Basic Electrical Technology

[ELE 1051]

L25 - Electrical Power system components

Outline

Power System Components

- Generation
- Transmission, Distribution
- Protection & Control

Types of Loads

Power System Background

Branch of Electrical Sciences dealing with *Generation, Transmission* & *Distribution* of electrical energy.

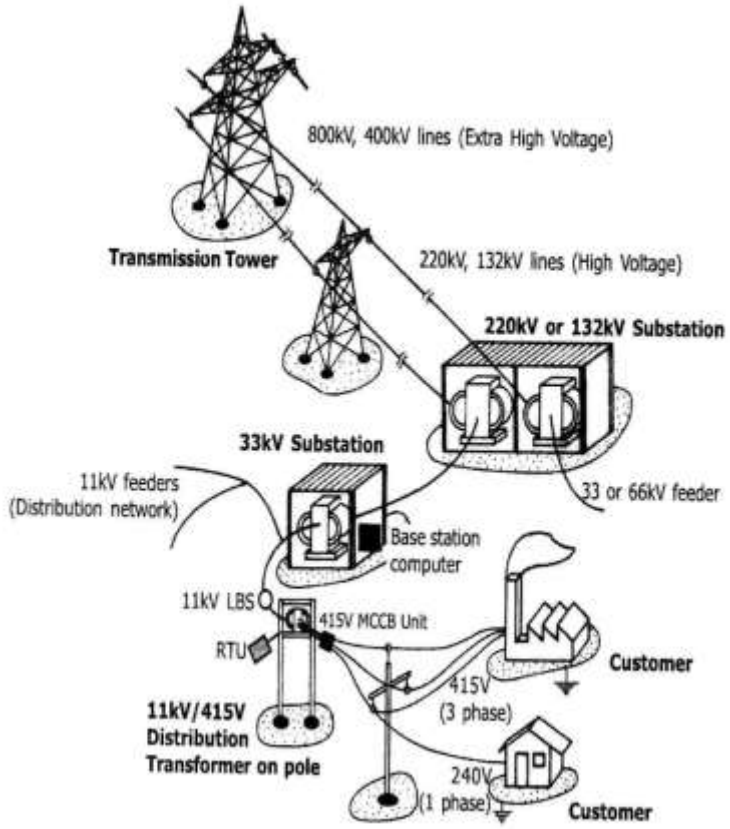
Pearl Street Station in New York City, 1882

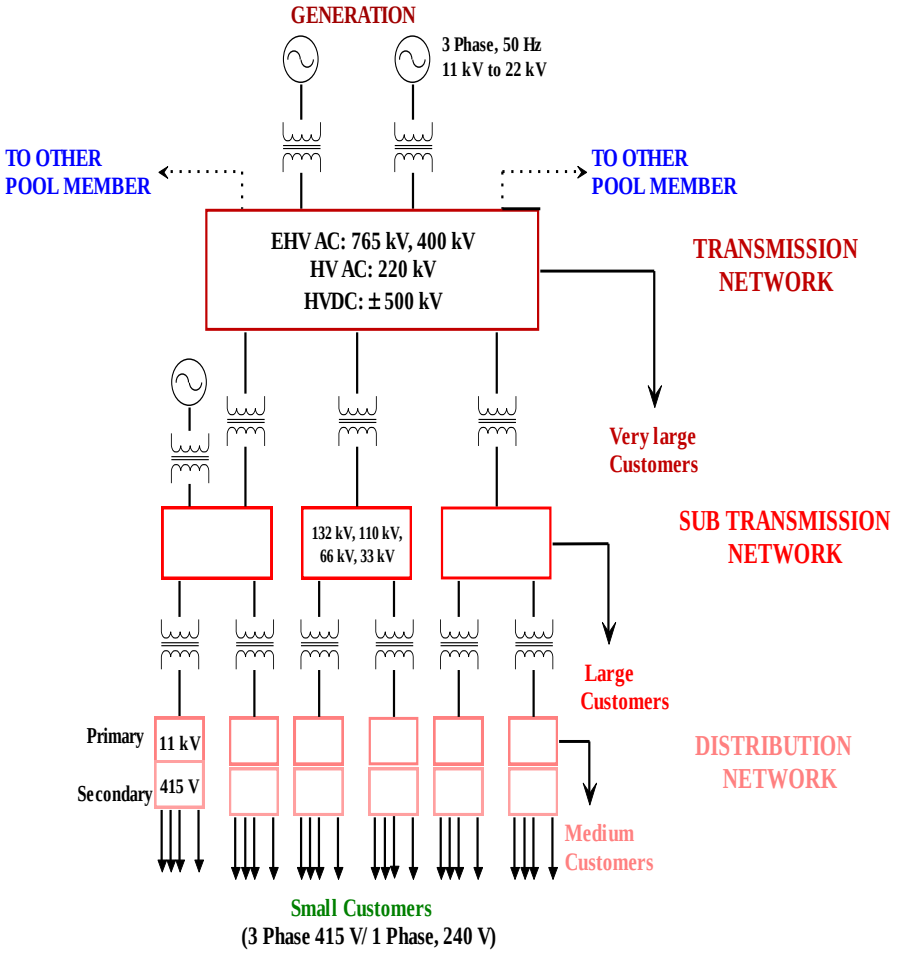
- "Illuminating Companies" by Thomas A Edison
- Concept of DC power generation

Three phase AC power system, 1896

- 2 generators and a transmission line @ 25 Hz.

Power System Structure





Courtesy: Olle I Elgerd

Power System Components

Generation subsystem

Transmission subsystem

Sub-transmission subsystem

Distribution subsystem

Protection and Control subsystem

Generation Subsystem

Primary Sources of Energy

- Fossil Fuel
  - Coal, Oil, Natural Gas
- Renewable Energy
  - Water, Solar, Wind, Tidal, Geo-thermal etc.
- Nuclear Energy

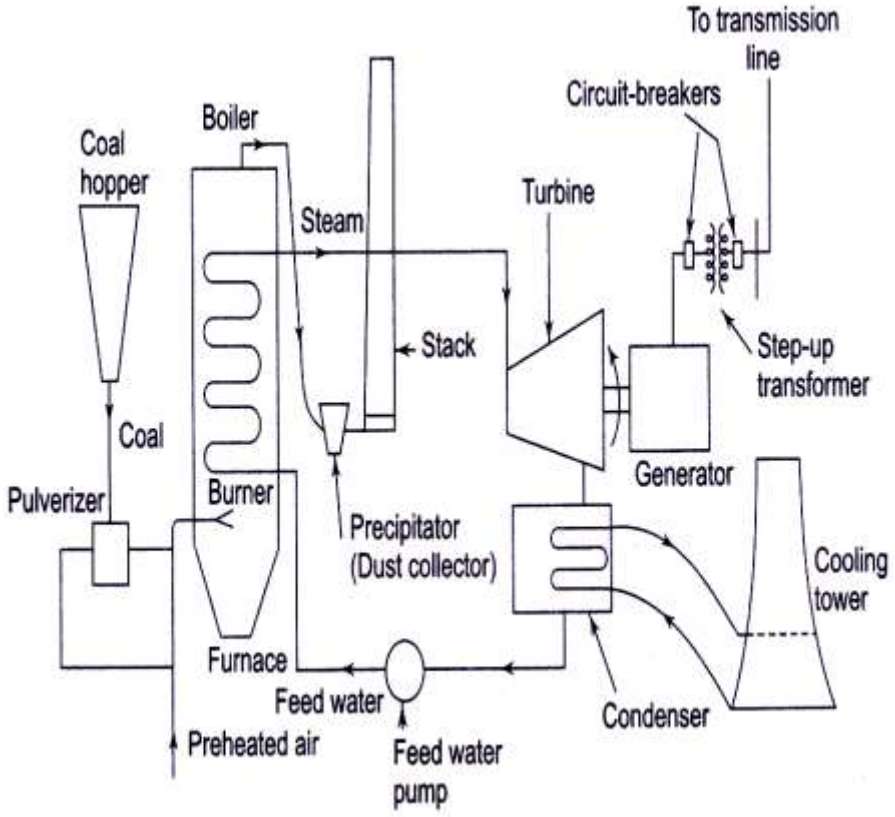
Generation Subsystem

Thermal Power Stations

- Coal Fired
  - Turbo alternators driven by steam turbine
- Oil Fired
  - Crude oil or Residual oil
- Gas Fired
  - Combined cycle- First stage: Gas turbine, Second stage: Steam Turbine
- Diesel Fired
  - IC engines as prime mover
  - Standby power plants

Generation Subsystem

Coal Fired Power plant



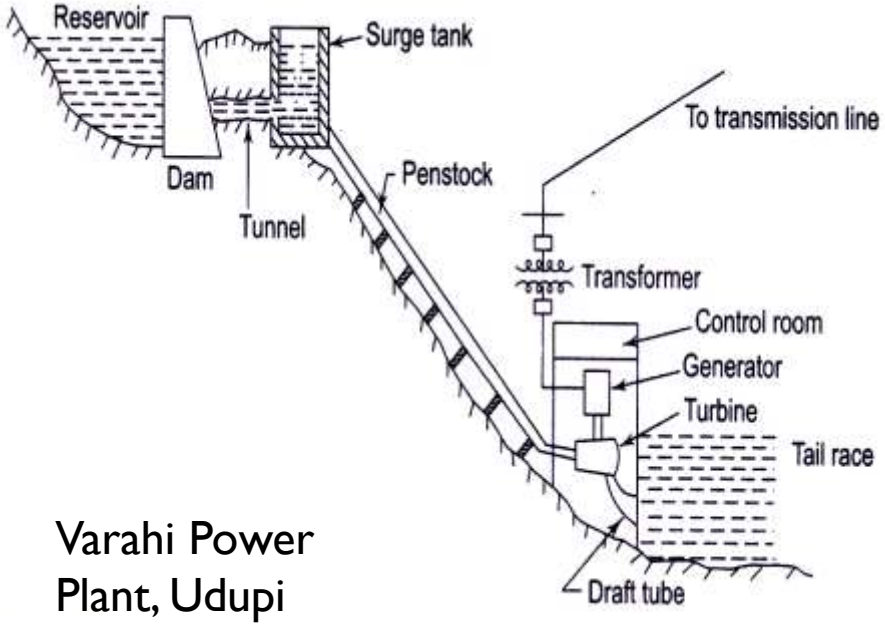
UPCL, Padubidri, Mangalore

Generation Subsystem

Hydroelectric Power Station

- Salient Pole alternators driven by turbines.
- Turbines: Impulse Turbine & Reaction Turbine
- Pumped storage plants

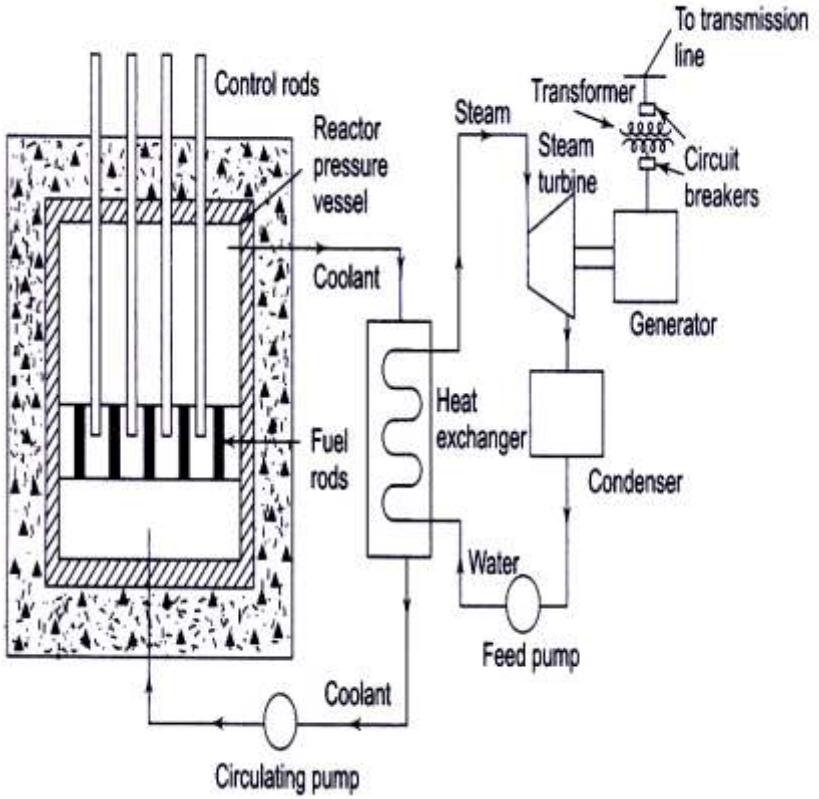
Varahi Power Plant, Udupi Dist.



Generation Subsystem

Nuclear Power Plant

- Fissile Material $^{235}_{92}U$, $^{239}_{94}Pu$
- Moderator
  - D2O, Graphite
- Control rods
  - Boron OR Cadmium
- Fast Breeder Reactors
  - Liquid metal (alloy of Na & K) is coolant



$$^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U - \beta \rightarrow {}^{239}_{93}Np - \beta \rightarrow {}^{239}_{94}Pu$$

Generation Subsystem

Non Conventional Power Stations

- Wind Power Stations
- Solar Power Stations
- Micro-Hydel Power Stations
- Bio-Mass Power Stations
- Geothermal Power Stations

Wind Farm in Karnataka

Solar Park, Charanka Village, Gujarat

1MW hydro plant, HP

Bio-mass Plant, Chattisgarh

Share of Renewable resources in India

Resource	Potential (MW)	Upto 9th Plan	Upto 10th Plan	11th Plan Target	Upto 30.09.10	Cumulative Achievement	12th Plan Projection (2017)	13th Plan Projection (2022)
Wind Power	48,500	1,667	5,427	9,000	4,714	12,809	27,300	38,500
Small Hydro Power	15,000	1,438	538	1,400	759	2,823	5,000	6,600
Bio Power	23,700	390	795	1,780	1,079	2,505	5,100	7,300
Solar Power	20-30 MW/sq km	2	1	50	8	18	4,000	20,000
Total		3,497	6,761	12,230	6,560	18,155	41,400	72,400

Source: Ministry of New & Renewable Energy, Govt. of India

Transmission, Sub-transmission & Distribution Subsystems

Transmission networks- EHV AC or HVDC

- Operates @765 kV/400 kV/ 220 kV AC or ± 500 kV DC.

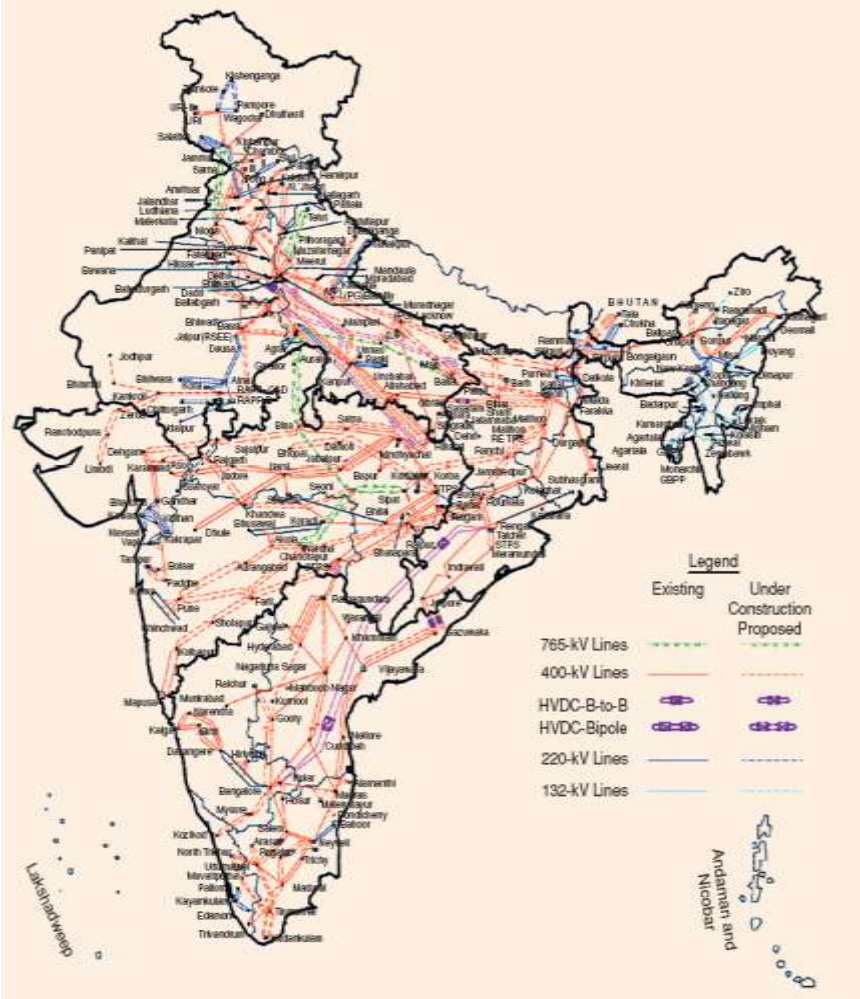
AC Sub-Transmission networks

- Operates @ 132 kV/ 110kV/ 66 kV/ 33 kV

AC Distribution Network

- Primary side: 11 kV
- Secondary side: 415 V, 4 Wire

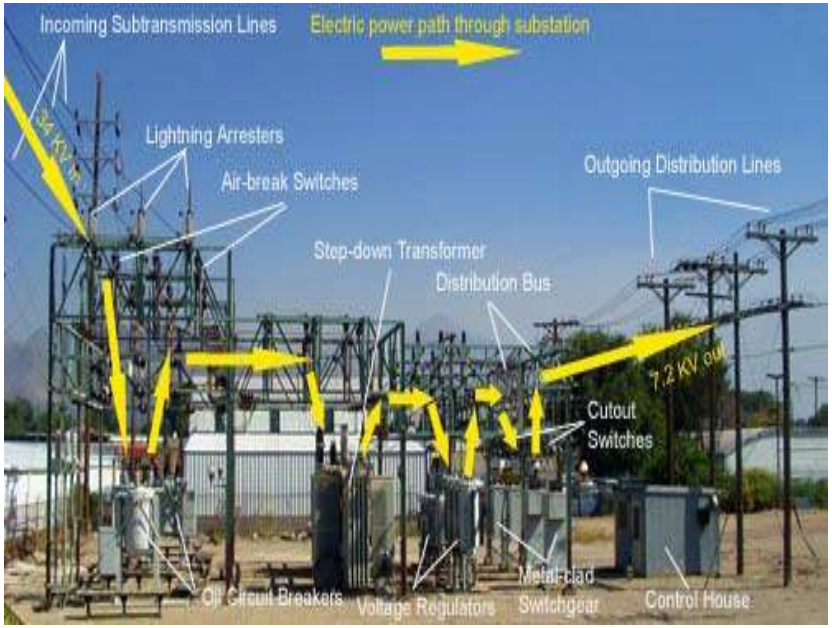
Transmission Network – A Glance



Substation

Substation Components

- Lightning Arrester
- Carrier line communication equipment (Wave Trap)
- Instrument Transformers (CT, PT)
- Circuit Breakers
- Isolators
- Bus Bars
- Power Transformers
- Control Room



Protection & Control Subsystem

Fail free power is *Hypothetical*.

Faults: Open Circuit & Short Circuit

Faults detection : *Relays*. Fault Isolation: *Circuit Breakers*

Modern Trend: Supervisory Control And Data Acquisition (SCADA) systems.

Types of Loads

Industrial Loads

- 3 Phase
- Complex Tariff Structure

Domestic Loads/Commercial Loads

- 1 Phase
- Tariff based on energy consumed- kWH

Domestic Loads and Power Ratings

Incandescent lamps - (5 W to 100 W)

Fluorescent lamps - (20 W & 40 W); CFL - (5 W to 25 W)

Air Conditioner (1.5 T) - 1800 W

Electric Iron - 750 W

Heaters/ Geysers – 2000 W

Ceiling Fan – 60 W

Washing Machine (with heater) – 2.5 kW

Refrigerator – 160 W

PC – 200 W, Laptop – 40 W

Reduce Electricity bill by minimizing the use of heating / environmental conditioning gadgets

Indian Power Sector – A Glance

Sector	MW	Percentage
State	93,540.70	37.4
Central	68,393.30	27.3
Private	88,322.96	35.3
Total	2,50,256.95	100.0

As on 31/07/2014

Source: Ministry of Power, Govt. of India

Indian Power Sector - A Glance

Fuel	MW	Percentage
Total Thermal	1,72,986.09	69.1
Coal	149,178.39	59.6
Gas	22,607.95	9.0
Oil	1,199.75	0.52
Hydro (Renewable)	40,798.76	16.3
Nuclear	4,780	1.9
RES*(MNRE)	31,692.11	12.7
Total	2,50,256.95	100

*RES include small hydro, bio-mass, urban and industrial waste power and wind energy

As on 31/07/2014

Source: Ministry of Power, Govt. of India

Summary

Detailed discussion of various power generating sources.

Different levels of voltages at transmission, sub-transmission and distribution stage.

Types of loads.

Indian Power Sector