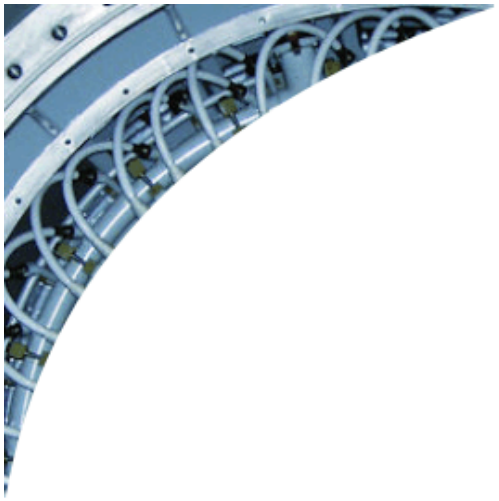
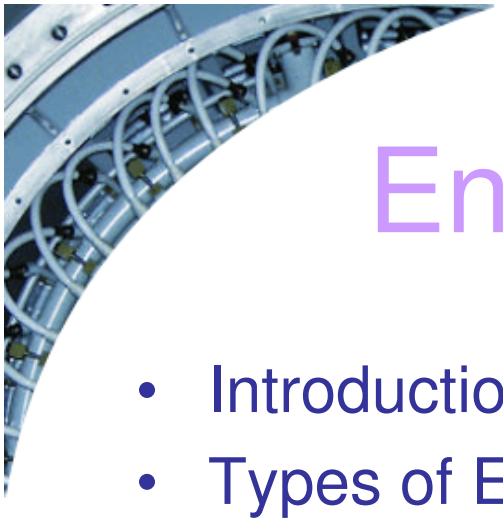
Introduction to Power Systems

- 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

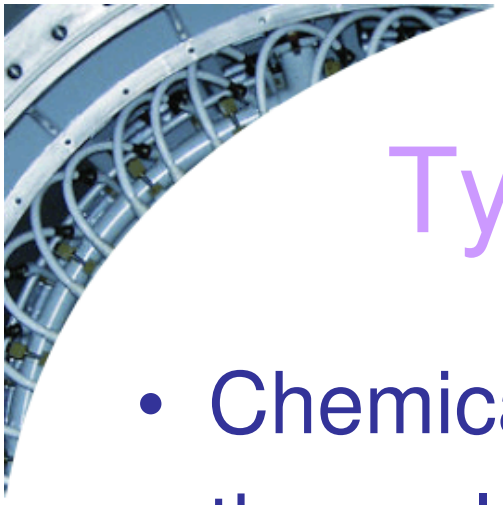
- There many sources of energy
- There many uses of energy

- thus *NEEDS/REQUIREMENTS* vs *SOURCES*

Types of Energy & Power

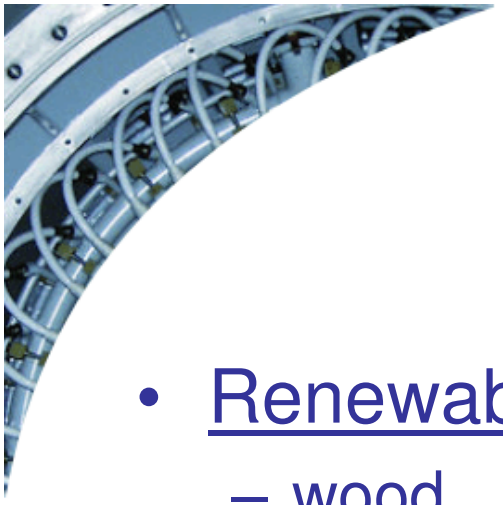
- “Capacity to do work”
- Energy >< Power

- 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*



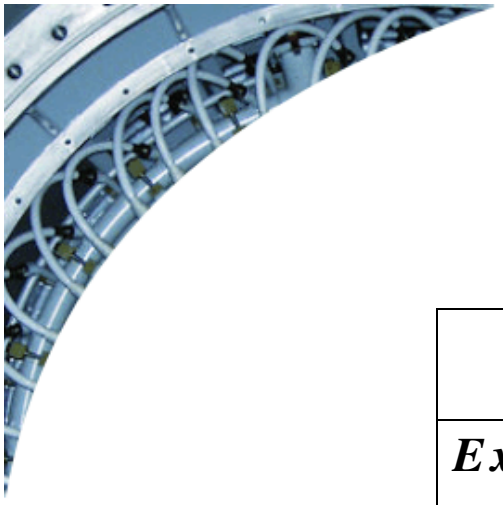
Types of Energy & Power

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



Sources of Energy

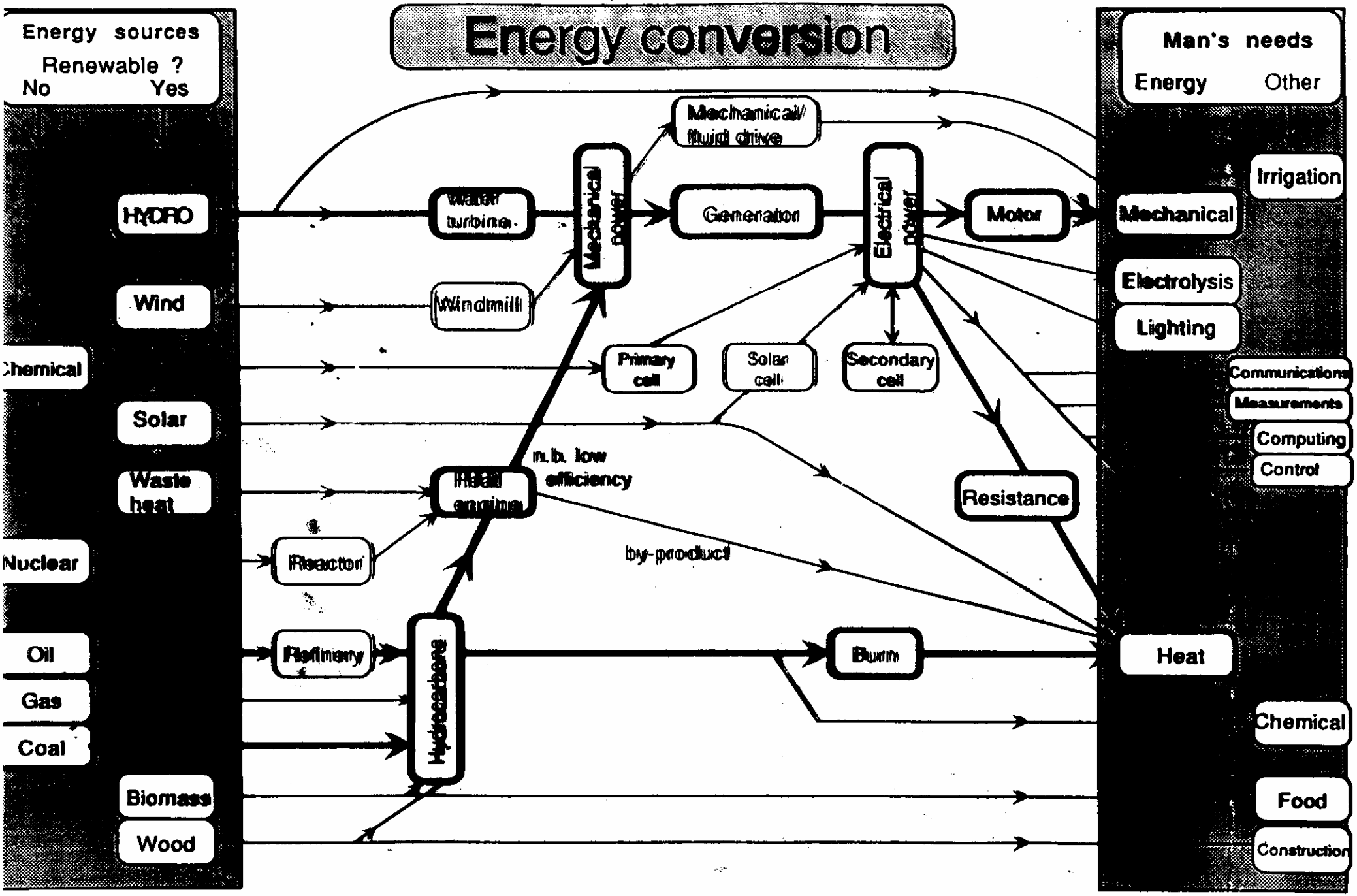
- Renewable
  - wood
  - solar
  - hydropower
  - wind power
  - specific
    - biomass
    - geothermal
    - tidal
- Non-renewable
  - coal
  - oil
  - natural gas
  - nuclear fuel



	Renewable	**Non Renewable**
Examples	Solar, biomass, wood, hydro, wind, tidal, geothermal.	Coal, oil, gas
Location	Natural local environment	Relatively conecntrated regions
Availability	A given average power	A given amount of stored energy
Life time of supply	No limit	Coal: 100-1000 years; oil: 10-100 years
Cost	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
Wind
Chemical
Solar
Waste heat
Nuclear
Oil
Gas
Coal
Biomass
Wood
Water turbine
Windmill
Reactor
Refinery
Heat engine
Hydrocarbons
Mechanical power
Mechanical/ fluid drive
Generation
Primary cell
Solar cell
Secondary cell
Electrical power
Motor
m.b. low efficiency
by-product
Resistance
Burn
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].

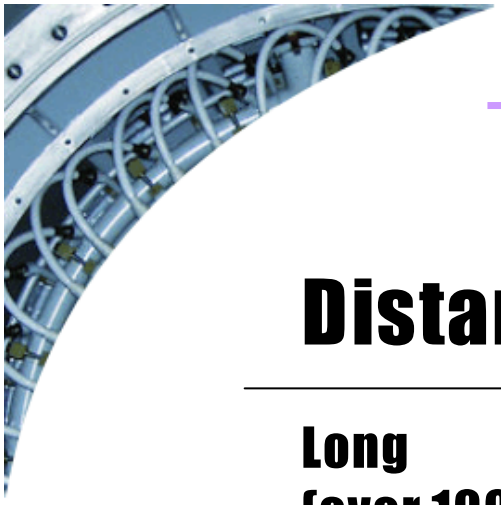
⇒ Other different features influence where energy is **needed** [in towns, mining, industry, farming]

⇒ 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

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

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