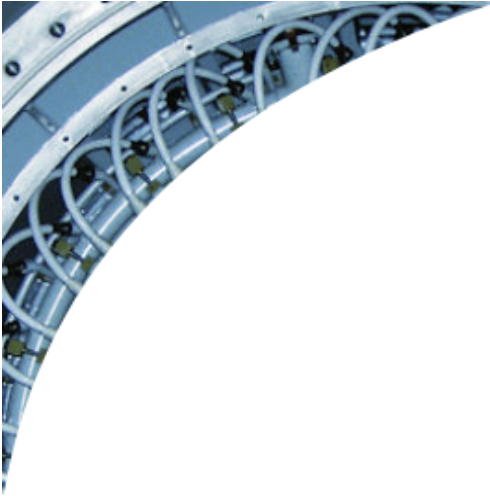




# Introduction to Power Systems

- Energy
- Transmission systems
- Three phase power systems
- Measurement of power in three phase systems



# Introduction to Power Systems

## ENERGY



# Energy: System Viewpoint

- Introduction
- Types of Energy
- Sources of Energy
- Conversion of Energy & Power
- Storage of Energy
- Transmission of Energy
- Role of Electric Power
- Competitive Uses of Natural Sources



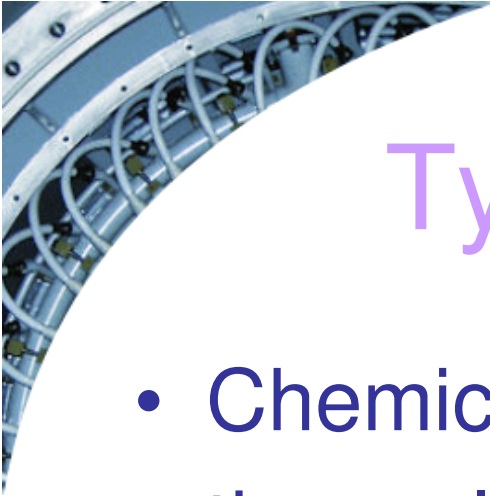
# Introduction

- Energy is essential for life
- Energy also determines quality of life
  
- There many sources of energy
- There many uses of energy
  
- thus NEEDS/REQUIREMENTS vs SOURCES



# Types of Energy & Power

- “Capacity to do work”
- Energy  $\gg$  Power
  
- Energy: term relevant for storage
  - *oil tanker, coal mine, water reservoir etc*
- Power: term relevant for flow of energy
  - *rotating shaft, electric cable, gas pipe-line etc*



# Types of Energy & Power

- Chemical & nuclear energy
- thermal energy
- potential & kinetic energy
- strain & pressure energy
- electric & magnetic energy
- mechanical power
- electric power



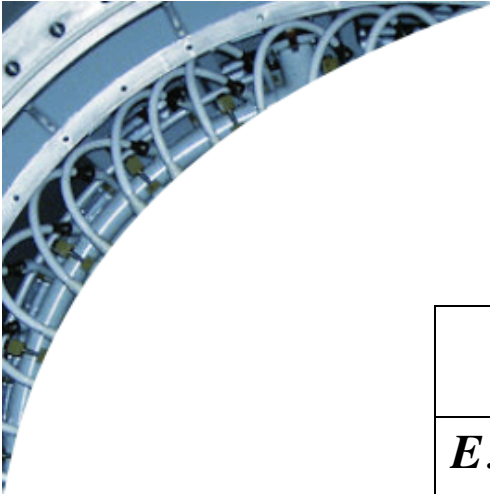
# Sources of Energy

- Renewable

- wood
- solar
- hydropower
- wind power
- specific
  - biomass
  - geothermal
  - tidal

- Non-renewable

- coal
- oil
- natural gas
- nuclear fuel



	<b>Renewable</b>	<b>Non Renewable</b>
<b>Examples</b>	Solar, biomass, wood, hydro, wind, tidal, geothermal.	Coal, oil, gas
<b>Location</b>	Natural local environment	Relatively concentrated regions
<b>Availability</b>	A given average power	A given amount of stored energy
<b>Life time of supply</b>	No limit	Coal: 100-1000 years; oil: 10-100 years
<b>Cost</b>	High capital, but low running costs	Oderate to high capital; moderate running costs

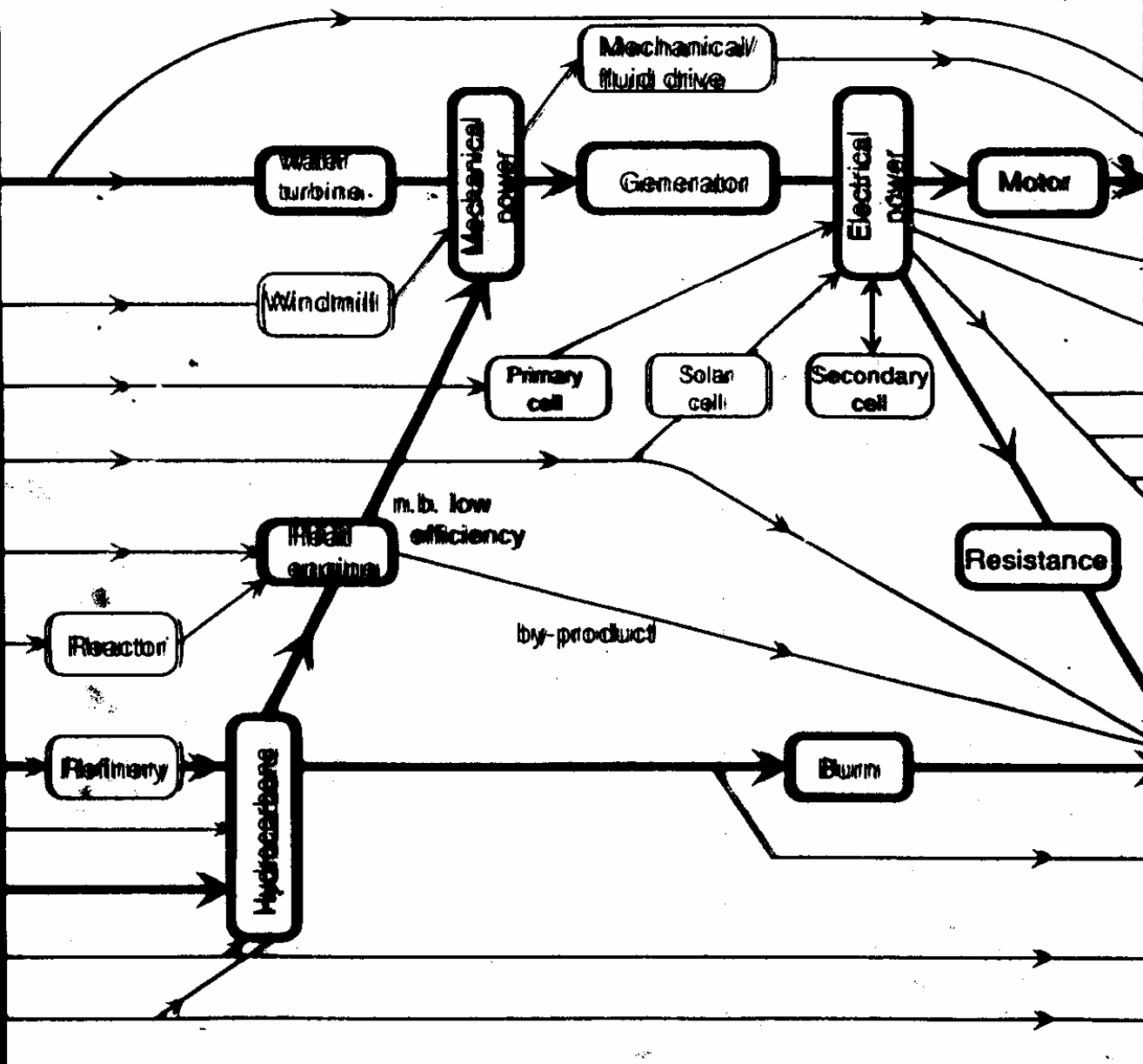


# Energy Conversion

- “law of conservation of energy”
- Examples
  - *chemical to thermal*
  - *thermal to mechanical*
  - *potential to kinetic to mechanical*
  - *mechanical to electrical to mechanical*
  - *electrical to thermal to electrical*
  - *electrical to chemical to electrical*

# Energy conversion

Energy sources		
Renewable ?	No	Yes
HYDRO	Water turbine	Yes
	Windmill	Yes
Wind	Windmill	Yes
	Primary cell	No
Chemical	Solar cell	Yes
	Secondary cell	No
Solar	Heat engine	No
	Resistance	No
Waste heat	Reactor	No
	Refinery	No
Nuclear	Hydrocarbons	No
	Burner	No
Oil	Heat	No
	Chemical	No
Gas	Food	No
	Construction	No
Coal	Biomass	Yes
	Wood	Yes



Man's needs	
Energy	Other
	Irrigation
Mechanical	
Electrolysis	
Lighting	
	Communications
	Measurements
	Computing
	Control
Heat	
	Chemical
	Food
	Construction



# Storage of Energy

- **Intermittent Supply**

- solar -charge batteries
- wind -fill up water resv
- river - lake
- petrol eng.-flywheel
- dc - capacitors/induct
- oil tankers
- mech spring

- **Intermittent Demand**

- pneumatic drill
- starter motor-battery
- “pumped storage”
- steam pressure in boiler
- capacitors - high spark discharge

. **Emergency Use: examples**



# Transmission of Energy

⇒ Geographical & geological features of the earth determine the **sources** of energy [oil, coal, hydro power etc].

⇒ Other different features influence where energy is **needed** [in towns, mining, industry, farming]

⇒ Usually **sources** and places of **utilization** are separate.  
So, **transmission** of energy becomes important



# Transmission of Energy

- Continuous transmission
- batch transmission
- economic factors



# Transmission of Energy

<b>Distance</b>	<b>Continuous</b>	<b>Batch</b>
<b>Long (over 1000 km)</b>	<b>Oil pipeline, gas pipeline, HVAC, HVDC</b>	<b>Oil tanker, coal ships</b>
<b>Medium (1-1000 km)</b>	<b>Oil &amp; gas pipeline, Medium to high voltage</b>	<b>Oil in vehicle, tank, coal in trains, biomass in truck</b>
<b>Short (10m-1km)</b>	<b>Gas pipe, elec(low, high Voltage) conveyor, flues</b>	<b>Biomass in truck, wood</b>
<b>Same building (under 30m)</b>	<b>As in Short</b>	<b>Solid fuel by hand or truck</b>



# Role of Electrical Power

- Disadvantages

- it does not occur naturally
- not required as end-product (except in electrolysis, communication & computing)
- Cannot be directly stored

- Advantages

- high conversion efficiency
- ease of transmission
- high transmission efficiency
- flexible distribution



# Competitive Uses of Sources

- Best balance of alternative sources and competitive needs
- Environmental issues
  - extra carbon dioxide & global warming
  - nuclear waste
  - non-renewable resources