$r_a = 0.01 \text{ pu} \quad X_s = 1 \text{ pu}$$

$$X_s \gg r_a$$

so  $r_a$  is neglected,



→ The frequency of Induced EMF

$$f = \frac{P N \phi}{120}$$

→ By using speed governor we can change the speed of alternator so freq may be changed.