History of the Development of Electric Power System and Indian Power Systems- An Overview

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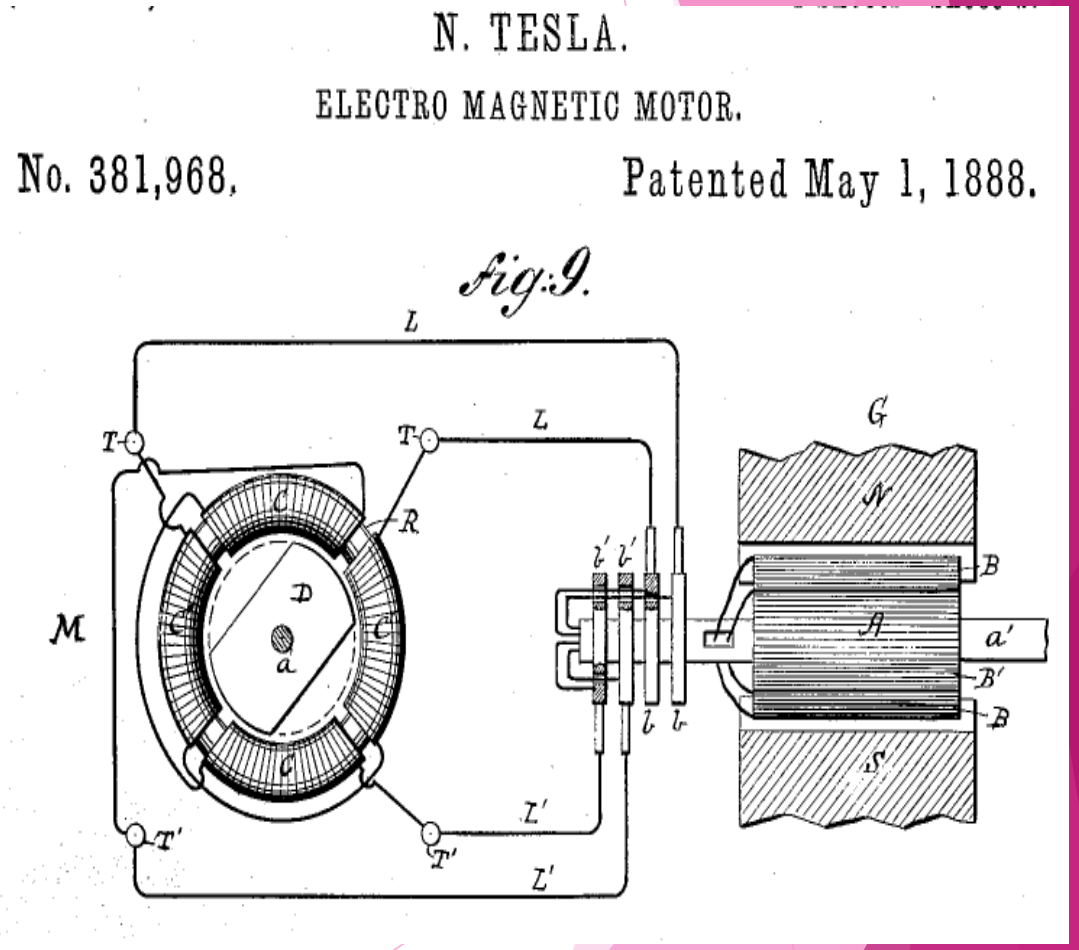
Interconnected Power Systems: Review

- Thousands of Generators operating in synchronism
- Over hundred thousands circuit kilometers of Transmission Lines over 230 kV
- Advantages of an interconnected system
  - Reliability/Continuity of service
  - Better economy

Brief History of Electric Power: Year 1880-1890

- Pearl Street dc system, USA, introduced by Thomas Edison in Manhattan supplying 59 customers
- Westinghouse/Tesla introduces AC system
- Tesla invents induction motor


N. TESLA.

ELECTRO MAGNETIC MOTOR.

No. 381,968. Patented May 1, 1888.

Fig. 9.

1884 Exhibition

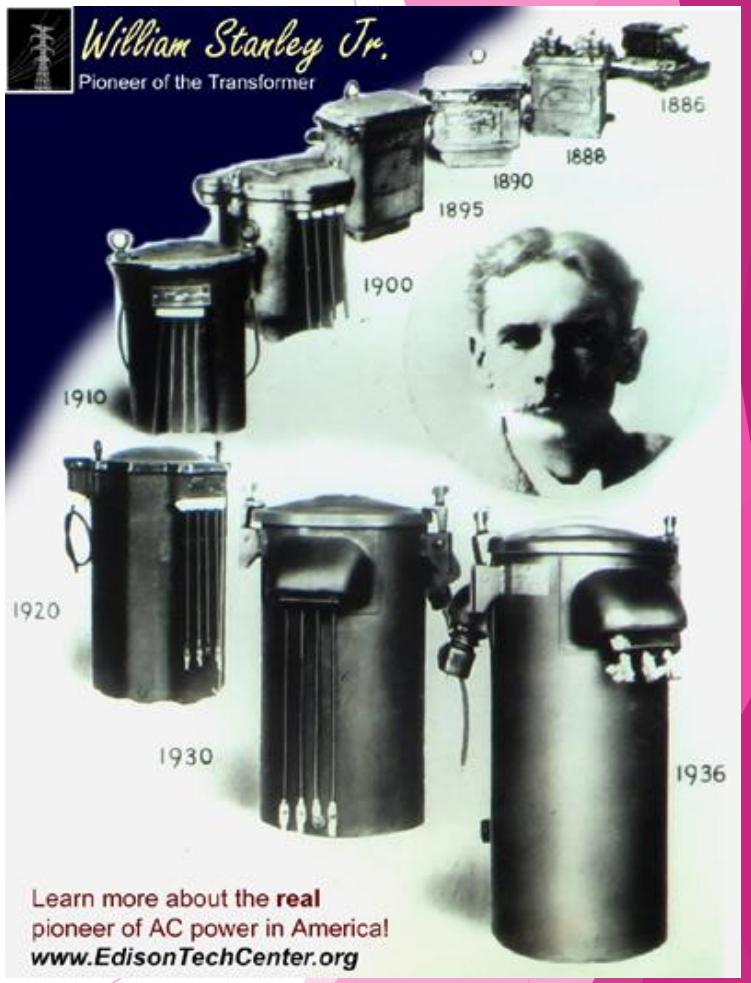
- An exhibition was created that highlighted Thomas Edison and reflected his highly developed ability to promote his inventions and products.
- The exhibition was featured with spectacular lighting displays powered by an impressive 100-kW “Jumbo” generator.

1884 Exhibition

- Edward Weston's dynamos and lamps were featured in the United States Electric Lighting Company's display. Weston's well known collection of scientific instruments was also shown.
- Other prominent exhibitors included Frank Sprague, Elihu Thompson, and the Brush Electric Company of Cleveland.
- The American Institute of Electrical Engineers (AIEE) held its first technical meeting.

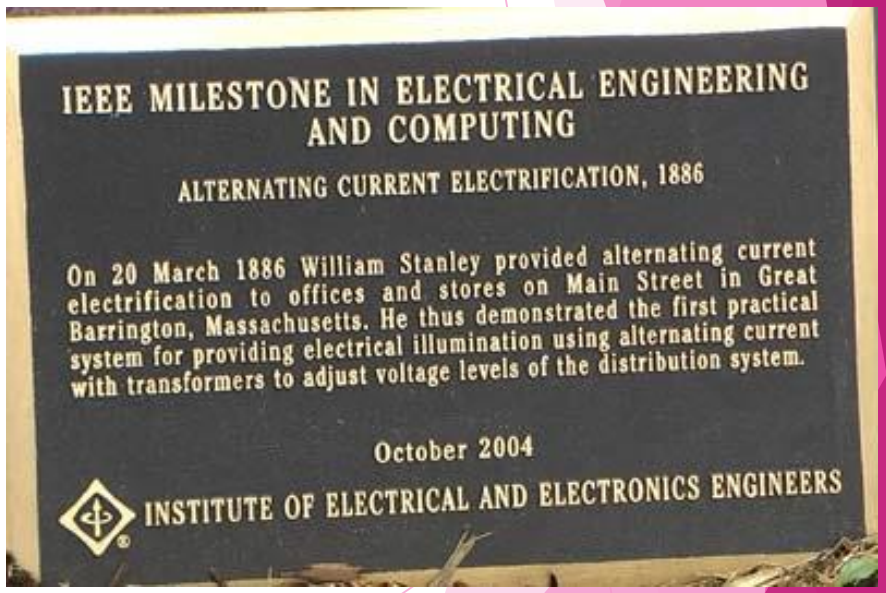
Brief History of Electric Power

- 1884 – Sprague produces practical dc motor
- 1885 – invention of transformer (http://www.edisontechcenter.org/Transformers.html)
- 1893 – First 3-phase transmission line operating at 2.3 kV

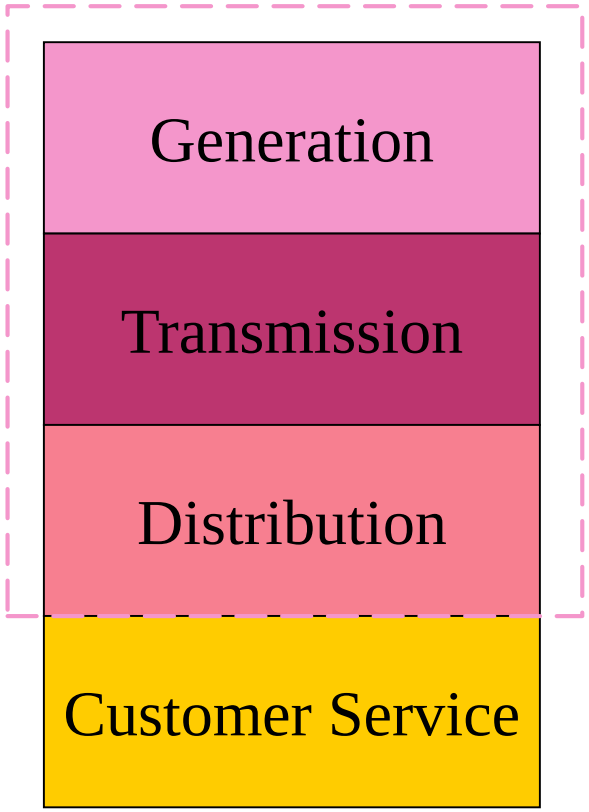


History of Electric Power

- 1896 – AC lines deliver electricity from hydro generation at Niagara Falls to Buffalo, 20 miles away
- Early 1900's – Private utilities supply all customers in area (city); recognized as a natural monopoly;
- By 1920's – Large interstate holding companies control most electricity systems



Vertical Monopolies



- Within a particular geographic market, the electric utility had an exclusive franchise
- The utility had the obligation to serve all existing and future customers.
- In India, every state had a utility called state electricity board to generate, transmit, and distribute the power to its all customers.

Problems with the Vertical Monopoly

- Each utility was enjoying monopoly in the service area
- There was no competitions among the neighboring utilities
- Private investors were least interested in power business
- The return on the utility's investments is regulated by the government.

Restructuring of Power Industry

- The prime goal is to separate out the activities of generation, transmission, and distribution.
- Each utility is reformed with three companies, namely GENCO, TRANSCO, and DISCOM; each operates independently.
- The competition is introduced specifically in generation and distribution sectors by allowing other private participants.

Utility Restructuring

- Driven by significant regional variations in electric rates
- Goal of competition is to reduce rates through the introduction of competition
- Eventual goal is to allow consumers to choose their electricity supplier

History of restructuring power industry in different countries*

- 1982 Chile
- 1990 UK
- 1992 Argentina, Sweden & Norway
- 1993 Bolivia & Colombia
- 1994 Australia
- 1996 New Zeeland
- 1997 Panama, El Salvador, Guatemala, Nicaragua, Costa Rica and Honduras
- 1998 California, USA and several others.

**A. R., Abhyankar and S.A. Khaparde, "Introduction to Deregulation in Power Industry"*

Restructuring power industry in India

- Indian power industry is restructured with the implementation of Electricity act 2003.
- The implementation of the act eliminates the licensing of setting up a generation plant.
- It imposes open access of transmission capacity.
- It enables to have more than one license in a geographical area.

History of the evolution of Indian Power System

1897-98	First hydro (130 kW) Darjeeling / thermal (1MW) in Calcutta by CESC.
1910	Indian Electricity Act 1910 enacted to regulate supply by the Licensees to the consumers.
1948	Indian Electricity (Supply) Act 1948' (ES Act). Formation of State Electricity Boards with full powers to control generation, distribution and utilization of electricity within their respective states and Central Electricity Authority for planning and development of power system.
1964	Five Regional Electricity Boards (REBs) were formed by the Government of India with the concurrence of State Governments with a view to ensure integrated grid operation and regional cooperation on power.
1976	Creation of Central Generating Companies for development of super thermal power stations at coal pit heads and large hydroelectric stations leading to creation of NTPC, NHPC, NPC, NLC & NEEPCO.

Data Curtsey: http://www.powersector.in/market-dynamics

History of the evolution of Indian Power System

1991	ES Act 1948 amended to pave the way for the formation of private Generating companies. CEA empowered to fix the norms for determining the tariff of all generating companies. RBI allows 100% foreign investment in power sector without any export obligations.
1992	First Gazette Notifications on the criteria for fixing the tariff for sale of electricity by the Generating companies to SEBs or any other agency.
1998	Electricity Regulatory Commission Act 1998 enacted paving the way for the formation of Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERC). Regulatory power of the State governments transferred to SERC. Consequently, Tariff regulatory function of CEA transferred to CERC.
1998	Act amended to provide for of Central Transmission Utility (CTU) and State Transmission Utilities (STU).
2003	Electricity Act 2003 enacted by the Parliament.

Data Curtsey: http://www.powersector.in/market-dynamics

Power System: Definition

Section 8(A) Electricity Supply Act 1948, amendment 1976:

"power system" means a system under the control of the Government or any Board or Generating Company or other agency and having one or more –
(i) generating stations; or
(ii) main transmission lines and sub- stations; or
(iii) generating stations and main transmission lines and sub-stations;

Power System: Definition

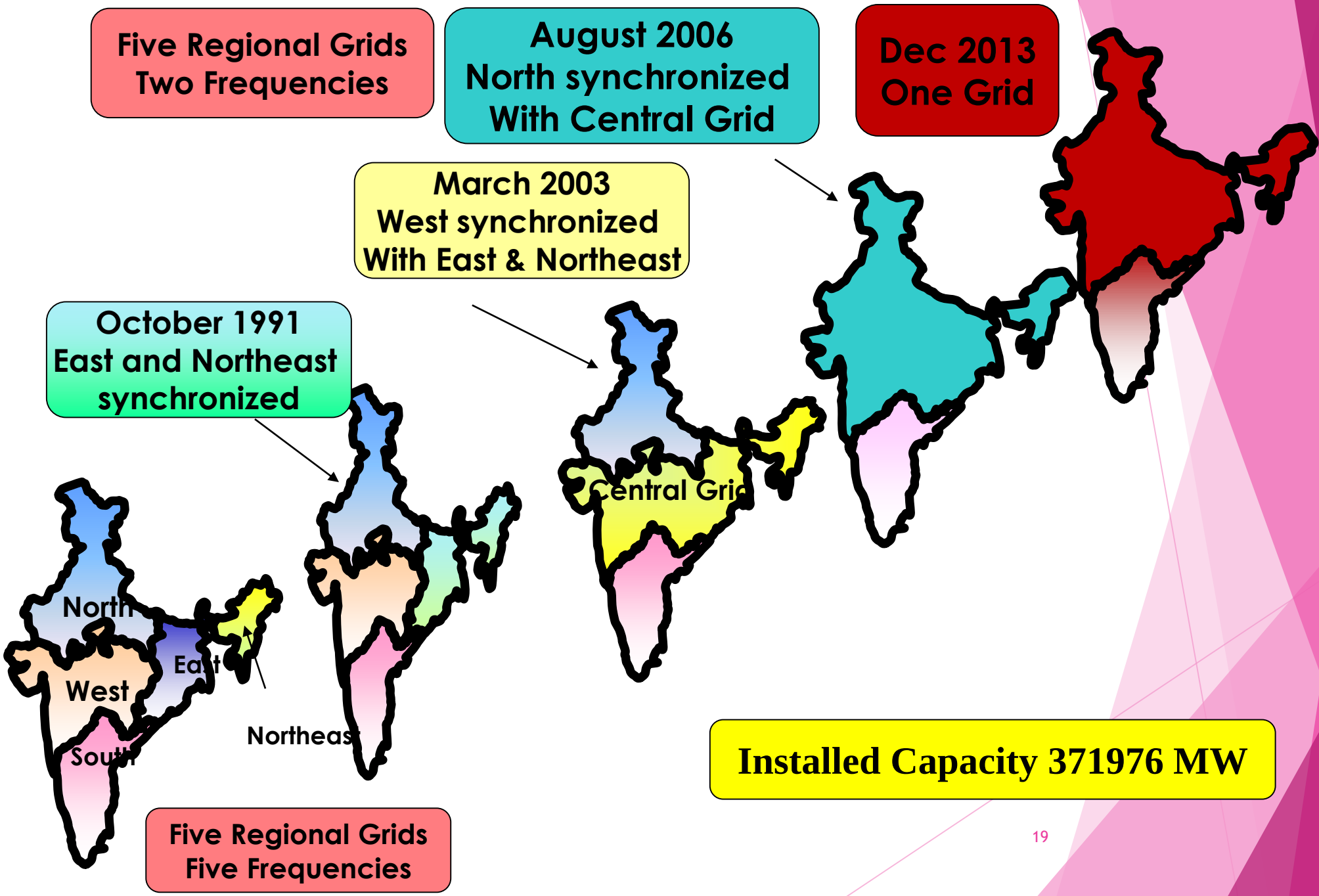
Section 2(50) Electricity Act 2003:

"power system" means all aspects of generation, transmission, distribution and supply of electricity and includes one or more of the following, namely:--

(a) generating stations;
(b) transmission or main transmission lines;
(c) sub-stations;
(d) tie-lines;
(e) load despatch activities;
(f) mains or distribution mains;
(g) electric supply-lines;
(h) overhead lines;
(i) service lines;
(j) works;

Indian National Grid: Transformations

- Grid management on regional basis started in sixties.
- Initially, State grids were inter-connected to form five regional grids namely Northern (NR), Eastern (ER), Western (WR), North Eastern (NER) and Southern (SR) regional grid.
- In October 1991, North Eastern and Eastern grids (ER-NER) were connected.
- In March 2003, Westerns and ER-NER were interconnected .
- August 2006, North and East grids were interconnected thereby 4 regional grids NR, ER, WR and NER grids are synchronously connected forming central grid operating at one frequency.
- On 31st December 2013, Southern Region (SR) was connected to Central Grid in Synchronous mode with the commissioning of 765kV Raichur-Solapur Transmission line thereby achieving 'ONE NATION'-'ONE GRID'-'ONE FREQUENCY'.


Five Regional Grids
Two Frequencies
August 2006
North synchronized
With Central Grid
Dec 2013
One Grid
March 2003
West synchronized
With East & Northeast
October 1991
East and Northeast
synchronized
Central Grid
North
East
West
Northeast
South
Five Regional Grids
Five Frequencies
Installed Capacity 371976 MW

Thank you…