Energy resources

Energy resources

- Growing energy needs
- Renewable and non-renewable energy sources
- Use of alternate energy sources.

Energy resources

- Energy consumption of a nation is usually considered as an index of its development.
- Almost all the developmental activities are directly or indirectly dependent upon energy.
- There is a large gap in per capita energy use between the developed and the developing nations.

Energy resources

- At global level, around 24% of total energy is used for transportation, 40% for industrial use, 30% for commercial and domestic use and remaining 6% for agricultural and others.

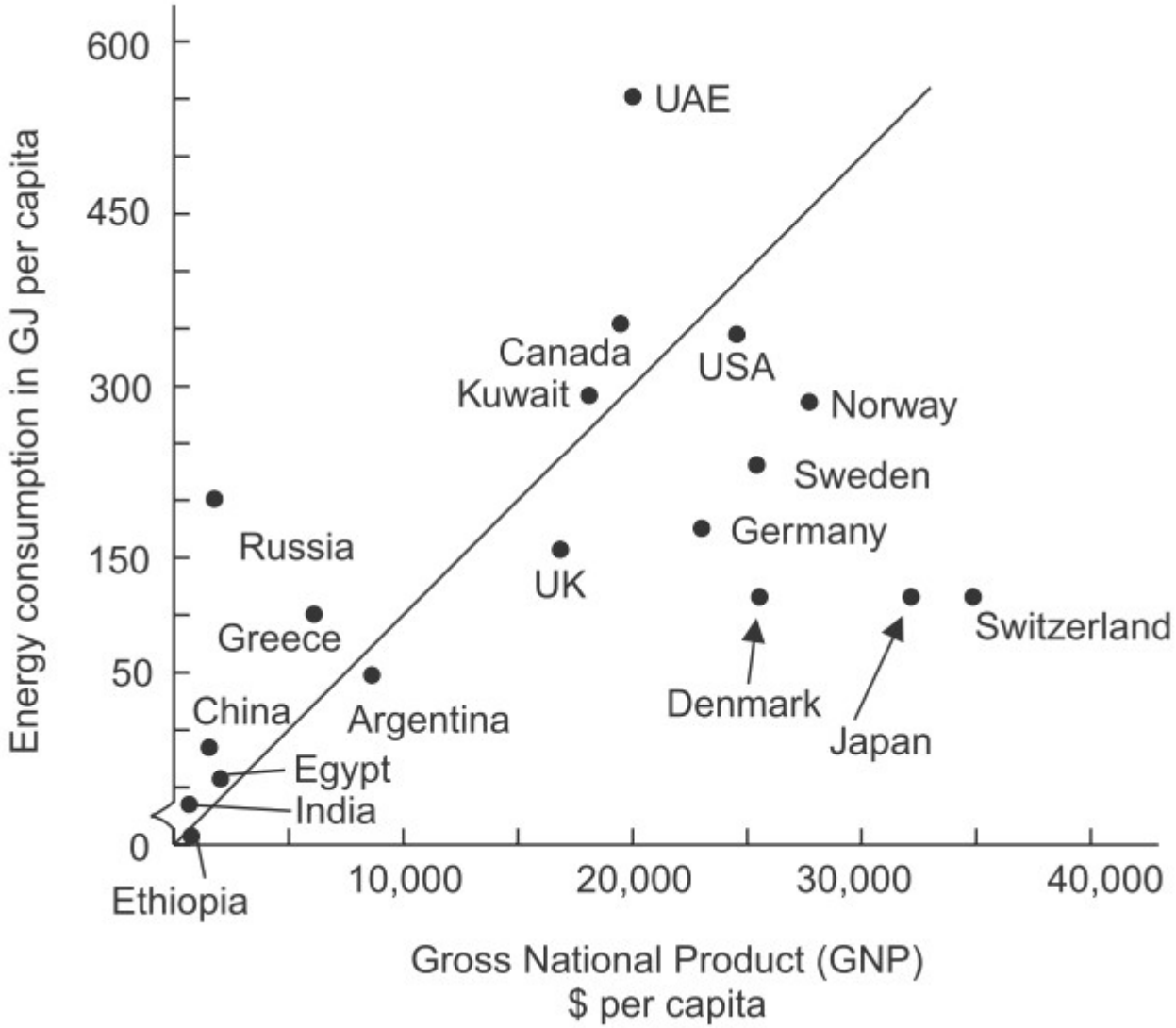
Growing Energy Needs

- Development in different sectors depends upon energy.
- Agriculture, industry, mining, transportation, lighting, cooling and heating in buildings require energy.
- With the increasing population the world the demand of energy is also increasing.
- Fossil fuels like coal, oil and natural gas which are the main sources of the commercial energy, are depleting fast and are not going to be exhausted in coming years.

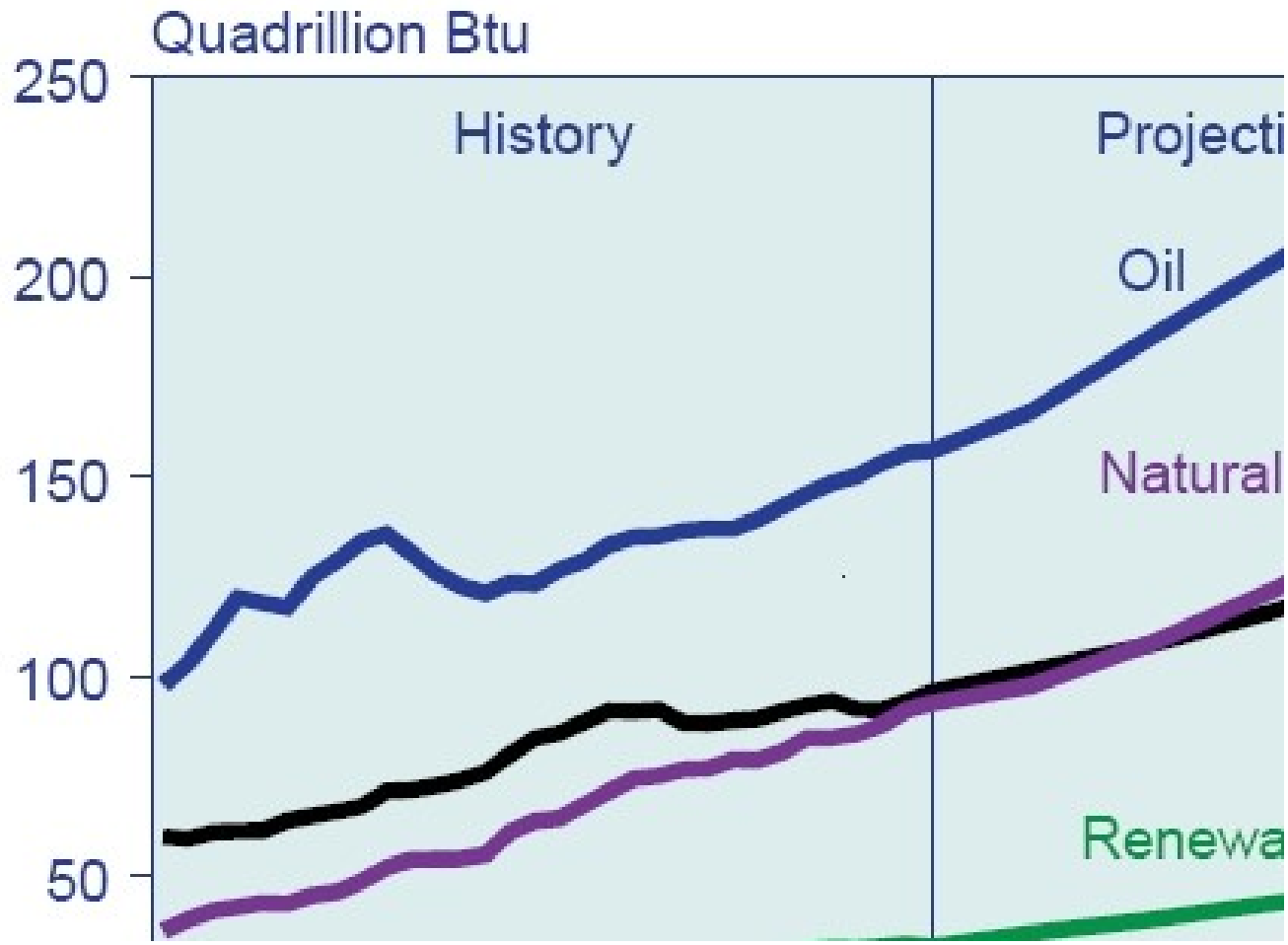
Growing Energy Needs

- Our life style is changing very fast from a simple way of life to a comfortable life style.
- The number of electric gadgets, air conditioners is rapidly increasing in our homes
- The number of private cars and scooters have multiplied many folds
- All of these consume energy

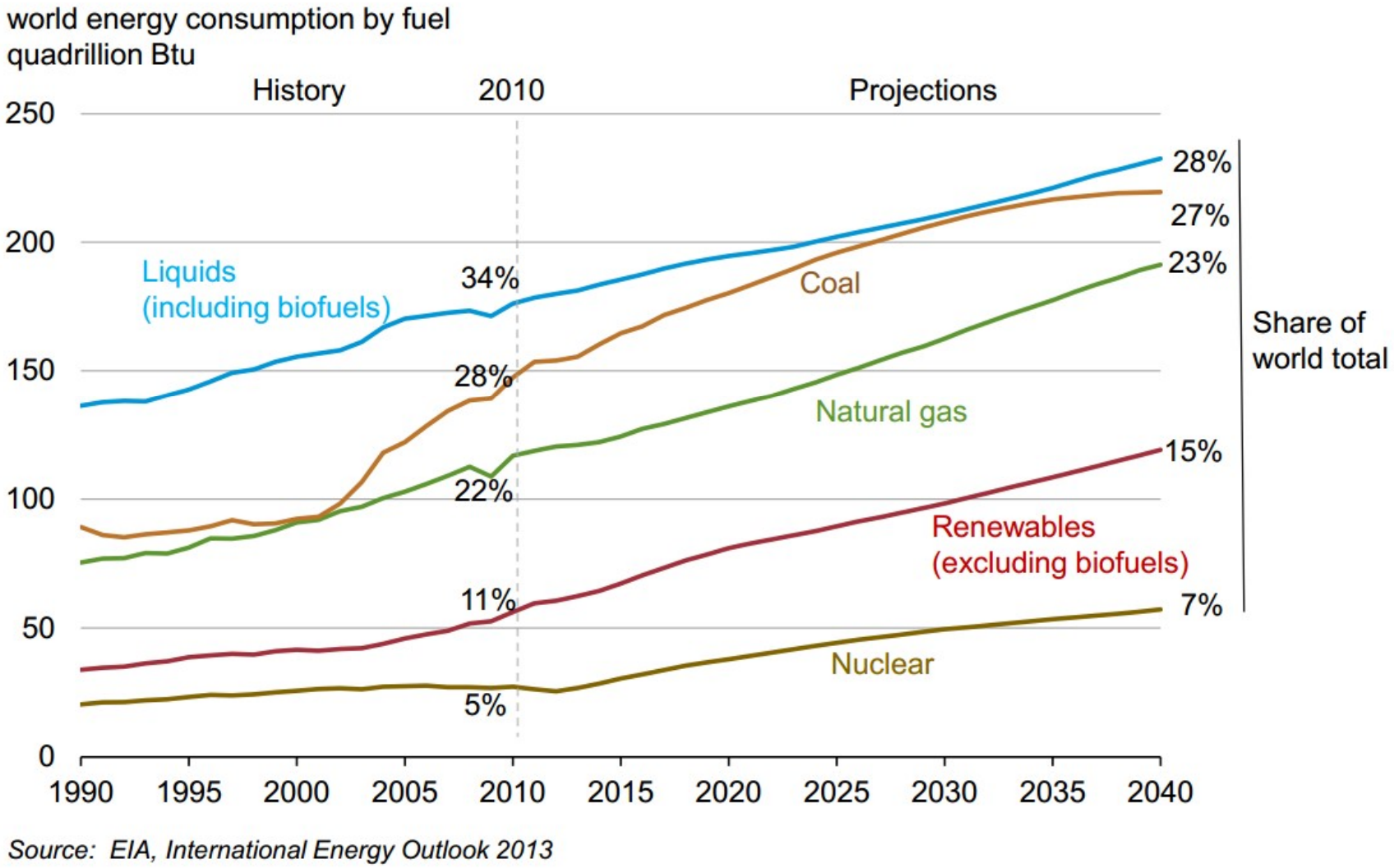
Per capita energy use and GNP



Growing Energy Needs

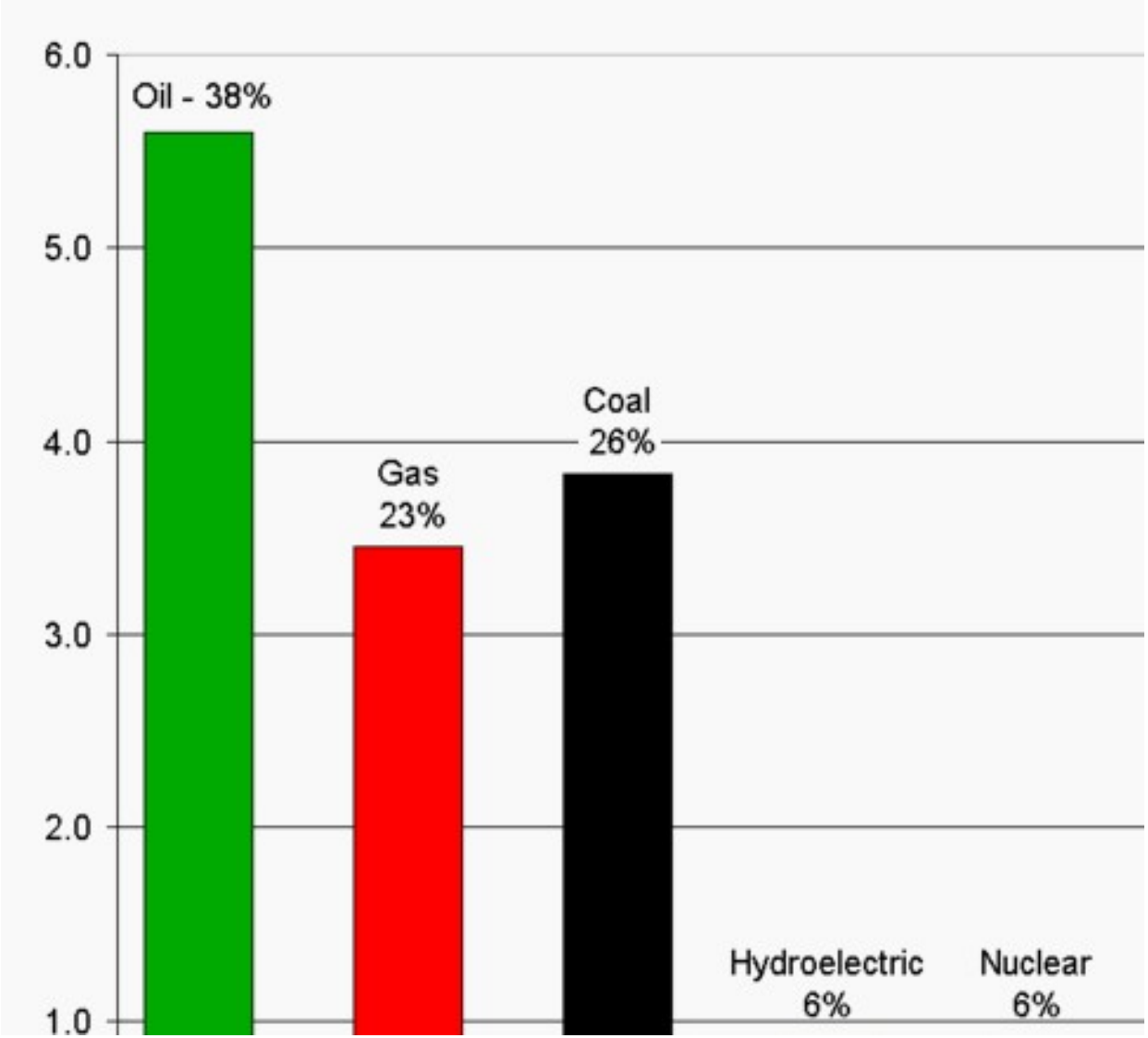


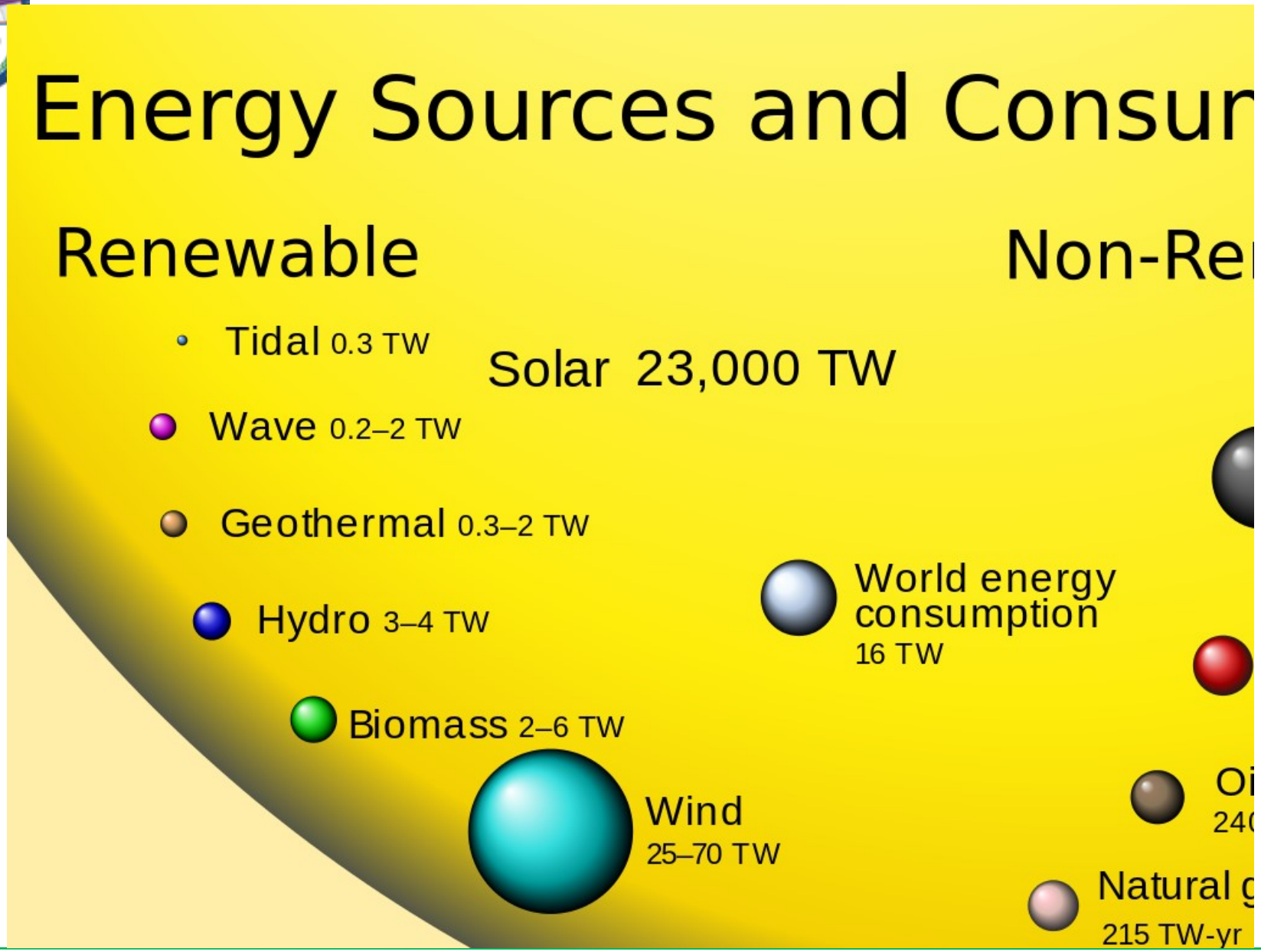
World Energy Consumption



Source: EIA, International Energy Outlook 2013

Worldwide Energy Sources





Renewable and Non-renewable Energy Sources

- Renewable Resources which can be generated continuously in nature and are inexhaustible e.g. wood, solar energy, wind energy, tidal energy, hydropower, biomass energy, bio-fuels, geo-thermal energy and hydrogen.

- Non-renewable Resources which have formed in nature over a long period of time and cannot be quickly replenished when exhausted e.g. coal, petroleum, natural gas and nuclear fuels like uranium.

Fossil Fuels

- Fossil fuels are found under the earth and are formed by the decomposition, of organic matter (by heat & pressure) buried under the soil for millions of years. Fossil fuels can be found in solid, liquid or gaseous state.
- Coal - Solid
- Petroleum - Liquid
- Natural Gas - Gaseous State

Renewable and Non-renewable Energy Sources

- Renewable resources are natural resources that can be replenished in a short period of time.
- Solar
- Geothermal
- Wind
- Biomass
- Hydro-power
- Tidal energy

Coal

- India has high coal deposits in Bokaro, Jharia, Raniganj, Singrauli, Godavari Valley, Chandrapur.
- 4 types of coal –Anthracite, Bituminous, Lignite, Peat
- Coal Is in abundance But Dirty Fuel
- Used in electricity production
- World's most abundant fossil fuel
- U.S. reserves should last about 250 years
- Sulfur and particulate pollutants ,Mercury and radioactive pollutants

Coal

Advantages

- Availability
- Low cost,
- Low risk of fire hazards
- Easy storage
- Easy transportation

Coal

Disadvantages

Combustion of coal is a slow process.

Control of combustion is not easy.

A large quantity of ash is produced and so its disposal is a problem.

Smoke containing SO2 and NO2 also produced.

Calorific value and thermal efficiency is low.

Petroleum or Crude Oil

- Found underground or under ocean
- Crude oil is the single largest source of commercial energy in world
- Can be extracted profitably at competitive prices with modern technology
- It is a mixture of hydrocarbons
- Purified in refineries to produce petroleum products viz. Gasoline, Kerosene, Diesel etc.

Petroleum or Crude Oil

Oil Refinery

Natural gas

- Natural gas is the cleanest fossil fuel
- Transported and supplied in these forms
  - Compressed natural gas (CNG)
  - Piped natural gas (PNG)
  - Liquefied Natural gas (LNG)
- Less carbon dioxide and very small amount of pollutants emitted per unit of energy than crude oil or coal
- Estimated world supply of natural gas is for about 60-120 years

Disadvantages of fossil fuels

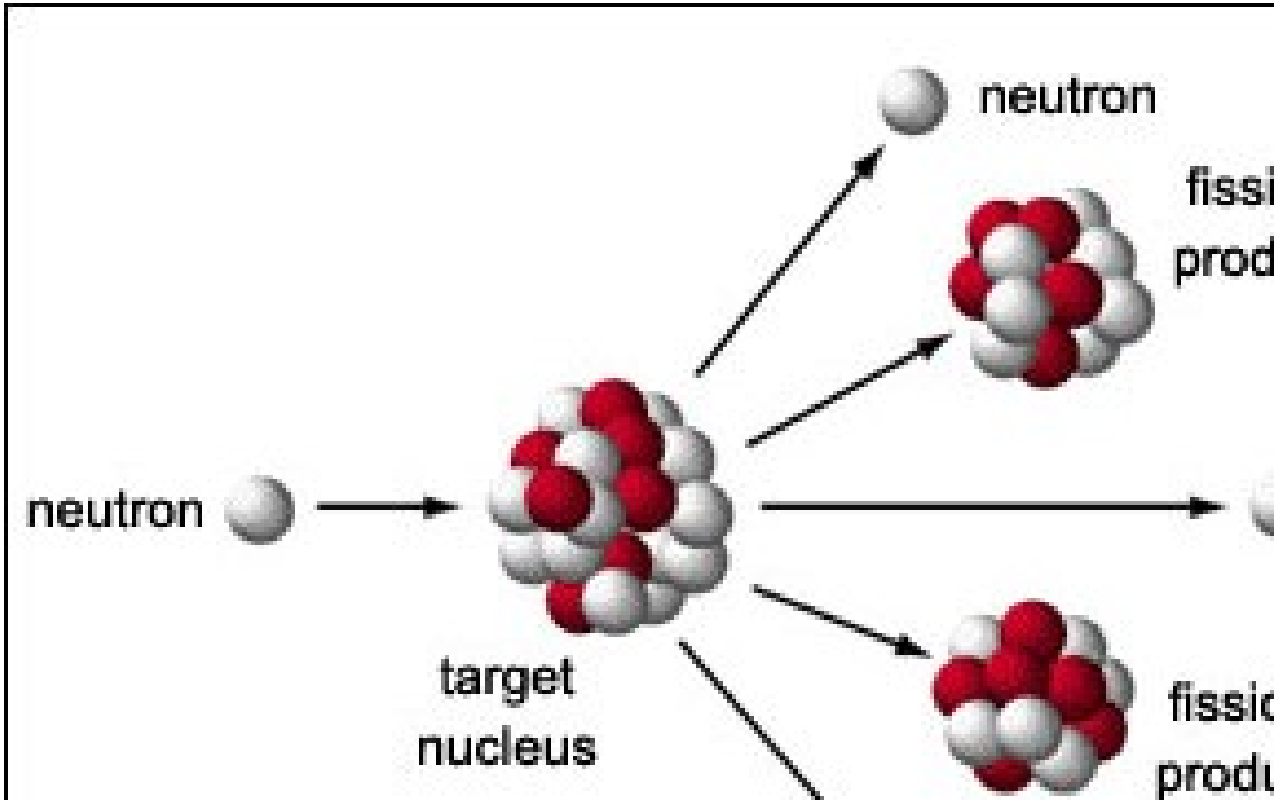
- Mining activities results in huge deforestation.
- Mining activities (mining, loading, unloading) also creates dust and noise pollutions which disturb wildlife.
- Mining activities, particularly under ground, cause mine firing and flooding which can create water pollution problems.
- Combustion of fossil fuels release gases like CO2, SO2, CO, NO2 which are responsible for green house effect and acid rains.
- Combustion of fossil fuels also release huge amounts of fly ash into the atmosphere which seriously effect health of human beings and animals.
- Use of petroleum products in transport system cause air pollution.
- Accidents like bursting of gas cylinders and burning of cars etc., sometimes take place.
- Storage of CNG and LPG needs high pressure.

Nuclear Energy

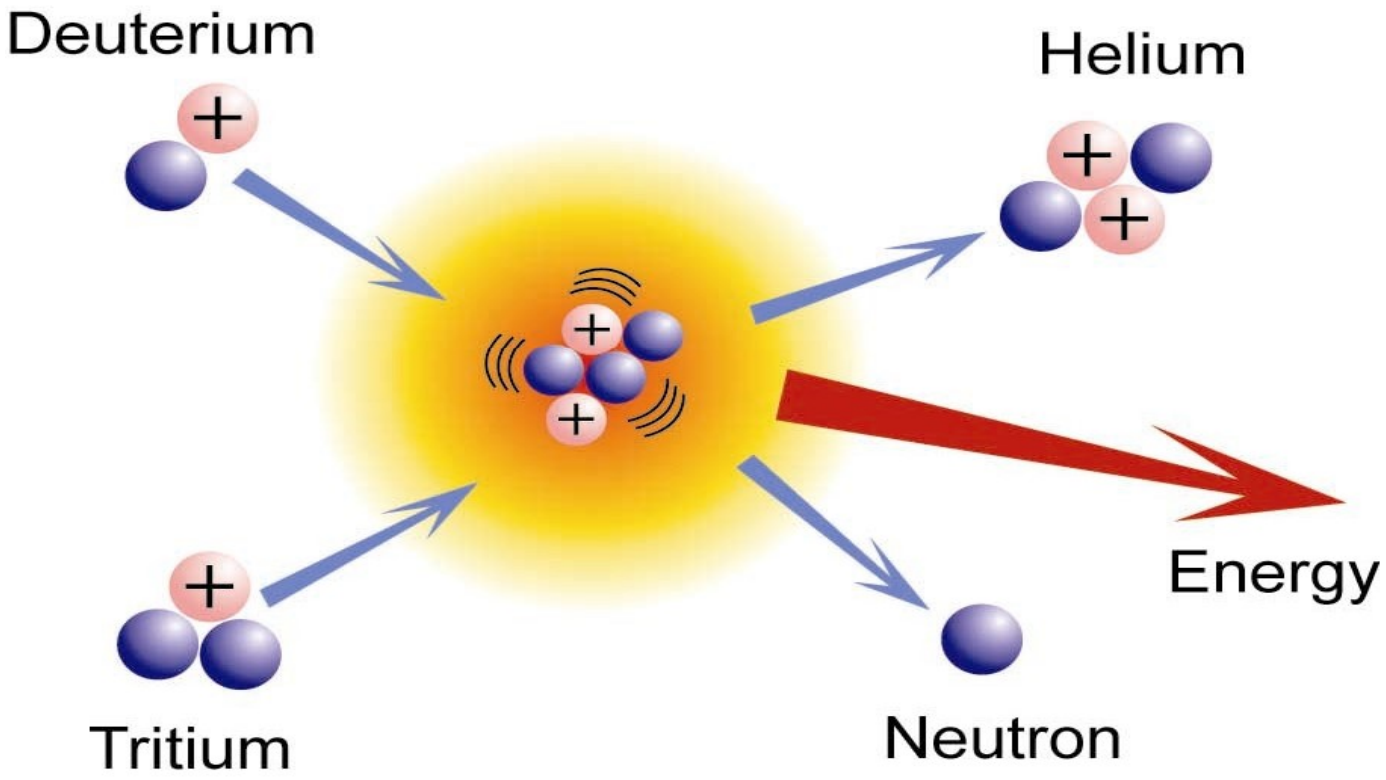
- Nuclear fission uses uranium to create energy.
- Nuclear energy is a nonrenewable resource because once the uranium is used, it is gone!

Kudankulam Nuclear Power Plant

Nuclear Fission



Nuclear Fusion



Nuclear Energy

Advantages

- Tremendous potential
- Energy potential high in India
- Currently 4 plants are operating in India (Total Capacity 2005 MW)
  - Tarapur
  - Kota
  - Kalpakkam
  - Narora

Nuclear Energy

Disadvantages

- Extraction of uranium is a dangerous process as radioactivity affects the body.
- Wasted heat generates thermal pollution
- The effluents may contain radioactive waste which is very harmful.
- Transportation and safety of nuclear fuel is a tough task.
- Accident in nuclear power plant may create havoc and effect very large area.
- Long term exposure to radiation may cause cancers, tumors and genetic problems.

Renewable Energy Sources

- Renewable Resources or Nonconventional energy resources are the resources which can be regenerated in nature within a short period of time and are therefore inexhaustible.
- Solar energy, wind energy, tidal energy, hydropower, wood, biomass energy, bio-fuels, geo-thermal energy and hydrogen are some examples.

Renewable Energy Sources

- Solar energy
  - Solar heating, solar power plants, photovoltaic cells
- Biomass energy
  - Direct: combustion of biomass
  - Indirect: chemical conversion to biofuel
- Wind energy
- Hydro energy
- Geothermal energy
  - Power plants, direct use
- Ocean energy
  - Tidal energy, wave energy

Solar Energy

- Solar power plants
- Solar heat collectors
- Solar cells
- Solar cooker
- Solar water heater
- Solar furnace and Solar power plants
- Solar heating
- Active and passive systems
- Photovoltaic cells

Solar Rooftop Panels

Solar Rooftop Panels

Solar Energy

Advantages

- Renewable and free
- High energy yield
- A very clean source of energy
- No air/water pollution during operation
- Low operating costs
- Will pay for themselves over time

Solar Energy

Disadvantages

- Intermittent source
- Energy storage issues
- Low energy density
- Requires pretty much land

Wind Energy

- Freely available source of energy
- Wind turbines directly generate electricity
- Quite efficient (not a heat engine)
- High net energy yield
- Minimum wind speed required 15 km/hr
- World's second fastest-growing source of energy
- India´s Potential is 20,000 MW
- Vast potential
  - Land
  - Offshore

Wind Power Generators

Wind Energy

Advantages

- Long operating life
- Low operating and maintenance costs
- Can be quickly built, economical
- Competitive with hydro and fossil fuels
- Land can be used for other purposes
- Can combine wind and agricultural farms

Wind Energy

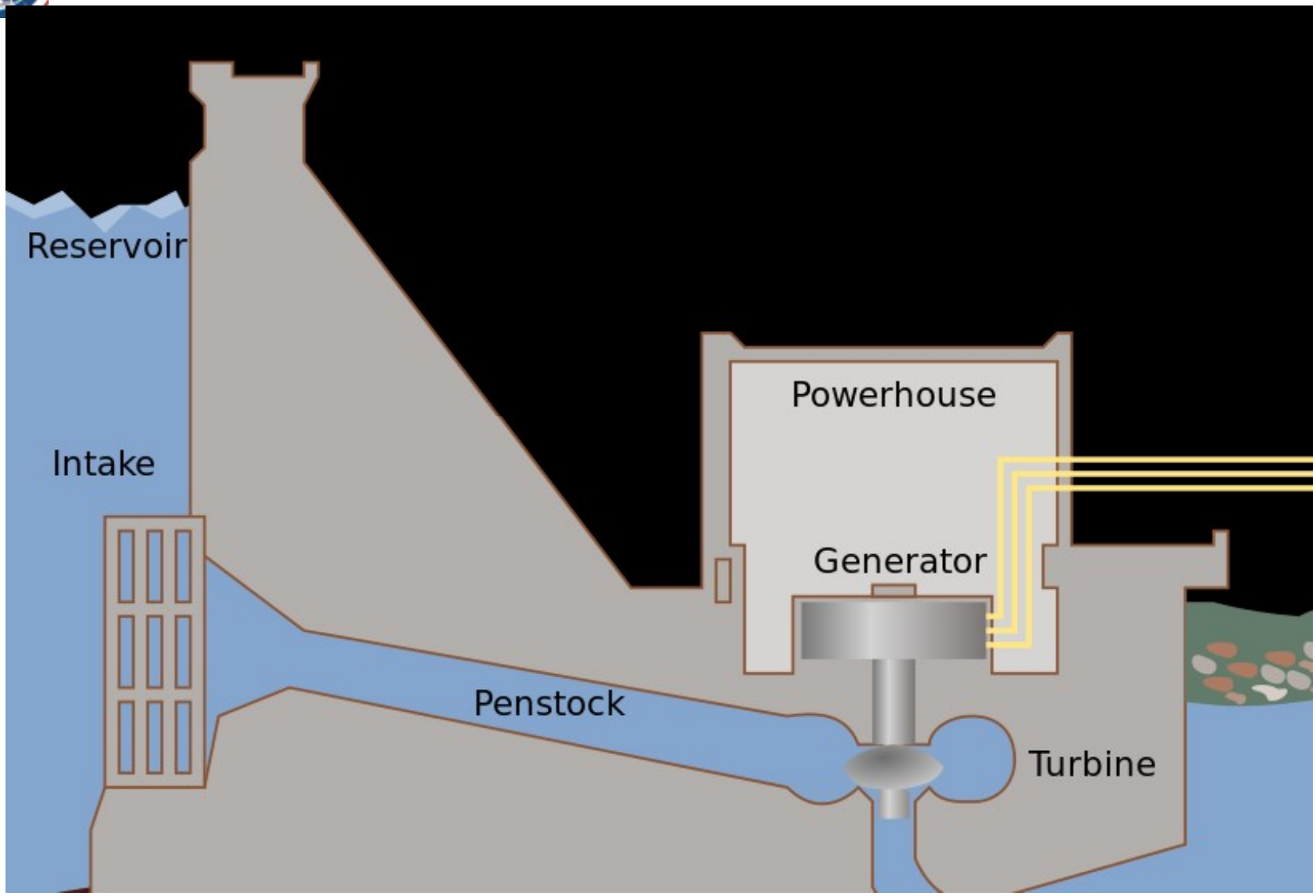
Disadvantages

- Energy storage issues
- An intermittent source of energy; need backup (eg stored energy) for low-wind days
- Must be connected to the electrical grid
- Only practical in areas that are windy enough
- Visual pollution
- Danger to birds
- Low energy density of wind
- Must use large areas of land

Hydro Energy

- Hydropower
  - Leading renewable energy source
  - Much unused capacity
- Dams and reservoirs
  - Turbines generate electricity
  - Eventually fill with silt
- Micro-hydro generators
- Potential of India : 4 X 10 ^{11}KW-hours

Hydro Energy



Hydro Energy

Hydro Energy

Advantages

- Cheap to operate
- Long life and lower operating costs than all other power plants
- Renewable
- High yield
- Lower energy cost than any other method
- Easy Availability

Hydro Energy

Advantages

- Some countries depend almost entirely on it
- Not intermittent (if reservoir is large enough)
- Reservoirs have multiple uses
- Flood control, drinking water, aquaculture, recreation
- Less air pollution than fossil fuel combustion

Hydro Energy

- Disadvantages:
  - Human population displacement
  - More significant breeding ground for disease
  - Reduces availability of water downstream
  - Ecosystem impacts
    - Barriers to migrating fish
    - Loss of biodiversity both upstream and downstream
    - Coastal erosion
    - Reduces nutrient flow (dissolved and particulate)

Hydro Energy

- Disadvantages:
  - Water pollution problems
    - Low dissolved oxygen (DO)
    - Increased H_2S toxicity; other DO-related problems
    - Siltation a big problem (also shortens dam life)
  - Air pollution
    - Actually may be a significant source of GHGs (CH_4, N_2O, CO_2)
  - Decommissioning is a big problem
- The Size Issue
  - Many (most) of the above problems are significantly worse for larger dams
  - However, small dams have shorter lifetimes, less capacity, and are more intermittent

Biomass Energy

- Biomass energy is the use of living and recently dead biological material as an energy source
- Ultimately dependent on the capture of solar energy and conversion to a chemical (carbohydrate) fuel
- Theoretically it is a carbon neutral and renewable source of energy

Biomass Energy

- Traditional use of wood as fuel
- Biodegradable waste
  - Examples: manure, crop residue, sewage, municipal solid waste
- Production of a liquid or gaseous ***biofuel***
  - *Biogas* due to the breakdown of biomass in the absence of O_2
  - *Bioethanol* from fermentation, often from corn. Cellulosic bioethanol is usually from a grass (switchgrass)
  - *Biodiesel* from rapeseed and other sources

Biomass Energy

Advantages

- Versatile
- Renewable
- No net CO_2 emissions (ideally)
- Emits less SO_2 and NO_x than fossil fuels

Biomass Energy

Disadvantages

- Low energy density/yield
  - In some cases (eg, corn-derived bioethanol) may yield no net energy
- Land conversion
  - Biodiversity loss
  - Possible decrease in agricultural food productivity
- Usual problems associated with intensive agriculture
  - Nutrient pollution
  - Soil depletion
  - Soil erosion
  - Other water pollution problems

Geothermal Energy

- Geothermal power plants
- Use earth's heat to power steam turbines
- Geothermal direct use
- Use hot springs (etc) as heat source
- Geothermal heat pumps

Advantages

- Renewable
- Easy to exploit in some cases
- CO2 production less than with fossil fuels
- High net energy yield

Geothermal Energy

Disadvantages

- Not available everywhere
- H_2S pollution
- Produces some water pollution (somewhat similar to mining)

Tidal Energy

- Tidal power, also called tidal energy, is a form of hydropower that converts the energy of tides into useful forms of power - mainly electricity.
- Although not yet widely used, tidal power has potential for future electricity generation.
- Tidal stream generators (or TSGs) make use of the kinetic energy of moving water to power turbines, in a similar way to wind turbines that use wind to power turbines.

Hydrogen as a future source of Energy

- The Hydrogen Economy is a hypothetical large-scale system in which elemental hydrogen (H2) is the primary form of energy storage
- Fuel cells would be the primary method of conversion of hydrogen to electrical energy.
- Efficient and clean; scalable
- In particular, hydrogen (usually) plays a central role in transportation.
- Potential Advantages
- Clean, renewable
- Potentially more reliable (using distributed generation)
- Poses great technological challenges for efficient hydrogen production, storage, and transport

Fuel Cells

- A fuel cell is basically a battery in which the reactants are continually supplied to the electrodes, and the products are continually removed.
- Much more efficient (2-3 times) than heat engines at generating electricity
- Most common type of fuel cells based on hydrogen (there are others)
- Fuel cells are scalable
- Large ones can power homes or neighborhoods
- Small ones can be used in appliances
- Distributed generation is a decentralized power system consisting of hydrogen generators and fuel cells