

ENERGY RESOURCES

Key Words

➤ **Energy** – enables one to do work. e.g. food gives us energy, so that we can **move, walk, run, jump,...**



➤ **Fuel** – anything that is burned or altered to obtain energy



Energy Resources.....contd.

Energy is used in the following activities:

- industrial
- domestic
- transportation

Note: **Electricity** is **not** an **energy source!** It is converted from other sources, e.g. coal, hydro, nuclear, etc.

Energy Resources.....contd.

- 99% of heat comes freely, as solar energy, from sun.
 - Without sun, earth would be $-240\text{ }^{\circ}\text{C}$
- Supplementing solar, @ 1%, are other primary non-renewable energy sources.

Energy Resources.....contd.

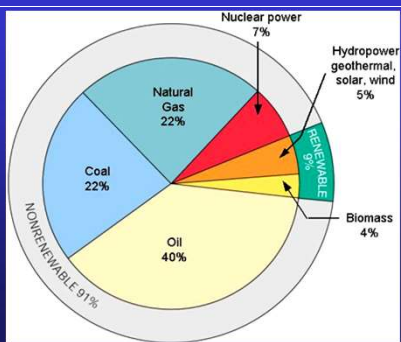
Two major types of Energy Resources:

a) Renewable (16%) **b) Non-renewable (84%)**

- | | |
|--------------------------|-----------------|
| ➤ Solar | ➤ Oil |
| ➤ Wind | ➤ Natural gas |
| ➤ Falling, flowing water | ➤ Coal |
| ➤ Biomass | ➤ Nuclear power |

Energy Resources.....contd.

Energy consumption by type, in USA



Energy Resources.....contd.

Evaluation of energy resources is dependent on its:

- a) Renewability
- b) Future availability
- c) Net yield - it takes energy to get energy
- d) Effects on Habitat degradation
- e) initial and running Costs
- f) Magnitude of disruption of communities
- g) Implications on Political or international issues
- h) Suitability in different locations
- i) Polluting effects on air, water, noise, visual, etc.

1. Energy from Non-Renewable Resources

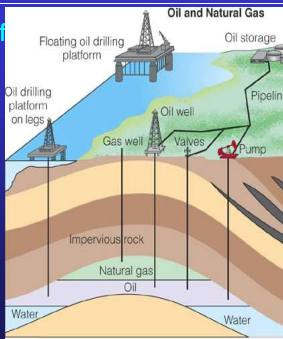
a) Fossil Fuels

These formed:

- > over millions of years, after dead plants and animals were immediately covered by sediments in seas or swamps.
- > After millions of years of pressure and heat (90°C to 120°C), turned these remains into **OIL**, **NATURAL GAS**, and **COAL**

A) Energy from Fossil Fuels.....contd.

Examples of some Important Non-Renewable Fossil Fuel Energy Resources



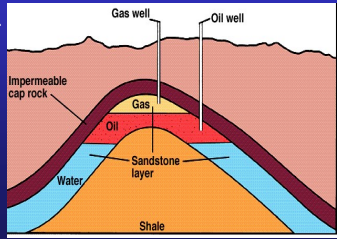
A) Energy from Fossil Fuels.....contd.

a) Oil & Natural Gas:

- occur together and were formed from both plants and animals after being buried.

When fossil fuels burn:

- sun's energy, stored as chemical energy underground, for millions of years, is used.

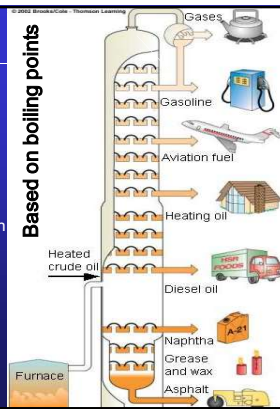


i) Oil

- Is also called Petroleum or crude oil
- Costs include those ass'd with:
 - Recovery
 - Refining
 - Transportation
 - Environmental protection
 - Highest risks are ass'd with transportation

Refining of crude oil yields many products:

- Asphalt
- Diesel
- Heating oil
- Aviation fuel
- Gasoline



Oil Shale and Tar Sands

These are **ancient fossil deposits** containing petroleum, which with **significant energy**, can be converted into transportation fuels.

❖ Oil Shale

- Is NOT oil, but an oily rock that contains a solid mix of hydrocarbons called **kerogen**.
- has been calculated that, per ton, it contains one-tenth the energy of crude oil.
- Global supplies are about 240 times those of conventional oil supplies.

Oil Shale and Tar Sands.....contd.

❖ Tar Sands:

These are:

- mixtures of mostly sand, clay, water, and a thick molasses-like substance called **bitumen** – a thick and sticky heavy oil.
- extracted by large electric shovels from mixtures of hot water + steam to extract bitumen.
- Bitumen is heated to convert it to synthetic crude oil, gasoline, and other petroleum products.

Trade-offs in the use of Conventional Oil

Advantages


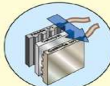






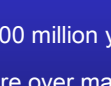
Disadvantages

- | | |
|----------------------------------|------------------------------------|
| ➤ Relatively low cost | ➤ Running out in 40-103 years |
| ➤ High net energy yield | ➤ Low prices encourage waste |
| ➤ Efficient distribution system. | ➤ Air pollution + greenhouse gases |
| | ➤ Water pollution. |

Trade-offs in the use of Conventional Oil

Trade-offs for Heavy oils from Oil Shale and Oil Sand

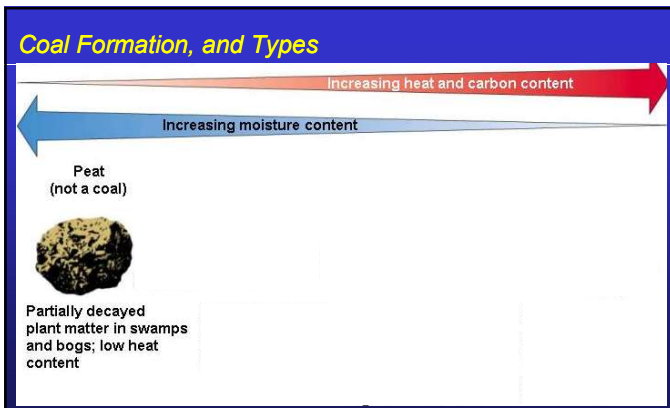
Advantages	Disadvantages
Moderate cost (oil sand)	High cost (oil shale)
Large potential supplies, especially oil sands in Canada	Low net energy yield
Easily transported within and between countries	Large amount of water needed for processing
Efficient distribution system in place	Severe land disruption from surface mining
Technology is well developed	Water pollution from mining residues
	Air pollution when burned
	CO ₂ emissions when burned

<i>ii) Energy from Natural Gas</i>		Advantages	Disadvantages
<ul style="list-style-type: none"> ➤ 50-90% is methane ➤ Is the cleanest of fossil fuels ➤ Still has ca. 200 years of supply ➤ Has its own Advantages and Disadvantages (trade-offs): 	Ample supplies (125 years)		Nonrenewable resource
	High net energy yield		Releases CO ₂ when burned
	Low cost (with huge subsidies)		Methane (a greenhouse gas) can leak from pipelines
	Less air pollution than other fossil fuels		Difficult to transfer from one country to another
	Lower CO ₂ emissions than other fossil fuels		Shipped across ocean as highly explosive LNG
Moderate environmental impact		Sometimes burned off and wasted at wells because of low price	
Easily transported by pipeline		Requires pipelines	
Low land use			
Good fuel for fuel cells and gas turbines			

iii) Energy from Coal

Coal is:

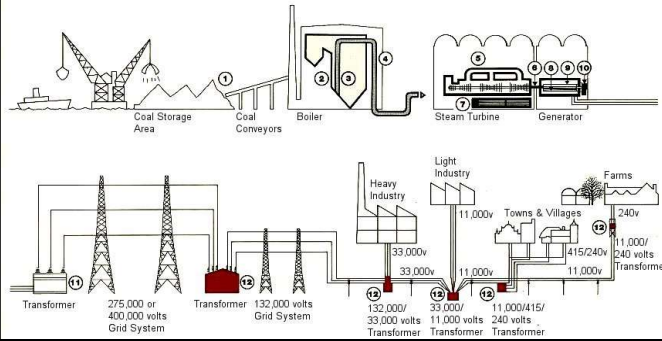
- Solid fossil fuel formed in several stages – and
 - from land plants that existed 300-400 million years ago.
- Subjected to intense heat and pressure over many millions of years, during its formation
- Composed mostly of carbon, with small amounts of sulphur



Energy generation from Coal

- Coal is crushed to a fine dust & burnt (*unlike Oil and Gas that can be burnt directly*) to generate electricity
- currently estimated to generate about 62% of world's, and 52% of USA's electricity.
- There are enough coal reserves to last for about 200-1000 years – world's largest being in USA, at 25%

Energy generation from Coal.....contd.



Energy generation from Coal...contd.

Trade-offs in the use of coal for energy generation:

- Mining and burning coal have severe environmental impacts.
- Burning accounts for over 1/3 of the world's CO₂ emissions.

Advantages	Disadvantages
Ample supplies (225-900 years)	Very high environmental impact
High net energy yield	Severe land disturbance, air pollution, and water pollution
Low cost (with huge subsidies)	High land use (including mining)
Mining and combustion technology well-developed	Severe threat to human health
Air pollution can be reduced with improved technology (but adds to cost)	High CO ₂ emissions when burned
	Releases radioactive particles and toxic mercury into air

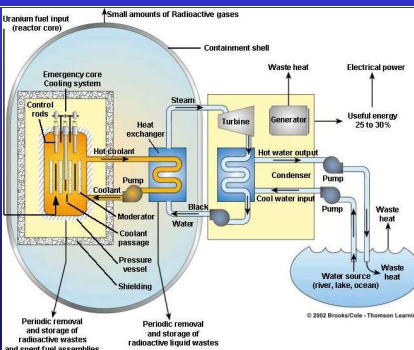
Nuclear Energy

- is generated using **Uranium** – a metal mined in various parts of the world.
- involves nuclear change, in which nuclei of certain isotopes with large mass-numbers are split apart into lighter nuclei, when struck by neutrons.
- produces ca. 11% of world's energy needs, & produces huge amounts of energy from small amounts of fuel, *without pollution, if handled.*

Nuclear Energy.....contd.

Involves Fission of Uranium-235 in reactors:

- generating heat used to produce steam
- that spins turbines to generate electricity.
- Produces radioactive fission fragments.



Nuclear Energy.....contd.

Trade-offs in

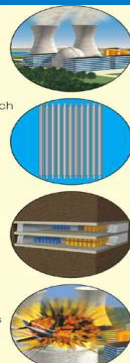
the use of

Nuclear Energy

Generation

Advantages

- Large fuel supply
- Low environmental impact (without accidents)
- Emits 1/6 as much CO₂ as coal
- Moderate land disruption and water pollution (without accidents)
- Moderate land use
- Low risk of accidents because of multiple safety systems (except in 35 poorly designed and run reactors in former Soviet Union and eastern Europe)



Disadvantages

- High cost even with large subsidies
- Low net energy yield
- High environmental impact (with major accidents)
- Catastrophic accidents can happen (Chernobyl)
- No widely acceptable solution for long-term storage of radioactive wastes and decommissioning worn-out plants
- Subject to terrorist attacks
- Spreads knowledge and technology for building nuclear weapons

Examples of Nuclear Plant Disasters

a) Three Mile Island - Pennsylvania

- Occurred on March 28, 1979 – via a Partial Core Melt-Down.
- No Deaths.
- Very Little Radiation Vented.

Examples of Nuclear Plant Disasters.....contd.

b) Chernobyl – Ukraine (Former USSR)

- Occurred on 26 April 1986 via explosion of 1 of 4 reactors
 - 31 immediate deaths.
 - 116,000 people evacuated.
 - 24,000 evacuees received high doses of radiation.
 - Caused Thyroid cancer in children.
- Damaged reactor entombed in concrete, other reactors returned to service within months.
- Eventually, remaining reactors put out of service.

Dealing with Nuclear Waste

These:

- Are High- and low-level wastes + radioactive fission fragments
- Create terrorist threats – storage casks hold 5-10 X more radioactivity than nuclear power plants
- Have the following disposal proposals
 - Underground burial
 - Disposal in space (illegal under international law)
 - Burial in ice sheets.
 - Dumping into subduction zones.
 - Burial in ocean mud.
 - Conversion into harmless materials (no way to do this with current technology).

Dealing with Nuclear Waste.....contd. Yucca Mountain

In 1982, Congress called for a high-level radioactive disposal site to be selected by March 1987, and to be completed by 1998.

- Final site selection occurred in 1989 @ Yucca Mountain, Nevada
- Wastes stored and guarded in one place
- Possible long-term groundwater contamination
- Security and safety concerns during waste transport to site
- Critics contend it is safer to store wastes at existing nuclear power plants.

Low Level Waste Materials other than Radioactive Isotopes)

These include:

- cooling water from nuclear reactors
- material from decommissioned reactors
- protective clothing, and
- like materials.
 - Prior to 1970, US alone placed 50,000 barrels of low-level radioactive waste on ocean floor.
 - There was a Moratorium in 1970 for this, and eventual Ban in 1983.

2. Energy from Renewable Resources

These renewable resources include:

- a) Solar
- b) Flowing water
- c) Wind
- d) Biomass
- e) Geothermal

A. Solar Power



- Is energy from the sun – source of most of Earth's energy
- Some of the ways, in which man uses Sun's energy:

➤ Solar Cells



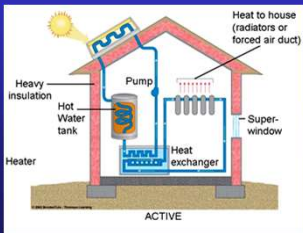
➤ Solar water heating



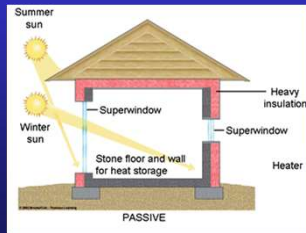
A. Solar Power.....contd.

Using Solar Energy to Provide Heat:

Active solar heating



Passive solar heating



Advantages of using Solar Power

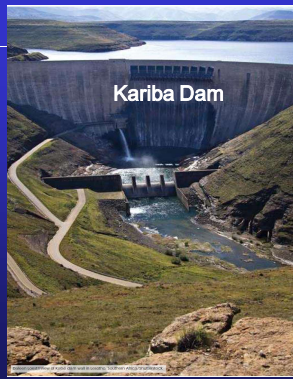
- Is **free** – no fuel, no waste & no pollution.
- Easy to use even in remote places
- Good for low-power uses, such as solar powered garden lights and battery chargers
- Is **renewable** since sun is always there.

Disadvantages of using Solar Power

- Does not work at night.
- Very expensive to build solar power stations.
- Can be unreliable unless in places that are very sunny.

B. Hydro-Electric Power

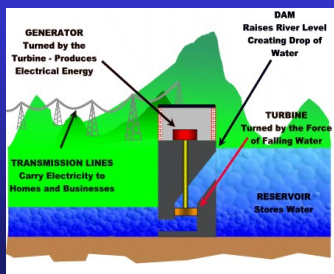
- Hydro-electric power is generated from falling water
- Nowadays, there are many hydro-electric power stations, providing around 20% of world's electricity.



B. Hydro-Electric Power.....contd.

How it works:

- A dam is built to trap water, usually in a river valley.
- Water is allowed to flow through tunnels in the dam, to turn turbines and thus, drive generators to produce electricity.



B.1 Advantages of using Hydro-Power

- Once dam is built, energy is **almost free**.
- **No waste or pollution** produced.
- Much more **reliable** than wind or solar power.
- **Water can be stored** above the dam & used when it is needed.
- Hydro-electric power stations can increase to full power very quickly, unlike other power stations.

B.1 Advantages of using Hydro-Power.....contd.

- Electricity can be generated constantly (all the time)
- **Hydro-electric power is renewable** – Sun provides water by evaporation from seas, and will continue to do it.

B.2 Disadvantages of using Hydro-Power

- **dams** are very **expensive to build**.
 - Building large dam will **flood very large areas** upstream, causing problems for animals that live there.
 - **Finding suitable site can be difficult** – especially with what to do with people, plants and animals living there already
- water quality and quantity downstream can be affected, which could have **an impact on plant life**.

C. Wind Power

...also comes from the sun:

- winds blow because sun warms atmosphere.
- Warm air tends to rise, and winds are due to other air moving in to replace it.
- wind blows **propellers** around, which turn **generators** to produce electricity.



C. Wind Power.....contd.

- Tendency to build many towers together is to make a **wind farm** produce more electricity.
- The **more the N° of towers**, the **more wind**, and the **larger the propellers**, the **more electricity can be produced**.



C.1 Advantages of using Wind Power

- Wind is free.
- Wind produces no waste or greenhouse gases.
- Land beneath can usually still be used for farming.
- Wind farms can be tourist attractions.
- A good method of supplying energy to remote areas
- Wind power is **renewable** as winds will keep on blowing.



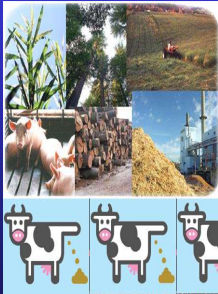
C.2 Disadvantages of using Wind Power

- Winds are not always predictable – **some days may have no wind.**
- Suitable areas for wind farms are often near coasts, where **land is expensive.**
- Some people feel that covering landscape with towers is **ugly**
- Can **kill birds.**
- Can affect television reception if located near residential areas
- Can be **noisy.**

D. Biomass

Energy from

- Biomass plantations
- Crop residues
- Animal manure
- Biogas
- Ethanol
- Methanol
- organic materials....



Energy from

- Wood logs and pellets
- Charcoal
- Agric. waste – stalks + other plant debris
- Timbering wastes
- Aquatic plants
- Urban wastes

D. Biomass.....contd.

- **Sugar cane** can be used to make alcohol, which can be burned to generate power
- Other solid wastes, can be burned to provide heat, or used to make steam for a power station
- **rubbish, animal manure, woodchips, seaweed, corn stalks** and other waste may also be used as sources of energy.

D.1 Advantages of using Biomass

- It makes sense to **use waste materials** where we can.
- The fuel tends to be **cheap**.
- **Less demand on the Earth's resources.**
- Is renewable – so long as waste products continue to be made...
 - ...through planting & growing more sugar cane & more trees...

D.2 Disadvantages of using Biomass

- **Collecting** waste in sufficient **quantities** can be difficult.
- Burning of fuel causes **pollution**.
- Some waste materials are not available all year round.

E. Geothermal Energy

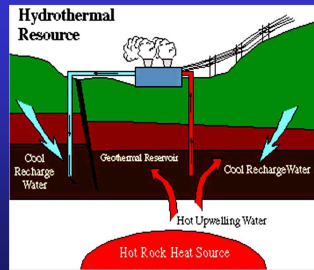
- is energy from heat inside the Earth.



E. Geothermal Energy.....contd.

How it works:

- Hot rocks heats up groundwater to produce steam;
- When holes are drilled down to hot region, steam comes up...
- steam is purified & used to drive turbines, which drive generators to make electricity.
- **an important resource in volcanically active places**

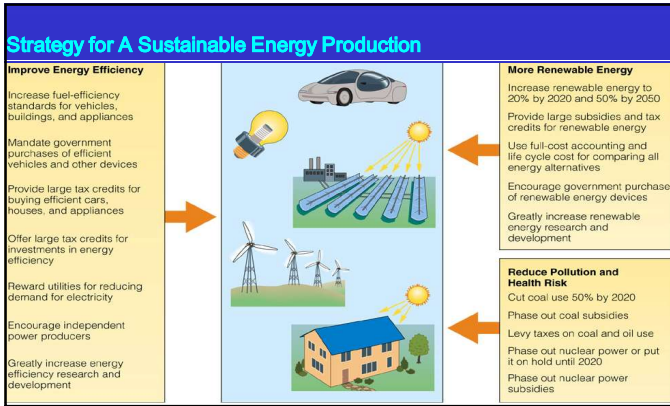


E.1 Advantages of using Geothermal Energy

- does not produce **any pollution**.
- power stations don't take up much space.
- **no fuel is needed**.
- Once built, energy from a geothermal power station is **almost free**.
- **is renewable** – energy keeps on coming, so long as not too much cold water is pumped down to cool rocks too much.

E.2 Disadvantages of using Geothermal Energy

- There are **not many places, where you can build a geothermal power station**.
- Sometimes **a geothermal site may "run out of steam"**, perhaps for several years.
- **Dangerous gases and minerals may come up** from underground.



- ### Strategy for A Sustainable Energy Production.....contd.
- Drive a car that gets at least 15 kilometers per liter.
 - Use mass transit, walking, and bicycling.
 - Turn off lights, TV sets, computers, and other electronic equipment when they are not in use.
 - Wash laundry in warm or cold water.
 - For cooling, open windows.
 - Buy the most energy-efficient homes, lights, cars, and appliances available.
 - Turn down the thermostat on water heaters to 43-49°C and insulate hot water heaters and pipes.

End of Lecture
