UNIT - 1

ENERGY & SOURCES OF ENERGY

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- OPEC (Organisation of Petroleum Exporting Countries)
- Conventional, non-conventional energy sources

- Renewable: wind, solar, tidal etc
  consumption does not deplete source
  can utilise unlimited amount

- Non-renewable: petroleum
  consumption depletes source
  cannot utilise indefinitely

- OPEC started restricting petroleum export
- 19x increase in cost ; 1973

- per capita energy consumption

Classification of Resources

1) Usability

- Primary

  energy yield ratio : $\frac{\text{energy produced (utilisation)}}{\text{energy spent in extraction}}$

  raw form

- Intermediate

  already transformed from raw sources

- Secondary

  utilised energy

2) Long term availability
   - renewable
   - non-renewable

3)
   - commercial
   - non-commercial

4) Traditional
   - conventional
   - non-conventional

Types of Coal

1) Bituminous
   - soft coal
   - 40-80% carbon
   - calorific value high

2) Anthracite
   - hardest coal
   - 80-90% carbon
   - high quality
   - less pollution (blue flame)
   - Jammu/Kashmir

3) Peat
   - more moisture, impurities
   - 40-55%
   - too much pollution
   - to be transformed to Bituminous/Anthracite

4) Lignite
   - Brown coal
   - 40-55% C
   - Dark black/brown

Oil & Natural gas

- gas: more temp, pressure
- oil & gas produced together

- natural gas: CH_4, CH_3CH_3, odourless, highly flammable
- no Sulphur

Disadvantages

- pollution
- global warming
- sea level up 6-8 inches
- temperature up by 0.5°C
- Alaska, Russia
- coral reefs

Green Power

- eco-friendly and non-polluting resources
- power generated with no pollution
- solar, wind etc

Advantages & Disadvantages of Conventional Energy

Advantages

- low cost
- high energy efficiency
- well-built technology for extraction (comfortable)

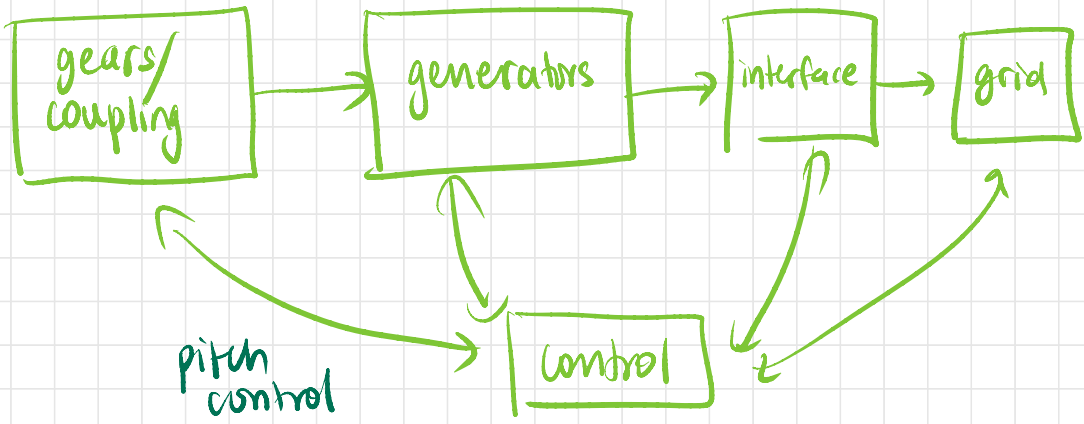
Disadvantages

- polluting
- non-renewable

Environmental aspects of energy

1) Trade-off between environment and energy
2) Ecology
3) Green house effect & global warming
4) Pollution & pollutants
5) Green power

WECS - Wind Energy Conversion Systems

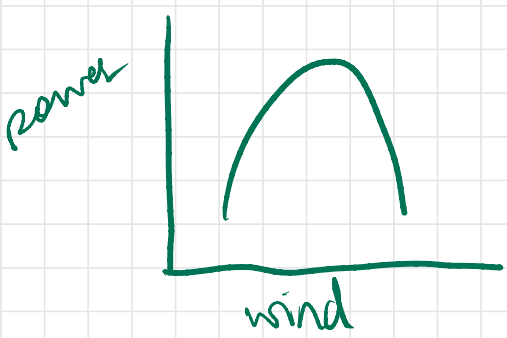


Generator

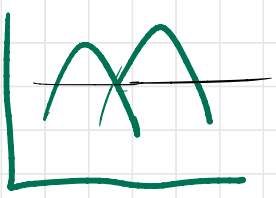
1. DC → low
2. Synchronous → coal, fossil also; problems w/ wind speed
   - reluctance motor
   - grid requirements
3. Induction generators → no dc to start; used now
   - excitation energy

Operations of WECS

1. Fixed Scheme one speed
   - → one speed



   - → two speed
     - 2 gear ratios



2. Var Scheme

change f wrt wind speed

Biomass

(i) fuel wood
16-20 MJ/kg

(ii) charcoal
30 MJ/kg

(iii) fuel pellets and briquettes

(iv) bio-diesel Jatropho & karanj ?

(v) Bio ethanol 25%

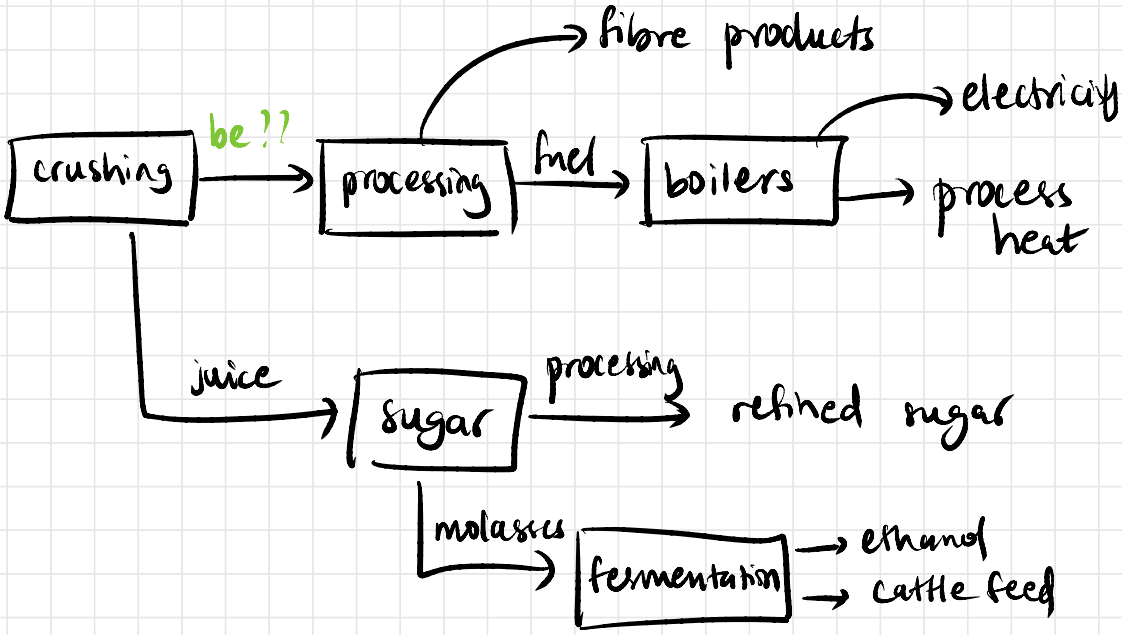
(vi) Biogas

(vii) Producer gas

- digester

Sources

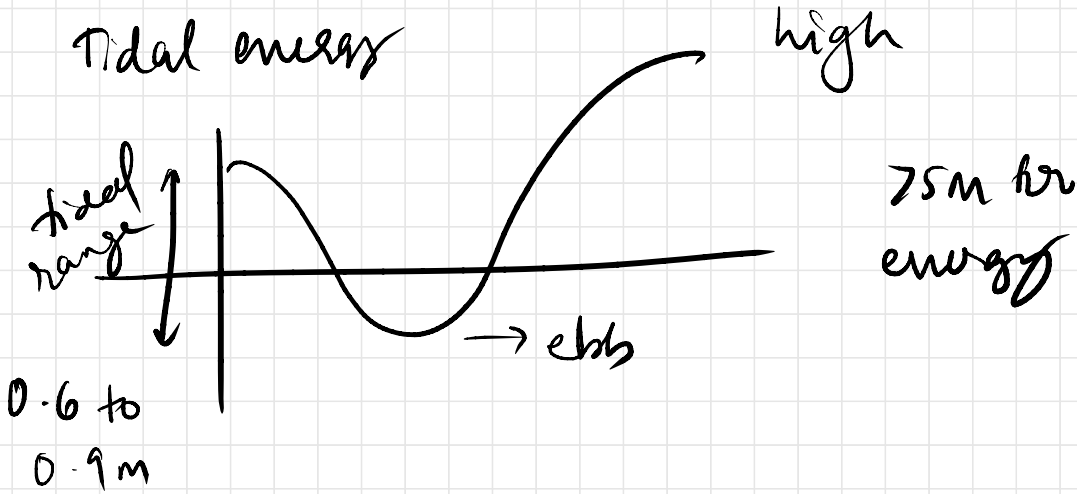
1. Forests
2. Agr. res
3. crops
4. aquatic plants
5. urban waste



Advantages

1) Maintains balance

Tidal energy



1) long term

2) 27.55 days

3) plane

4) complex interactions of $\vec{F}_g$

Power Plants

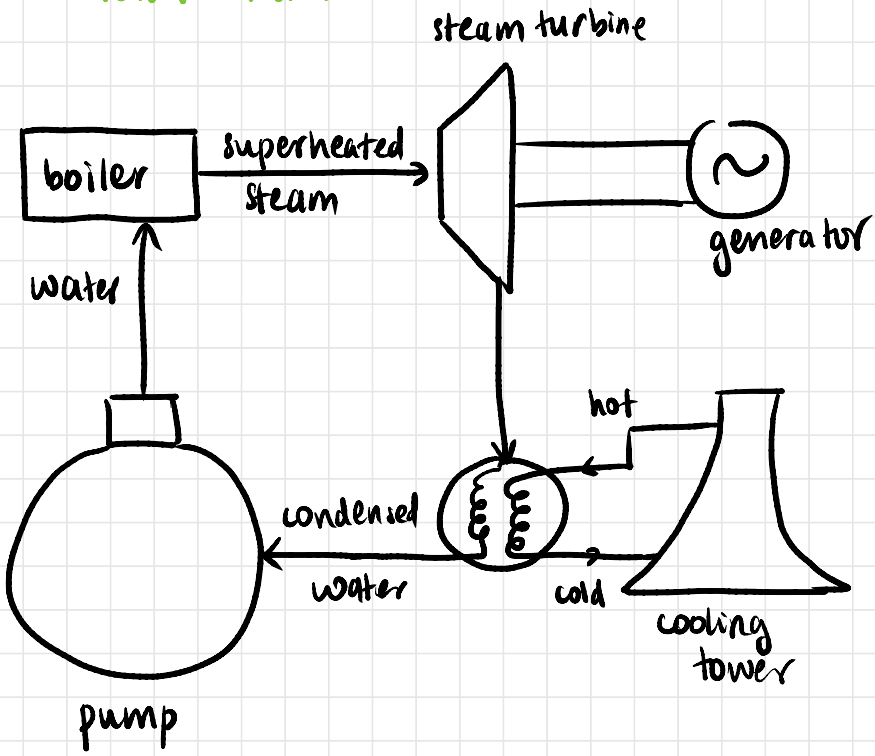
Thermal Power Plants

CE → TE → ME → EE

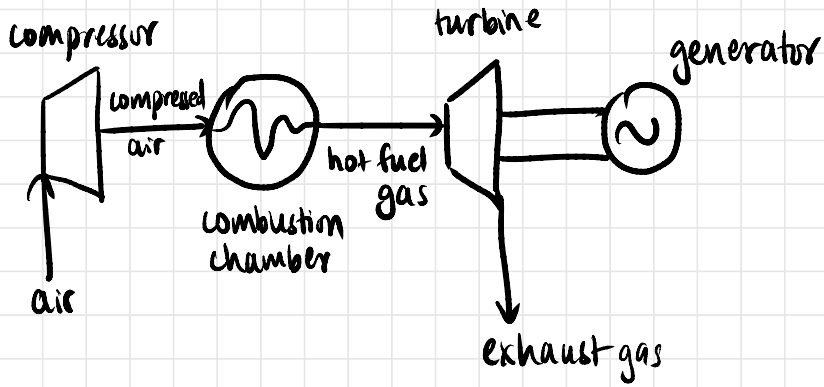
1) coal-based

2) Gas-based

Steam Power Plant



Gas Power Plant



Adv. of TPP

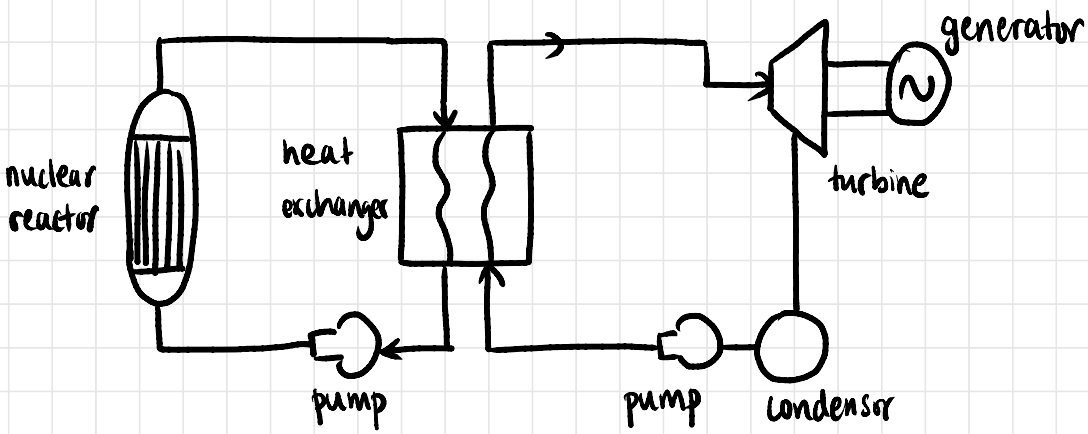
- low cost
- less space
- large amounts of power
- 65% of India's needs
- 85% coal based
- MP

Disadv. of TPP

- running cost
- maintainance cost
- pollution
- non-renewable
- storage of coal

Nuclear Power Plant

- heat to produce superheated steam for turbine



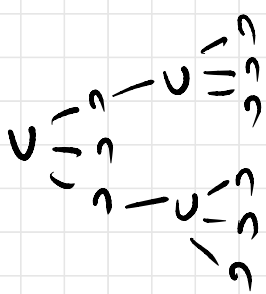
Components

1. Fuel

$_{92}U^{235}$, $_{92}U^{238}$, $_{92}U^{233}$, $_{94}Pu^{239}$

$_{92}U^{235}$ — 0.7%

slow moving neutrons



$$_{92}U^{235} \longrightarrow {}_{56}Ba^{144} + {}_{36}Kr^{89} + 3n + E$$

2. Moderator

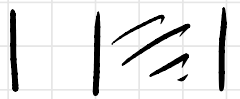
- to absorb K.E. of neutrons / slow down
- D_2O, H_2, O_2, N_2, C, Be
- H_2O ⟶ enriched Uranium ($_{92}U^{235}$)
  - absorbs too many neutrons
  - fine with enriched Uranium

3 control rods

- start reactor
- maintain
- stop during emergency
- absorb neutrons
- Cd, B, Hf

4. Sheilding

- neutrons, γ rays
- steel + concrete



steel 50-60 cm

concrete few metres

5. Reactor vessel

- core, reflector, sheid
- entry / exit of coolant
- withstand 200 bar

Types of Reactors

1) Neutron energy

- fast
- thermal

2) fuel

- natural
- enriched U

3) moderator

- D_2O
- H_2O
- graphite
- Be

4) coolant

- water
- gas

Pressurised Water Reactor (PWR)

- fuel: enriched U, moderator: H_2O
- water becomes radioactive
- steam not radioactive

Boiling Water Reactor (BWR)

- steam generated inside reactor

Heavy Water Cooled & CANDU Reactor

Canadian Deutrerium Uranium

- fuel: natural U
- moderator: D_2O
- coolant: D_2O
- controller: D_2O
- no control rods
- water cools entire power plant
- D_2O and H_2O exchange heat at heat exchanger

Gas Cooled Reactor (GCLR)

- coolant - gas

Liquid Metal Reactor

- fuel: enriched U
- high specific heat, BP
- $T \cong 540^\circ C$
- coolant: Na, K

Fast Breeder Reactor

- fuel: enriched U or Plutonium
- casing: depleted U
- neutrons go to depleted U and turn it into fissable U
- no moderator; coolant: liquid metal
- high P.D = 430 kW/litre of core

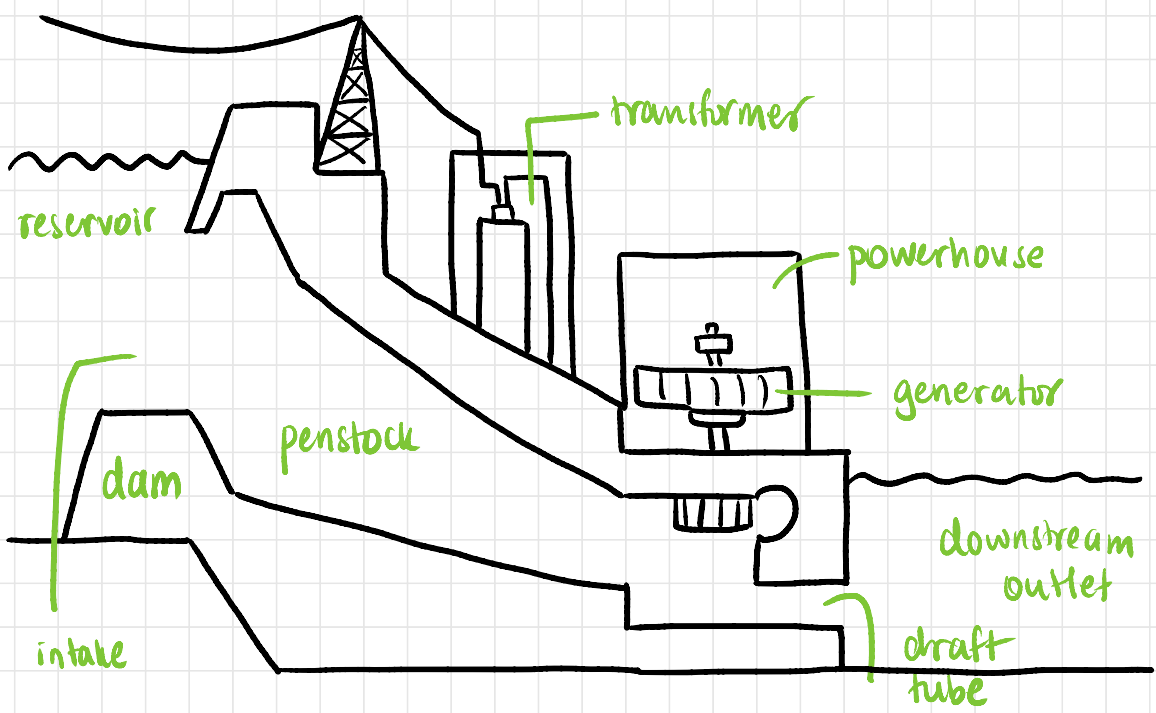
HYDRO POWER PLANTS

~18% of world's renewable energy

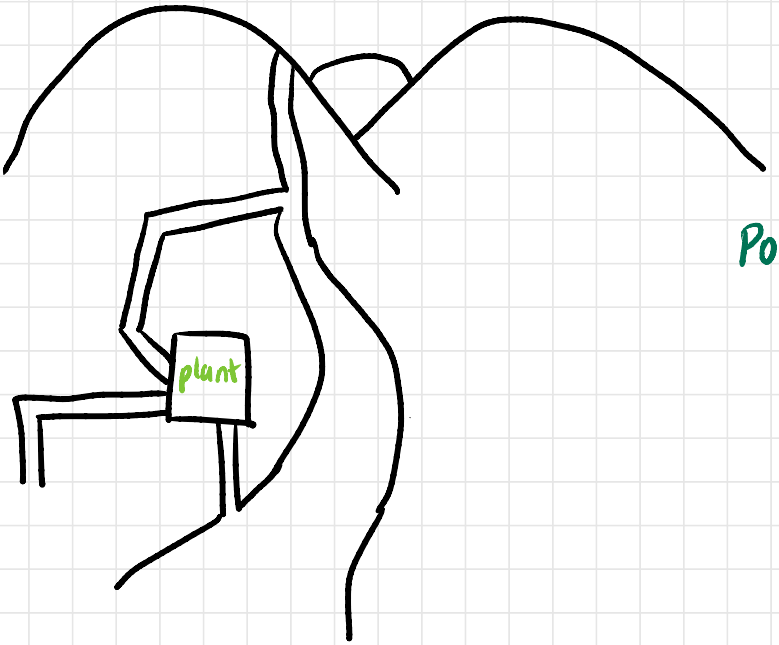
1) Impounding Facity
   - dams, power plants, reservoirs
2) Run of River (ROR) / Diversion

3) Pumped storage

Impounding Facility



Run of River



Pondage
- store a bit of water

- does not disrupt flow
- lower o/p power
- not reliable
- diversion affects aquatic ecosystem

small (< 10MW)
mini (< 1MW)
micro (< 100 kW)
pico (< 5kW)

Small Hydropower Plants (SHPs)

Fuel cells