

EEE-102 Basic Electrical Engineering

Spring 2024-25

Instructors: Anubrata Dey (Coordinator), Sohom Chakrabarty, Jeevanand S & Parikshit Pareek

Department of Electrical Engineering, IIT Roorkee

Course Overview

- ▶ Basics of Generation Transmission & Distribution
 - ▶ Basics of Control Systems
 - ▶ Direct Current (DC) Circuit Analysis
 - ▶ Network Theorems
 - ▶ Alternating Current (AC) Circuit Analysis
 - ▶ Basics of Measurement
 - ▶ Direct Current (DC) Machines
 - ▶ Alternating Current (AC) Machines
- **Practical Sessions:** Room 111, Electric Science Lab, Ground Floor, EE Building
- Let's ensure we wear **SHOES** in the lab.

Evaluation Policy

Type	CWS	PRS	MTE	ETE
Total Marks	15	20	25	40
Components	Final Quiz Classroom Conduct Individual Faculty Components	Final Quiz Lab Attendance Lab Viva & Reports	Written — —	Written — —

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- Each ‘Instructor’ will announce — [Individual Faculty Components](#) if any
- Rest components remain same for entire course.

Logistics— Generation, Transmission & Distribution (GTD) Part

- ▶ **Instructor:** Parikshit Pareek (pareek@ee.iitr.ac.in)
 - ▶ Course Website (For GTD Part): <https://psquare-lab.github.io/teaching>
 - ▶ Office Hours: Friday 1400-1500 Hrs.
 - ▶ Assignments: None.
 - ▶ Home Works: **No Submission Needed**, but **Part of Syllabus & Questions might appear in exams**
 - ▶ One Surprise Quiz (May Be)– In Class or Tutorial – CWS Instructor Policy
 - ▶ Mode of Teaching: Slides + Board
 - ▶ **Note: Not everything will be on slides.**

Prerequisites

- ▶ High School Physics– NCERT 12th Class Physics I
- ▶ Common Sense!

Why Should I Study EEE102 as a Non-EE B.Tech Student?

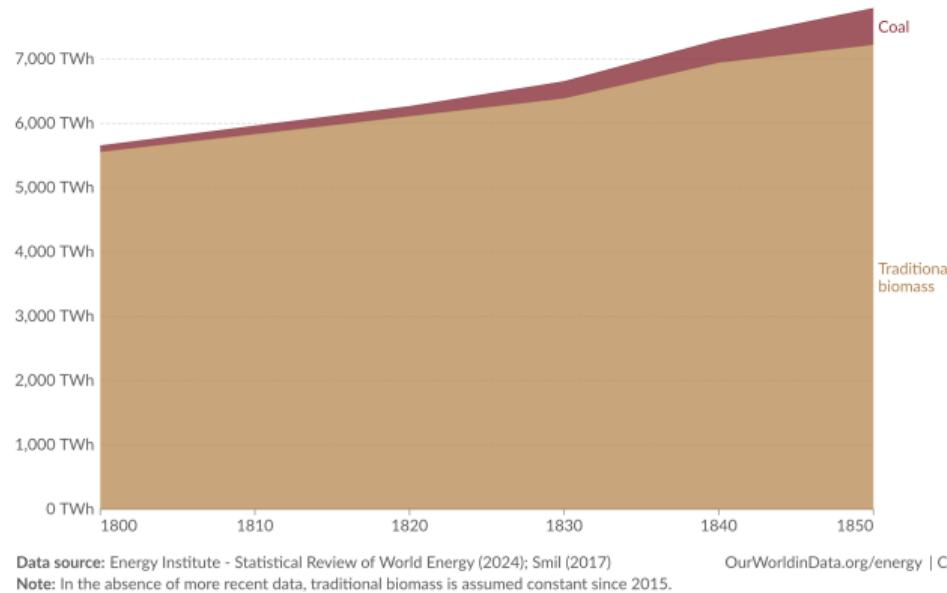
- ▶ World runs on Electrical Energy— So are/will your lives.
- ▶ Daily Life Relevance
- ▶ Jobs, and Career
- ▶ Life Journeys are Non-Linear: Hard to predict what knowledge is needed when.
- ▶ Meta Learning— Learning how to learn a new thing.

Note

This is not a Physics course but an **Engineering Class**, where the focus is primarily on **Systems & their Applications/Implications**, rather than delving deeply into first principles.

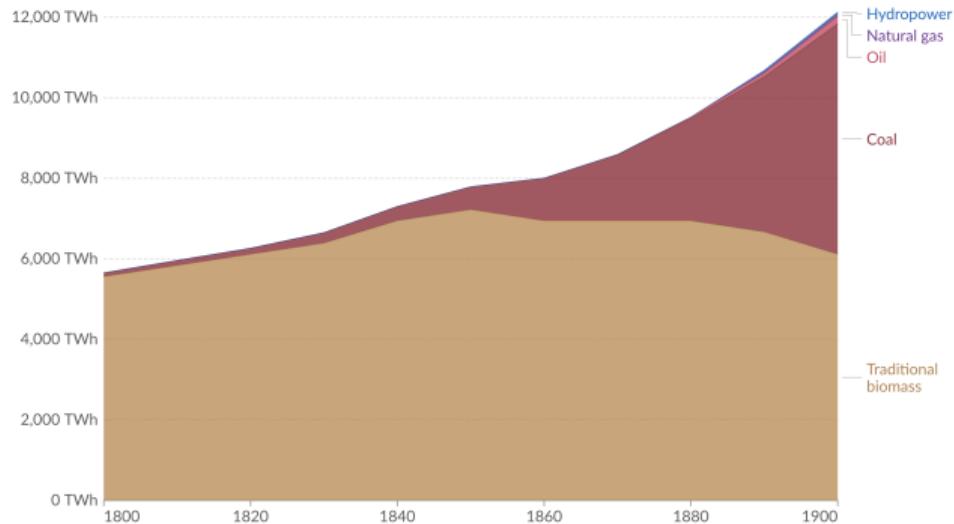
Why we need Energy? And How Much?

To Run Our Lives, To Get Work Done



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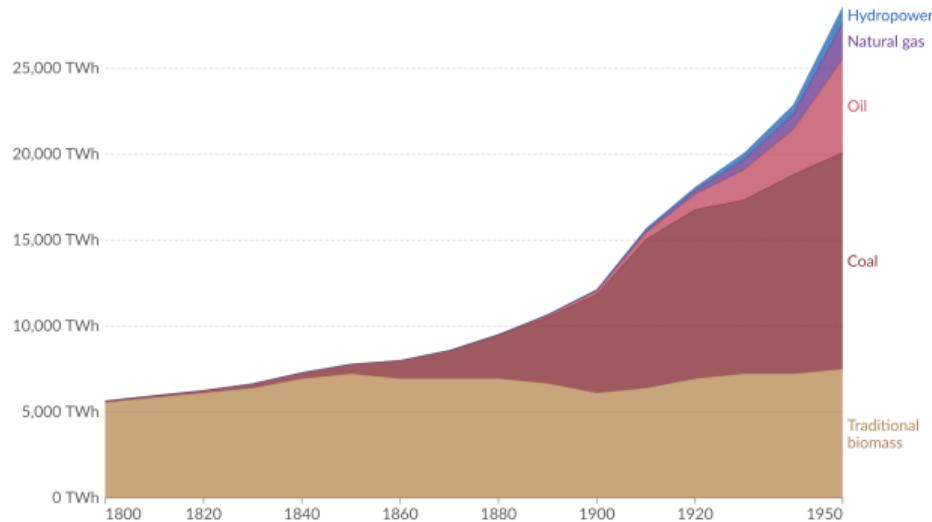
Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017)

Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

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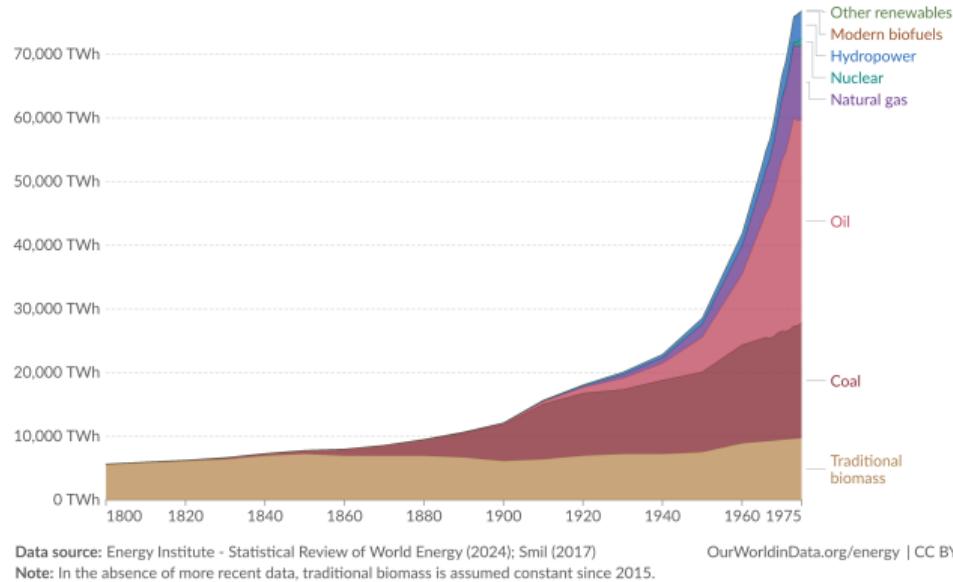
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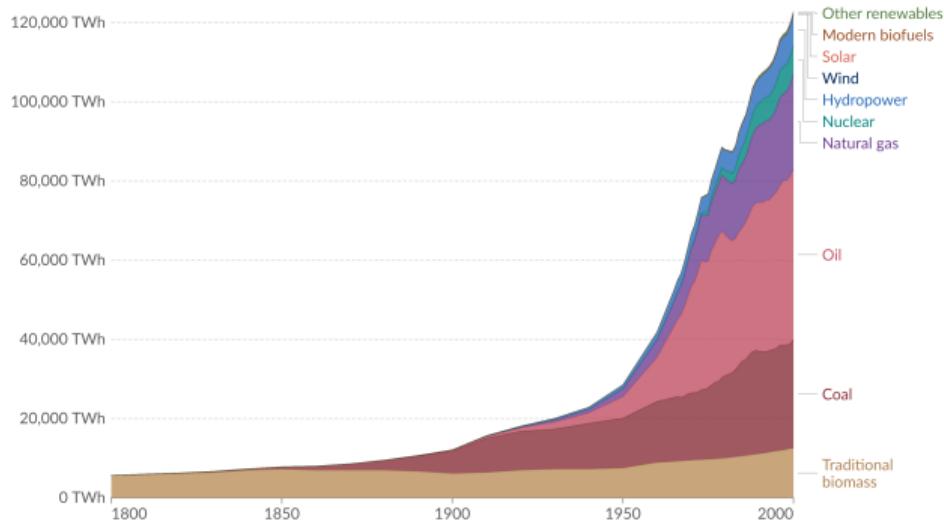
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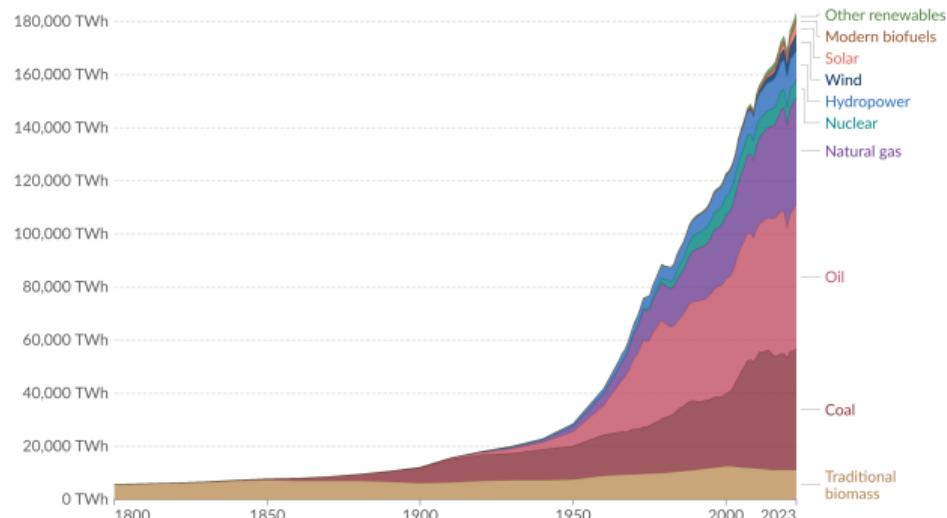
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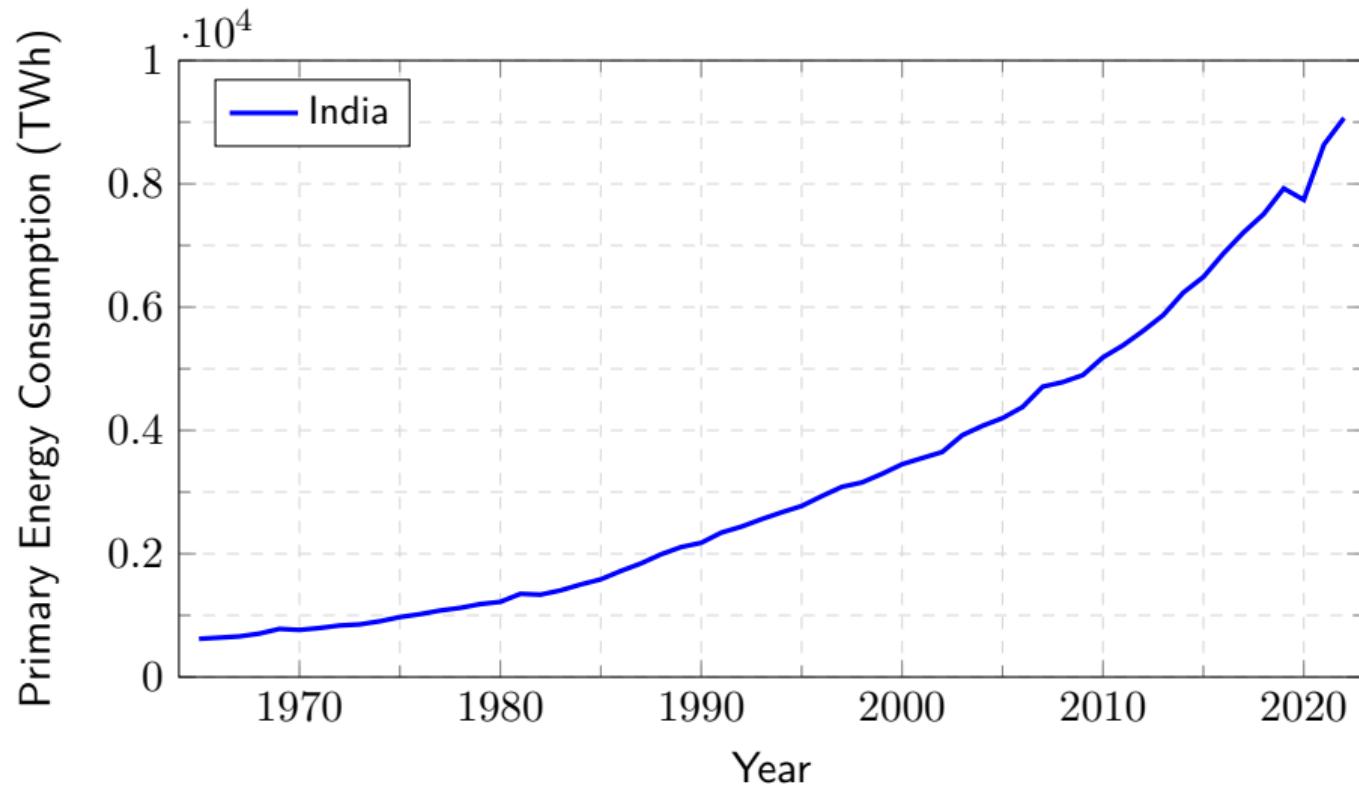


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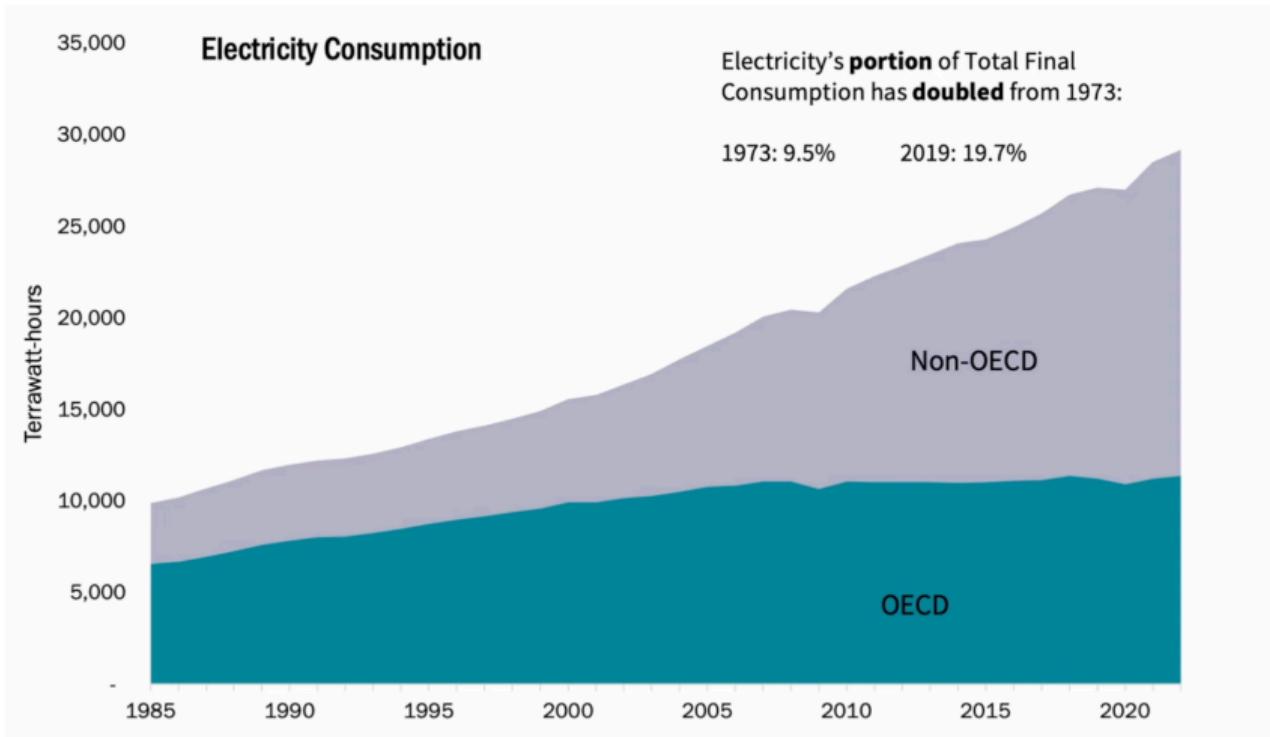
Indian Story: Primary Energy



Electricity - A Versatile Energy Currency

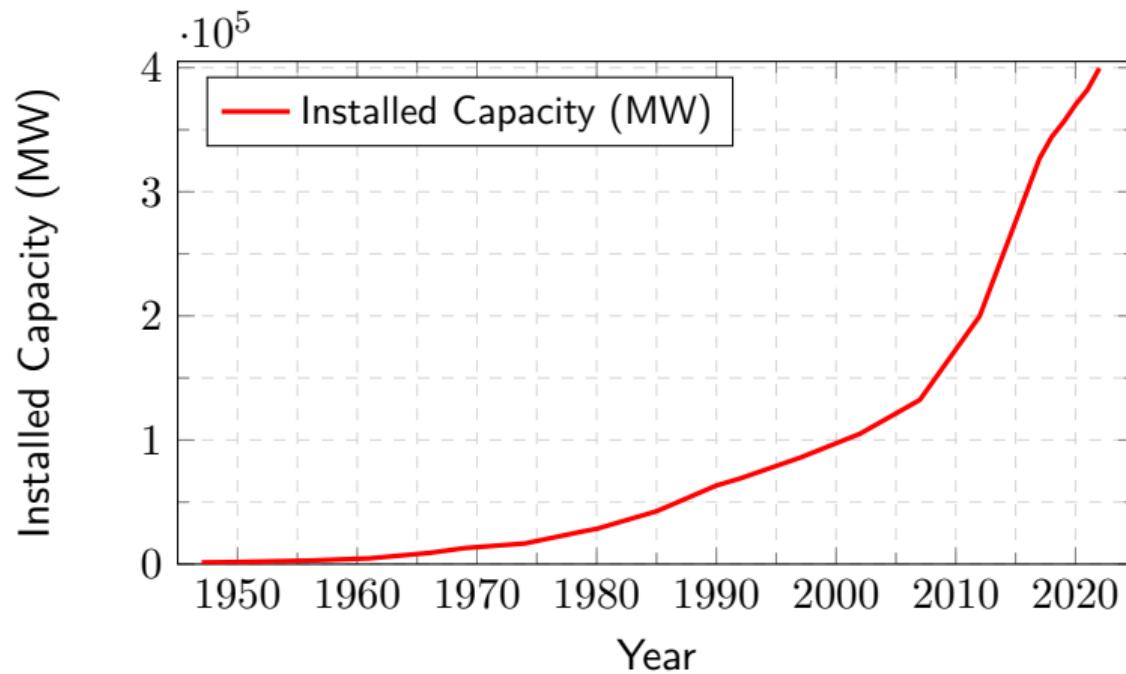
- ▶ **Energy Currency or Secondary Energy**
- ▶ **Fossil Fuels reign supreme**
- ▶ **Electricity unlocks the potential of many resources**
- ▶ **Air Pollution and Environment**
- ▶ **Efficiency**
- ▶ **Key Considerations:**
 - Real-time Balance*
 - Limited Storage*
 - Need for Reserves & Backup*
 - Value Beyond Cost*

Growth of Electricity Consumption



Source: Energy Institute Statistical Review of World Energy, 2023

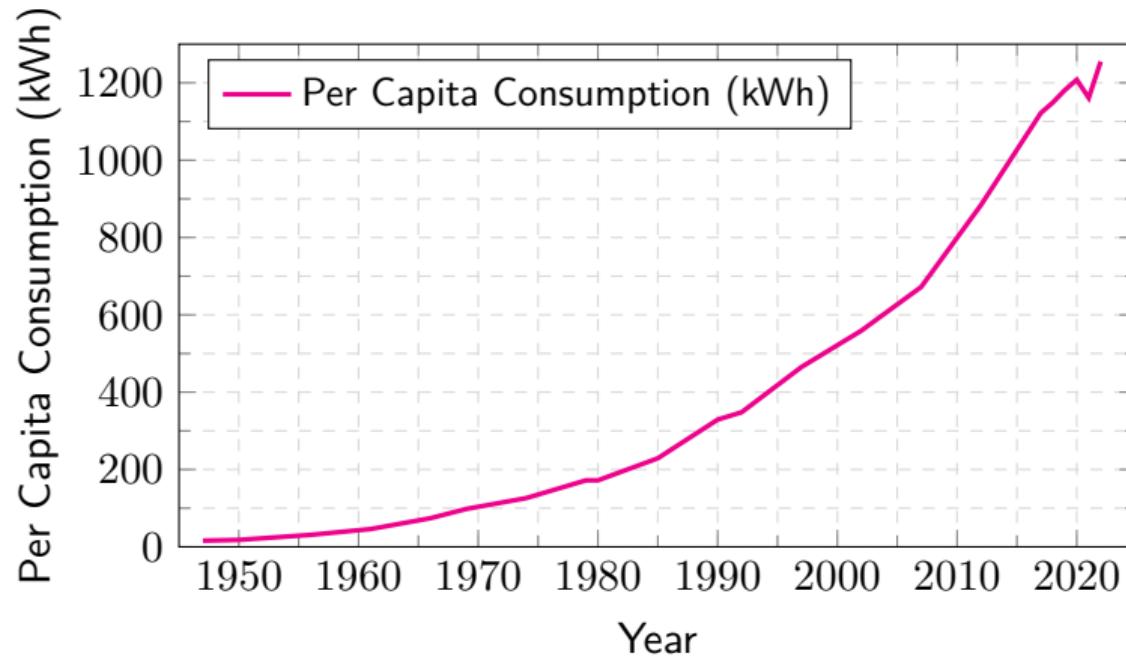
Indian Story: Electrical Energy



Data Source:

https://cea.nic.in/wp-content/uploads/pdm/2023/02/Growth_Book_2022_PDF.pdf

Indian Story: Per Capita Consumption



What does Per Capita Consumption Tells Us?

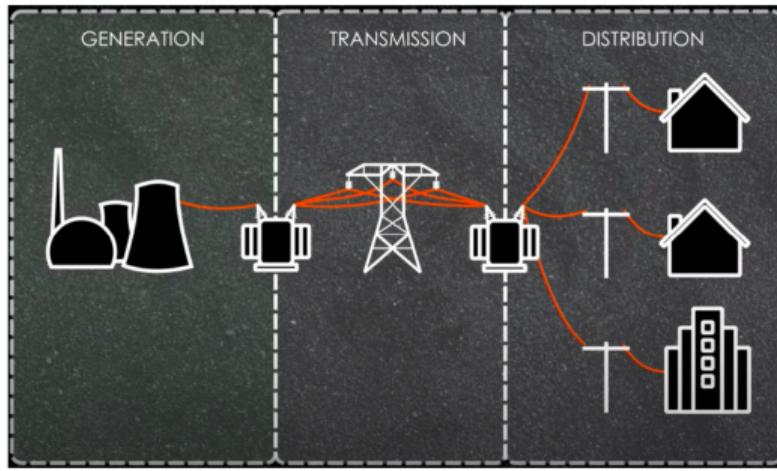
Nation's Economic Prosperity \propto Per Capita Consumption

Timeline of Energy Developments

- 1882 Edison established the first centralized power plant at Pearl Street Station, NYC.
- 1893 Westinghouse lit the Chicago World's Fair using an AC system.
- 1893 California's first 22-mile AC transmission line connected Folsom Powerhouse to Sacramento.
- 1921 Pulverized coal-fired power plant began operation in Wisconsin.
- 1939 First gas turbine for electricity debuted in Neuchatel, Switzerland.
- 1953 England ordered its first nuclear power station.
- 1965 First combined-cycle power plant achieved 40% efficiency, producing 13 MW.
- 2015 GE set 61.4% efficiency in combined-cycle power (592 MW).
- 2024 Siemens achieved 64.18% efficiency in combined-cycle power plants, new record.

The Grid

- ▶ Power grid is a system that makes sure electricity travels safely & reliably over long distances to reach everyone who needs it.
- ▶ A giant network of wires & equipment that brings electricity
 - From where it's made—like power plants or solar farms – **Generation**
 - To our homes, schools, and businesses – **Demand**



Generation

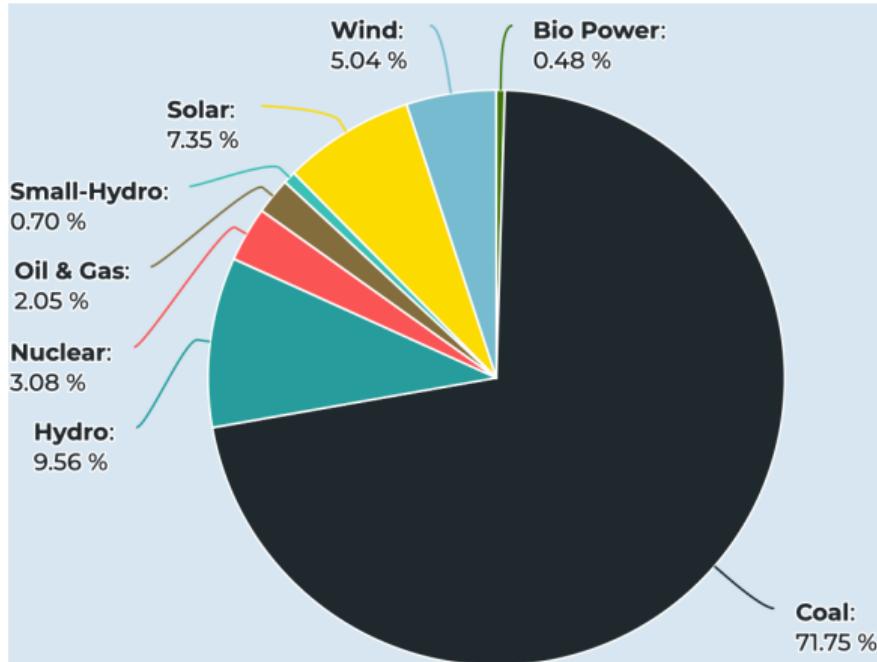


Figure: India's Power Generation Source Mix with Total 1231BU (as of 30th November)

Recap: Faraday's Law

- Change in Magnetic Flux induces in Electric Field or EMF.
- Check out these if you need to.
- https://phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_en.html
- <https://www.youtube.com/watch?v=Y86JAdBnqZA>

Generation– Almost All Except One

- ▶ Principle of Energy Conservation- **Conversion** is the Key
- ▶ Energy Balance Equation = Function(Input,Output,Stored,Losses):
- ▶ ElectroMechanical Conversion
 - Electrical Energy \iff Mechanical Energy
 - Reversible Means of Energy Flow via Magnetic Field
- ▶ Generic Electric Power Generation Process

$$\begin{bmatrix} \text{Electrical} \\ \text{System} \end{bmatrix} \iff \begin{bmatrix} \text{Coupling} \\ \text{Field} \end{bmatrix} \iff \begin{bmatrix} \text{Mechanical} \\ \text{System} \end{bmatrix}$$

Homework- Part of Syllabus

- ▶ Go through Indian Grid Numbers:
<https://iced.niti.gov.in/energy/electricity/generation>
- ▶ Try and identify one interesting data point related to your home state's power generation data
- ▶ Reading about energy losses across supply chain and solve substitution method numerical– [Document on Course Webpage](#).
- ▶ Watch this coal power plant video:
<https://www.youtube.com/watch?v=2IKECt4Y3RI&t=1s>

Additional Readings- Not Part of Syllabus

- Read [History of Electric Power in India \(1890 – 1990\)](#)