Environmental Sustainability

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(Module 5)

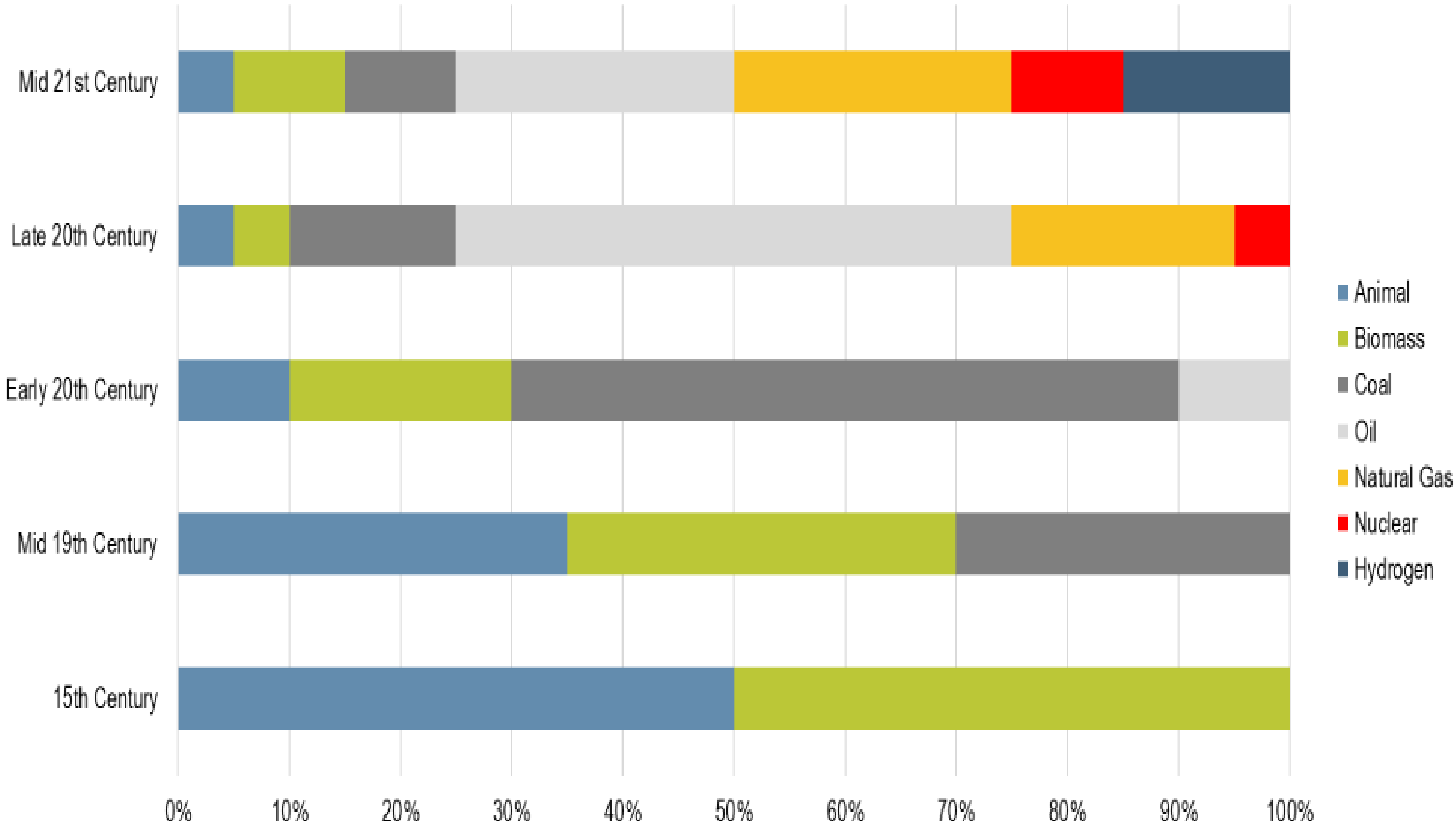
It doesn't matter how many resources you have.

If you don't know how to use them,
it will never be enough.

Examples of energy resources

- **Fossil fuels: Coal, Lignite, Crude oil, Natural gas, etc.**
- **Nuclear fuels: Uranium, Thorium, Deuterium etc.**
- **Hydro energy: The energy of falling water**
- **Geothermal: The heat from the underground streams**
- **Solar energy: Electromagnetic radiation from the sun**
- **Wind energy: The energy from moving air**
- **Tidal energy: The energy associated with the tidal waters**
- **Ocean Thermal energy: The temperature gradient existing naturally in oceans**
- **Biomass : Anaerobic degradation of organic/animal waste**

Changes in energy resources



Energy resources

- **The first form of energy technology probably was fire, which produced heat and the early man used it for cooking.**

- **Wind and hydropower have also been in use for the last 10,000 years**

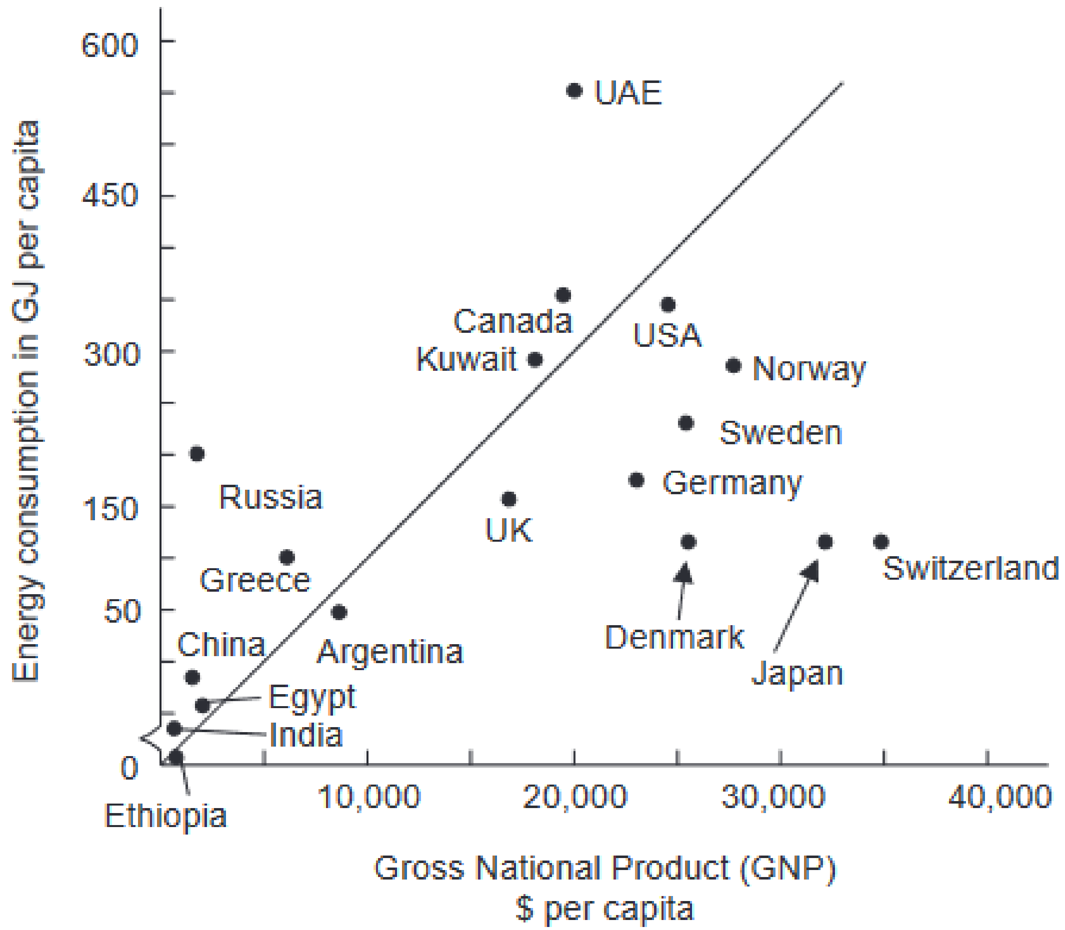
- **In 1970 due to the Iranian revolution and the Arab oil embargo the prices of oil shot up. This ultimately led to the exploration and use of several alternative sources of energy**

The energy consumption of a nation is usually considered as an index of its development. This is because almost all developmental activities are directly or indirectly dependent upon energy. We find wide disparities in per capita energy use between developed and the developing nations

Per Capita Energy Use

GNP: The total value of all the goods and services produced by a country in a year including income from foreign investments, divided by the number of people living there.

Energy Consumption per Capita: Total energy consumption is divided by the total population.



Developed countries like U.S.A. and Canada constitute about 5%of the world is population but consume one fourth of global energy resources. An average person there consumes 300 GJ (Giga Joules, equal to 60 barrels of oils) per year. By contrast, an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1 GJ in a year.

Per Capita Energy Use

By contrast, an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1 GJ in a year. So a person in a rich country consumes almost as much energy in a single day as one person does in a whole year in a poor country. This clearly shows that our life-style and standard of living are closely related to energy needs

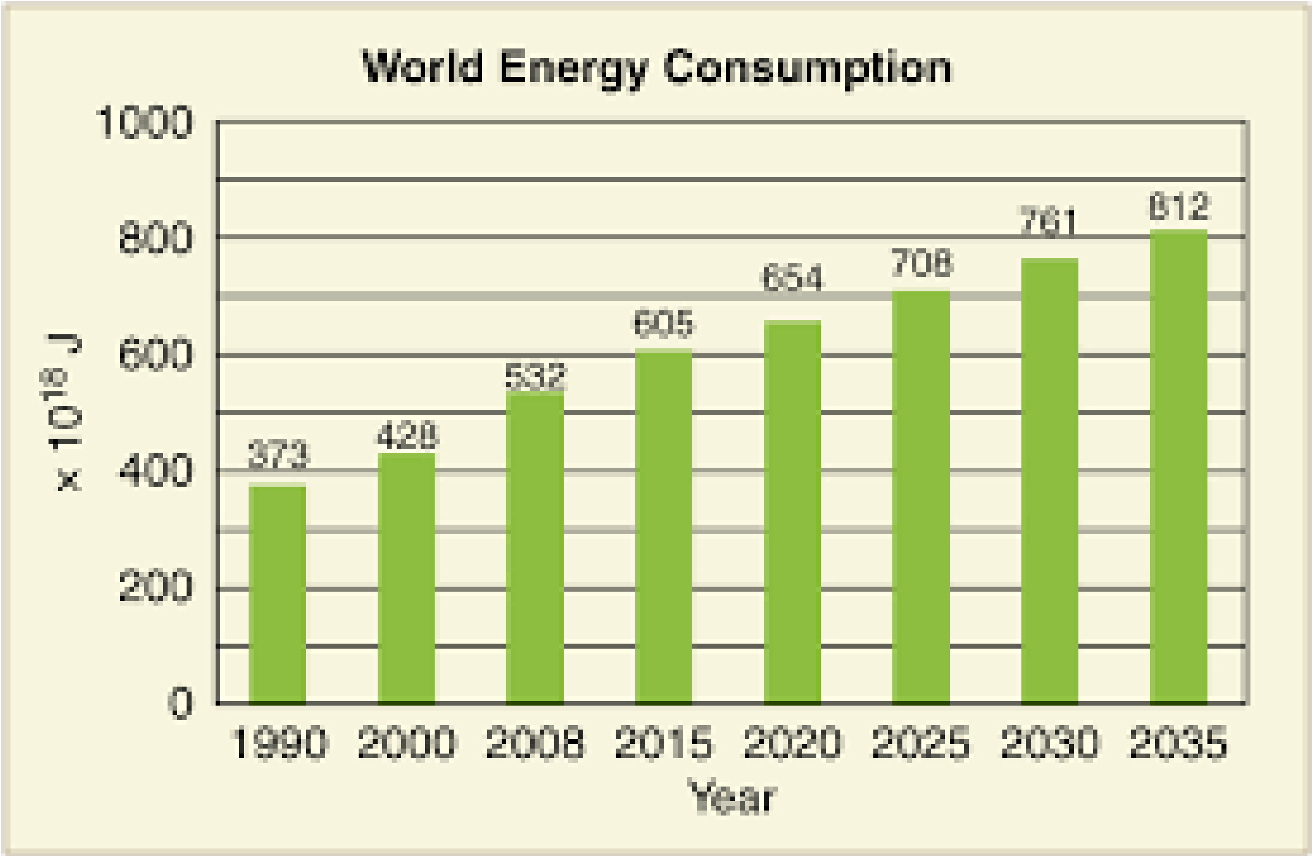
Strong correlation between per capita energy use and GNP (Gross National Product): U.S.A., Norway, Switzerland, etc. with high GNP show high energy use while India, China etc have low GNP and low energy use.

Bahrain and Quatar are oil rich states (UAE) and hence their energy consumption and GNP are more, although their development is not that high.

Who is responsible for the energy deficit? Think

Energy need is Growing

Development in different sectors relies largely upon energy. Agriculture, industry, mining, transportation, lighting, cooling and heating in buildings all need energy. With the demands of growing population the world is facing further energy deficit.



The fossil fuels like coal, oil, and natural gas which at present are supplying 95% of the commercial energy of the world resources and are not going to last for many more years.

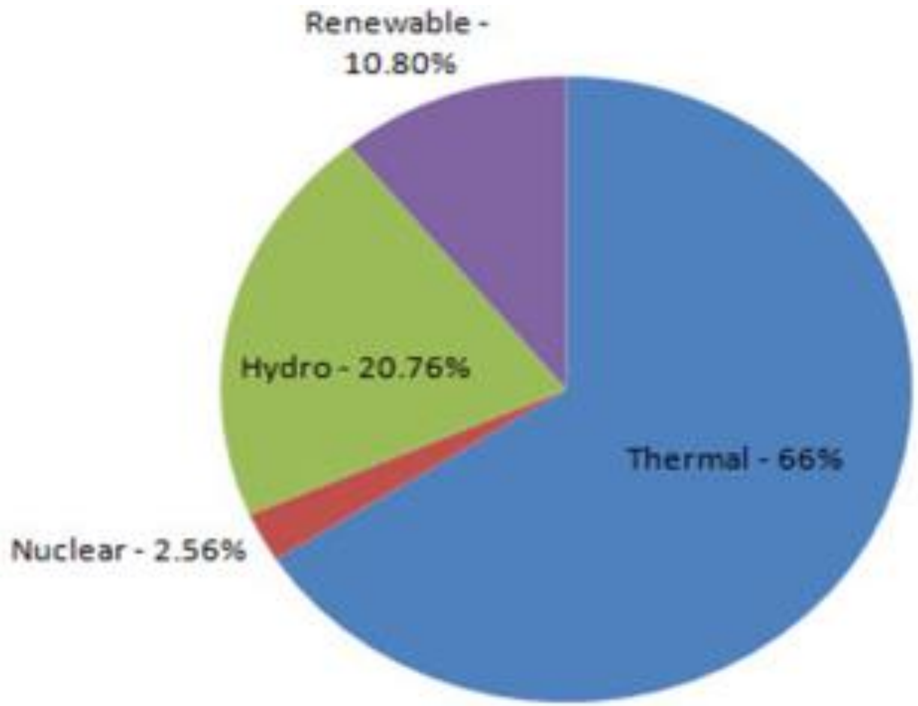
India's Energy Scenario

India is the 7th largest country and 4th largest power producing and 3rd biggest primary energy consumption country.

To maintain the growth rate, need rapid growth in the energy sector.

As per the 2011 census, 55.3% of rural households had access to electricity. Still, most of the rural areas have limited supply hours of electricity.

Total energy produced in the form of electricity is 66% from coal, 21% from hydro power, 2.5% from nuclear and 10.8% from renewable energy.



66% of the total energy requirement in India is delivered by commercial fuels and non-commercial fuel contributes the rest 34%.

In India, coal contributes about 66% of the total energy requirement. India with 68 billion tonnes of coal is the third largest coal producing country in the world.

With the current rate of mining, 323 million tonnes per year our coal reserve will be sufficient for about 200 years.

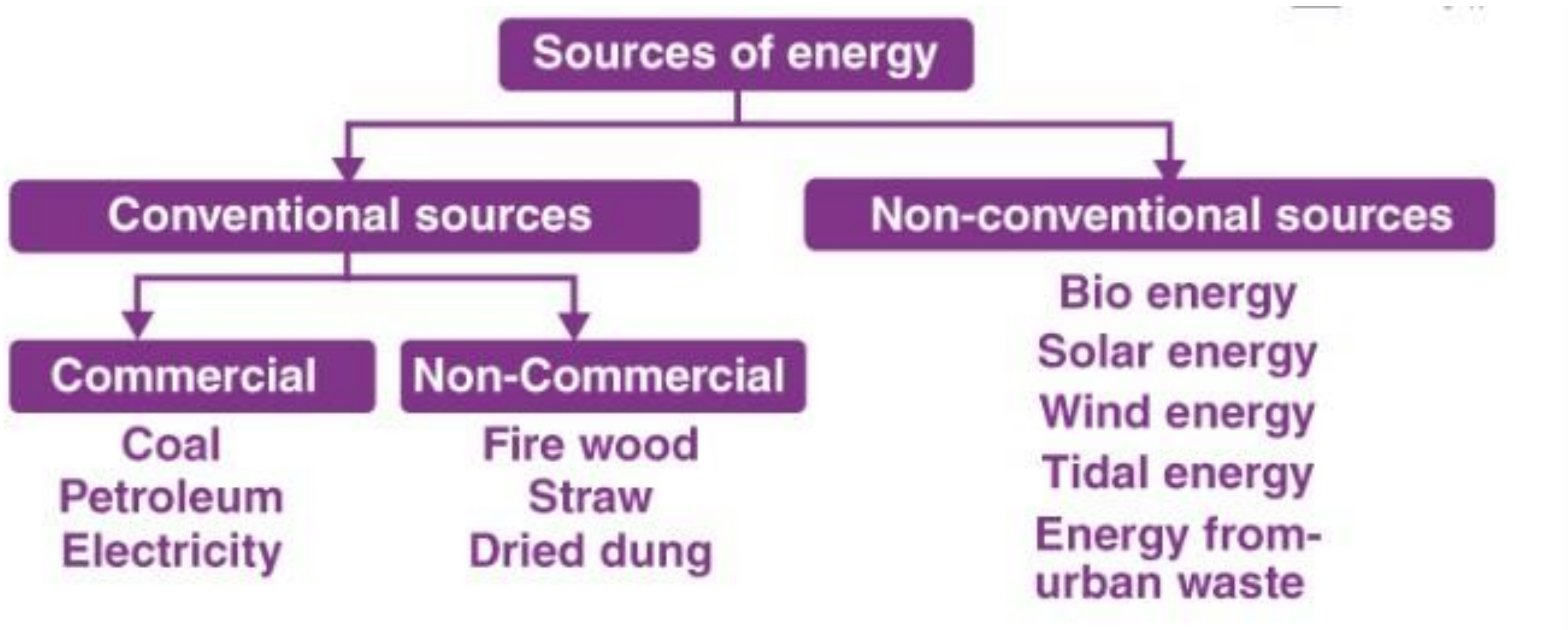
Oil with the stock of 250000 million tonnes, would suffice only for 100 years in India.

Our reserves of natural gas about 700 billion $meter^3$ will suffice only for the next 20 years.

Need of non-conventional sources in addition to conventional sources!!!

Conventional sources and non-conventional sources

A source of energy is one that can provide an adequate amount of energy in a usable form over a long period of time. These sources can be of two types:

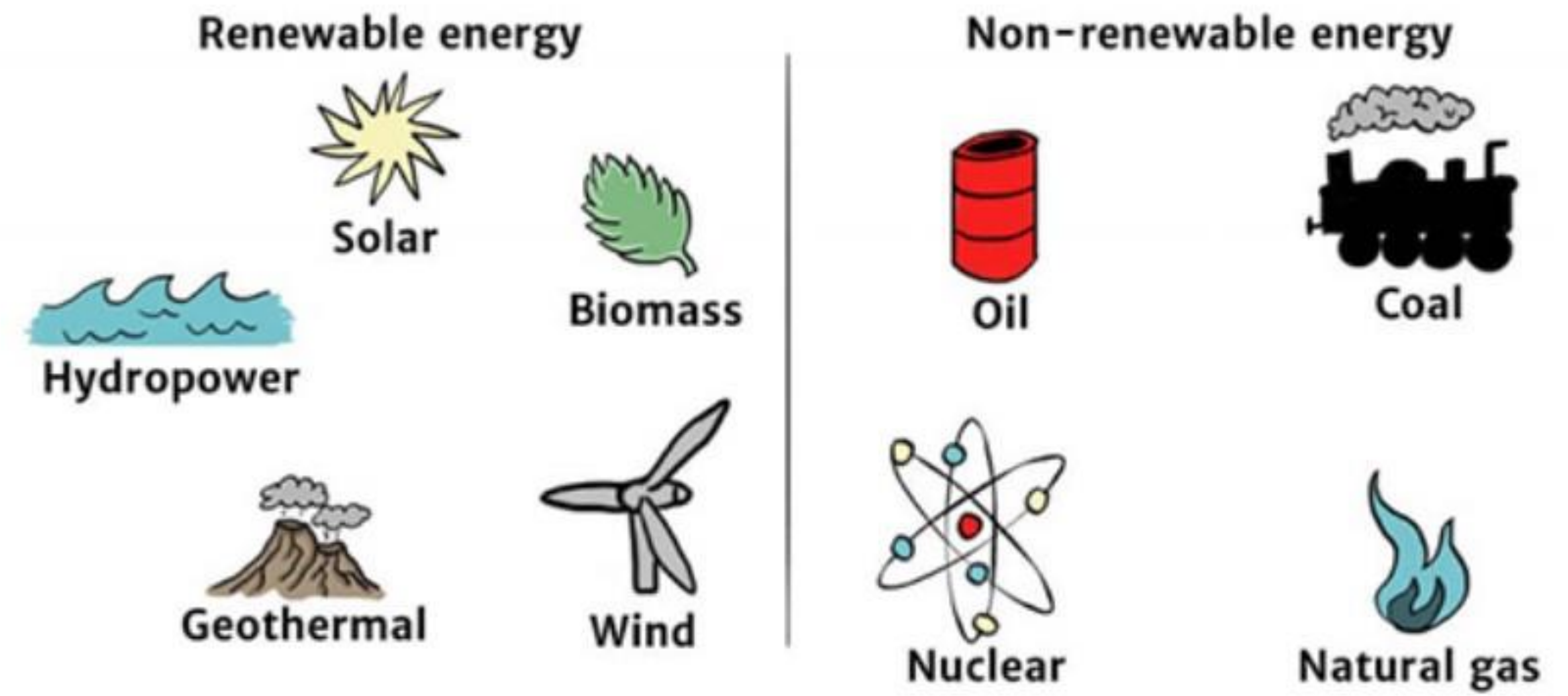


Nonconventional sources: Renewable Sources of Energy.

Conventional sources: Non-Renewable Sources of Energy

Renewable and non-renewable energy

Renewable Resources can be generated continuously in nature and are inexhaustible e.g. wood, solar energy, wind energy, tidal energy, hydropower, biomass energy, bio-fuels, geothermal energy and hydrogen. They are also known as non-conventional sources of energy and they can be used again and again in an endless manner



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

Non-renewable energy Sources

These are fossil fuels like coal, petroleum, natural gas, and nuclear fuels. These were formed by the **decomposition of the remains of plants and animals buried under the earth millions of years ago.**

The fuels are very precious because they have taken such a long time to be formed and if we exhaust their reserves at such a fast rate as we have been doing, ever since we discovered them, then very soon we will lose these resources forever.

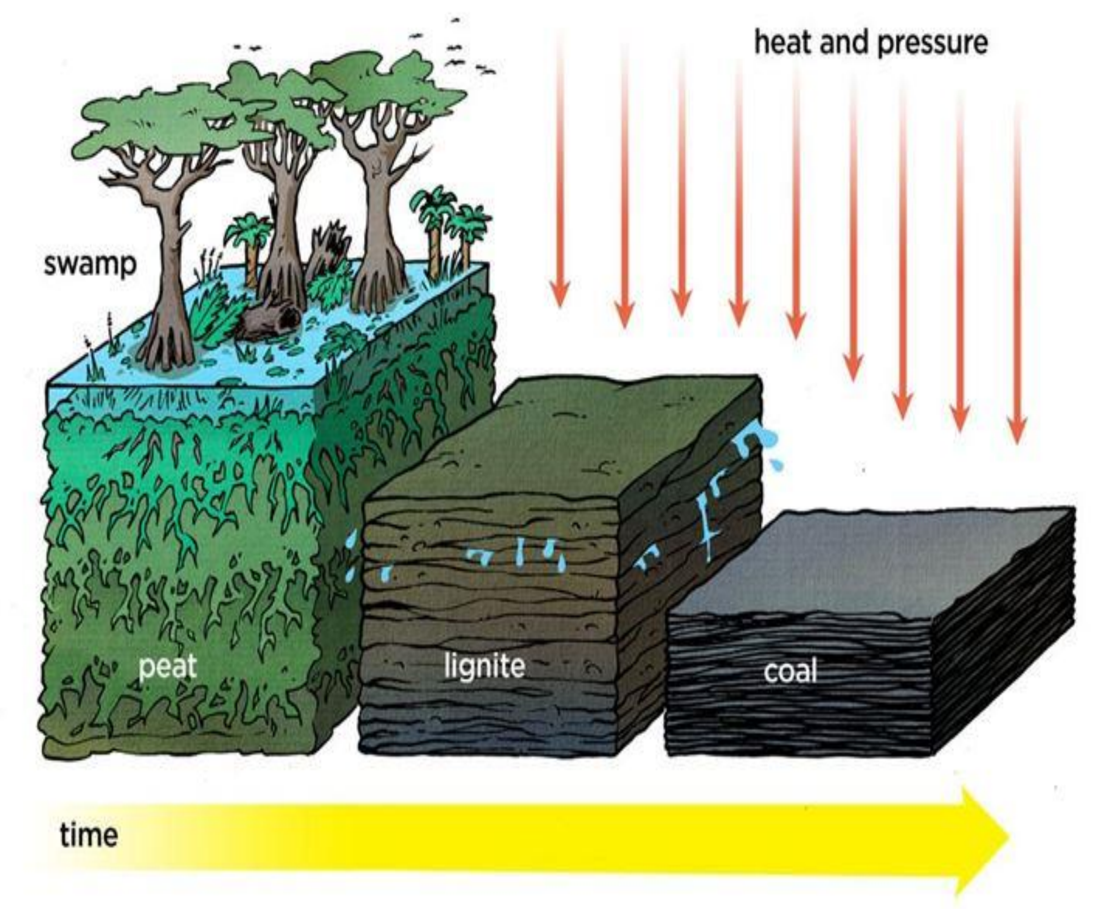
Non-renewable energy Sources: Coal

Formation of coal: Coal is fossil fuel that comes from the remain of prehistoric plants or animals.

Peat: It is an organic substance which is formed due to the partial decomposition of dead matter. The partial decomposition is due to the accumulation of the matter underwater which cuts off the oxygen supply.

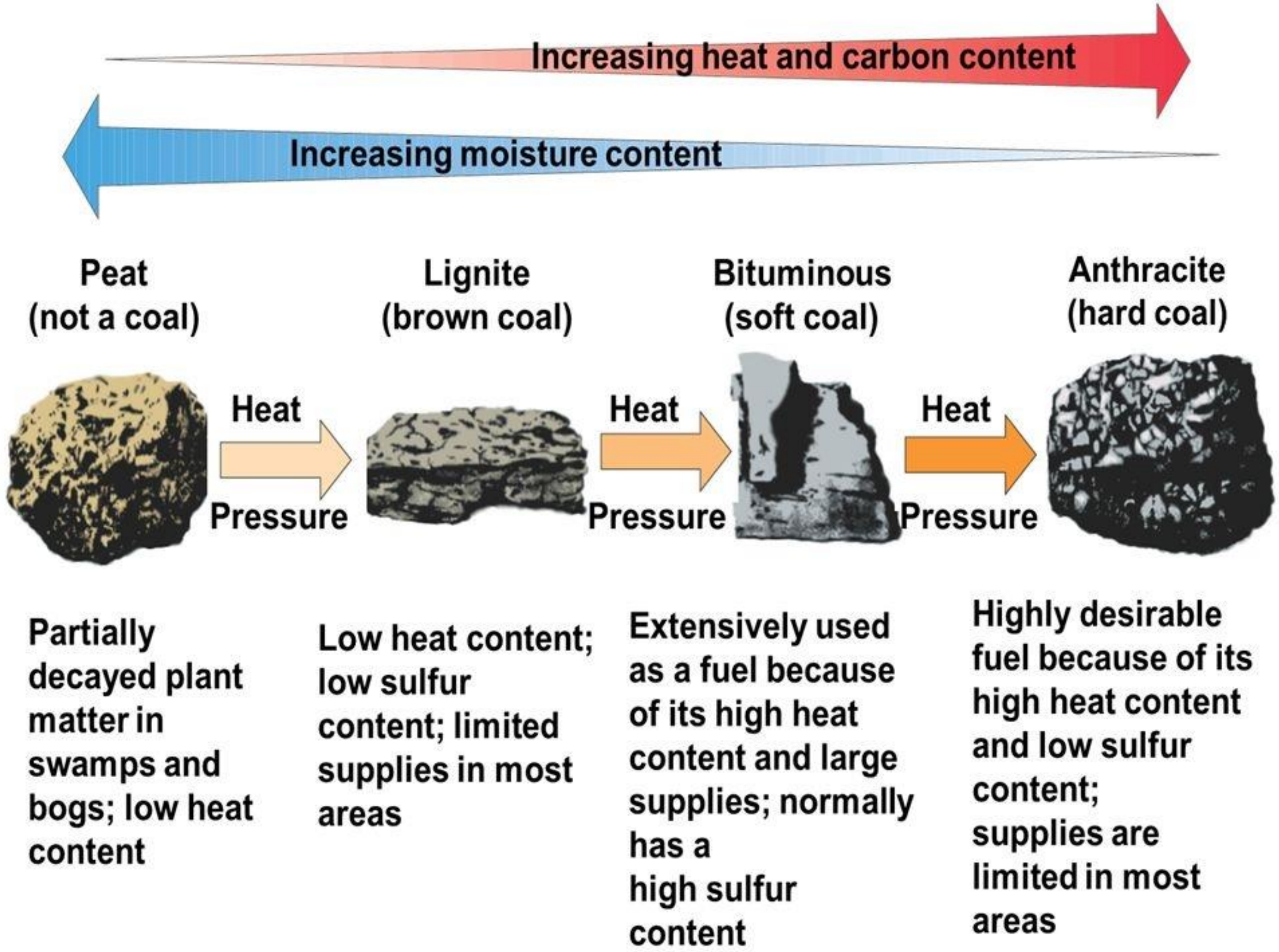
Lignite: It is a dark brown matter formed due to the pressure exerted by the sediments overlying the organic matter. It consists of traces of plants

Bituminous Coal: It is formed due to added pressure. This is also called soft coal.



Anthracite Coal: It is formed due to the high pressure and high temperature for a long period of time. It is hard, lustrous, and has the highest percentage of carbon among peat, lignite, bituminous, and anthracite. This is also called as hard coal.

Non renewable energy Sources: Coal



Anthracite coal has maximum carbon (90%) and calorific value (8700 kcal/kg.) Bituminous, lignite, and peat contain 80, 70 and 60% carbon, respectively. Coal is the most abundant fossil fuel in the world. **At the present rate of usage, the coal reserves are likely to last for about 200 years and if its use increases by 2% per year, then it will last for another 65 years.**

Non renewable energy Sources: Coal

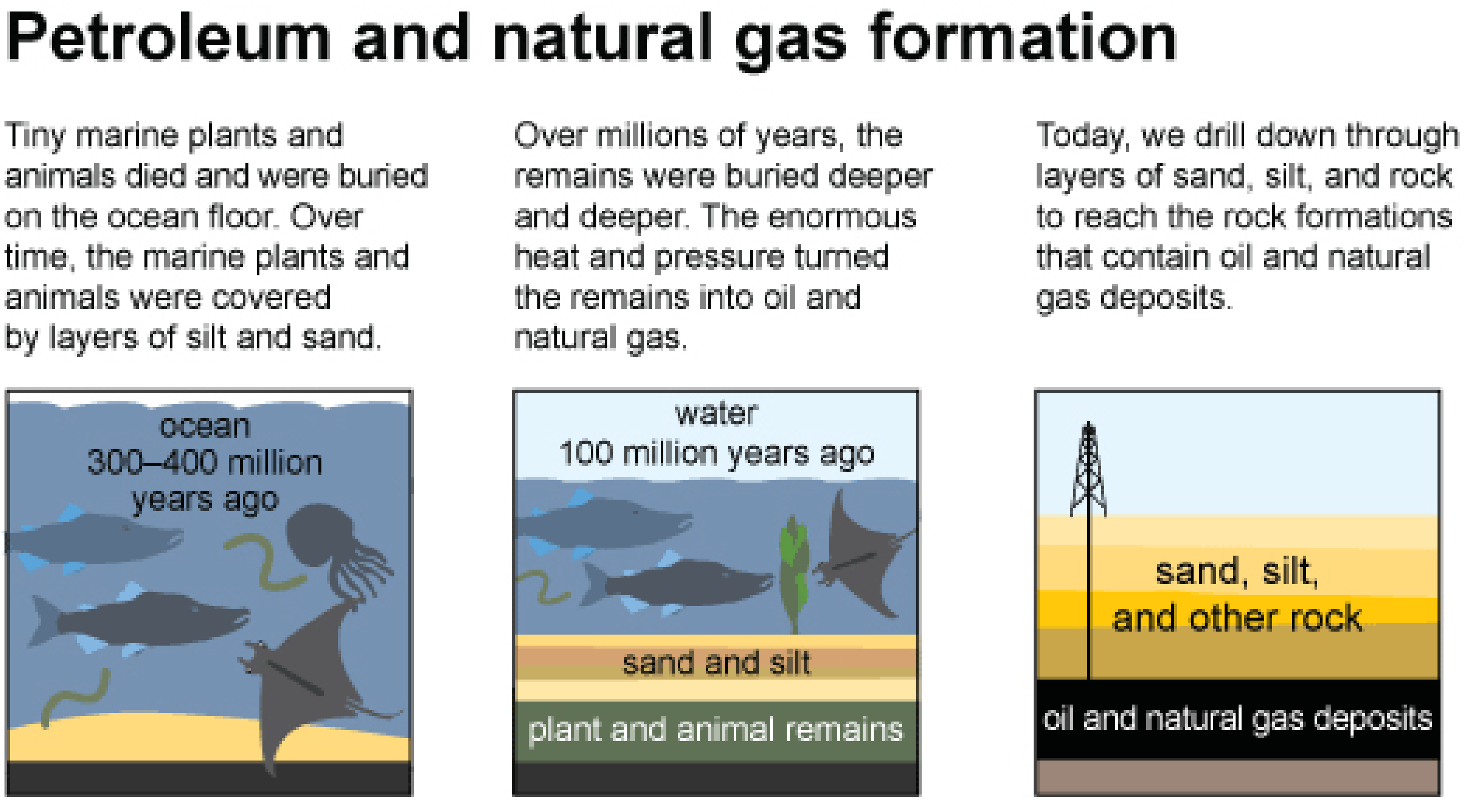
India has about 5% of world's coal and **Indian coal is not very good in terms of heat capacity**. Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli, and Godavari valley. **The coal states of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. Anthracite coal occurs only in J & K.**

Coal Ash: Growing Problem

Burning coal produces an ash that contains **highly toxic and indestructible chemicals such as arsenic, cadmium, chromium, lead, mercury, and radioactive radium.** Each year, the amount of ash produced by **coal-fired power plants in the United States would fill enough rail cars to make a train that would be over 13,800 kilometers (8,600 miles) lon**g—more than three times the distance between New York City and Los Angeles, California

Non-renewable energy Sources: Coal

Formation of Petroleum: **The word petroleum translates to *"rock oil."* It is derived from the Greek word "petra" and the Latin word "oleum". When it is drilled from the ground in the liquid form, it is called crude oil. Humans have known about its existence for 4000 years**



Source: Adapted from National Energy Education Development Project (public domain)

Millions to hundreds of millions of years ago, the remains of plants and animals (such as diatoms) built up in thick layers on the earth's surface and ocean floors, sometimes mixed with sand, silt, and calcium carbonate. Over time, these layers were buried under sand, silt, and rock. Pressure and heat changed some of this carbon and hydrogen-rich material into coal, some into oil (petroleum), and some into natural gas.

Non renewable energy Sources: Oil

It is the lifeline of global economy. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (Organization of Petroleum exporting countries). About 1/4thof the oil reserves are in Saudi Arabia.

At the present rate of usage, the world's crude oil reserves are estimated to get exhausted in just 40 years. Some optimists, however, believe that there are some yet undiscovered reserves. Even then the crude oil reserves will last for another 40 years or so.

Non renewable energy Sources: Natural Gas

It is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. Natural gas is the cleanest fossil fuel. It can be easily transported through pipelines. It has a high calorific value of about 50KJ/G and burns without any smoke

Compressed natural gas (CNG)

Synthetic natural gas (SNG)

Non renewable energy Sources
Nuclear Energy

Nuclear power is the use of **nuclear reactions** that **release** nuclear energy to generate **heat**, which most frequently is then used in steam turbines to produce electricity in a nuclear power plant.

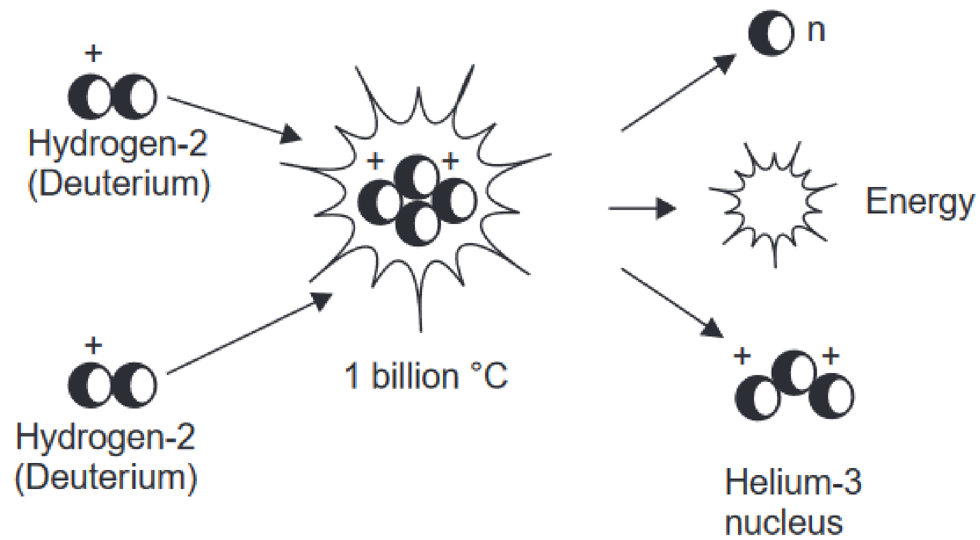
Nuclear reactions are of two type-

a) Nuclear Fusion

b) Nuclear Fission

Non renewable energy Sources
Nuclear Energy

Nuclear fusion is an atomic reaction in which multiple atoms combine to create a single, more massive atom. The resulting atom has a slightly smaller mass than the sum of the masses of the original atoms.



The difference in mass is released in the form of energy during the reaction, according to the Einstein formula $E = m c^2$,

Where,

E = Energy in joules

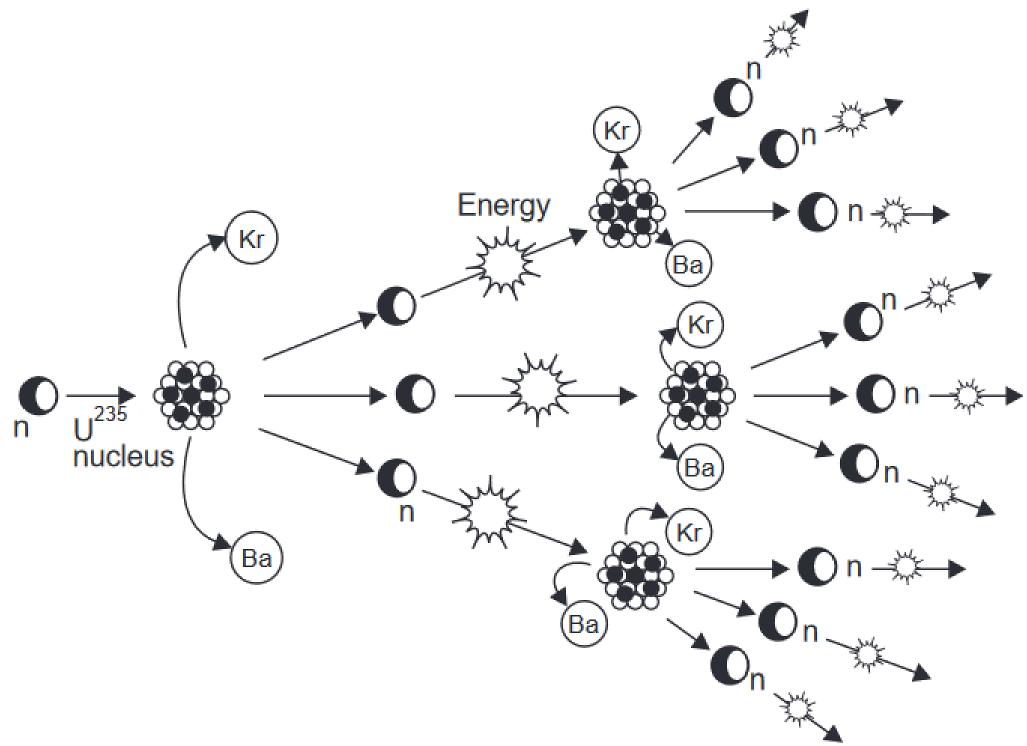
m = mass difference in kg

c = Speed of light (3×10^8 m/sec).

Non renewable energy Sources
Nuclear Energy

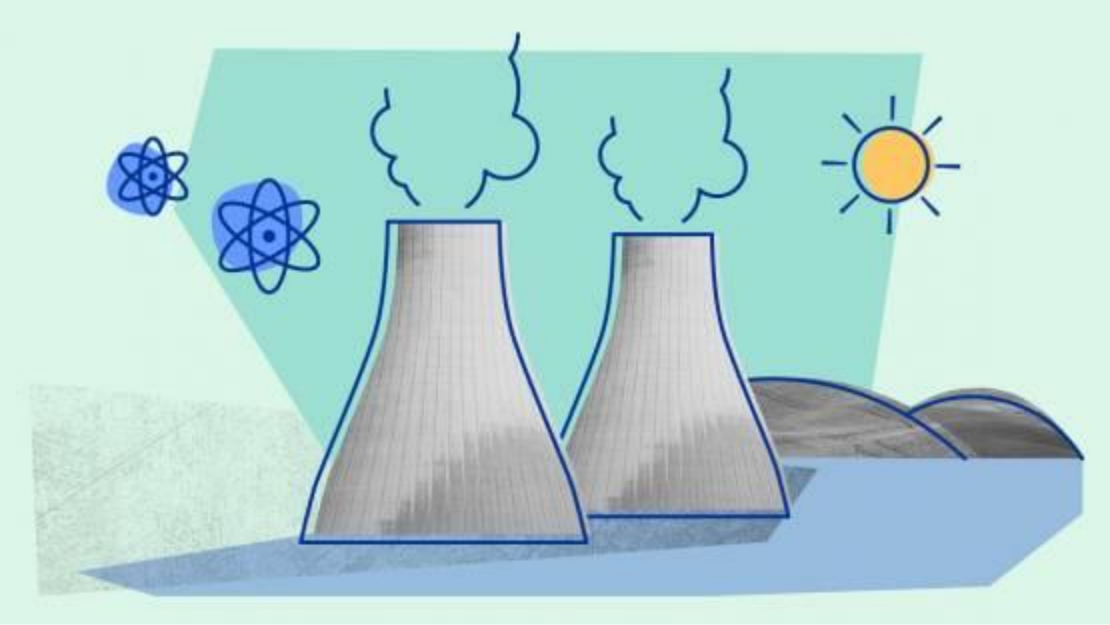
Nuclear fission is a nuclear reaction in which the nucleus of an atom splits into smaller parts (lighter nuclei). The fission process often produces free neutrons and gamma photons and releases a very large amount of energy.

Nuclear fission is used in nuclear weapons and nuclear reactors. Heat from nuclear fission is passed to a working fluid (water or gas), which runs through steam turbines



$$_{92}U^{235} + {}_{0}n^{1} = {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\ {}_{0}n^{1} + \text{Energy}$$

Non renewable energy Sources
Nuclear Energy



Advantages of Nuclear Power

- Clean
- Plentiful Supply
- High energy content in uranium
  - Small fuel pellet
  - Can provide base load power
  - Energy savings in transportation
- Operating cost is low after construction

Drawbacks to Using Nuclear Power

- Initial construction costs
- Radioactive waste byproduct
- Storage
- Disasters
- Public perception

Non renewable energy Sources
Nuclear Energy

- Nuclear power plants
  - 430 operating nuclear power plants (civilian) worldwide.

  - 30 countries generate nuclear electricity:
    - About 17% of all electricity is generated worldwide.
  - United States:
    - 109 licensed nuclear power plants; about 20% of the electricity.
    - Licenses are usually given for a 40-year period.
    - No new nuclear power plant built since 1979 (Three Mile Island incident).
  - China:
    - Plans to have 2 new nuclear reactors per year.

Nuclear Power: Indian Prospect

Nuclear power is the fifth-largest source of electricity in India after coal, gas, hydroelectricity and wind power.

As of 2016, India has 22 nuclear reactors in operation in 7 nuclear power plants, having a total installed capacity of 6,780 MW.

Nuclear power produced a total of 35 TWh of electricity in 2016.

6 more reactors are under construction with a combined generation capacity of 4,300 MW.

Renewable energy Sources: Solar Energy

Sun is the ultimate source of energy. The nuclear fusion reaction occurring in the sun releases an enormous quantity of energy in the form of light and heat.

1.4 kJ/sec/m^2 solar energy is received by the near-earth space.

Use

Drying clothes, Food grains

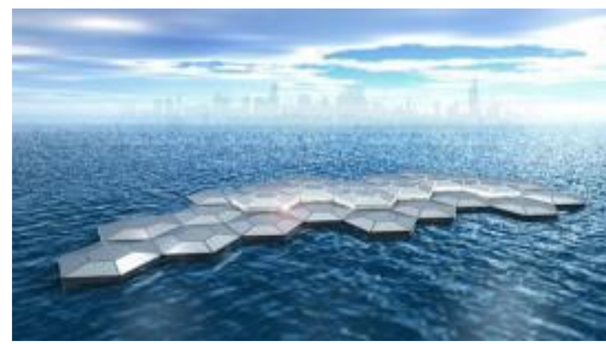
Preservation of eatables

Obtaining salt from seawater

Renewable energy Sources: Solar Energy

1. Solar Water Heating

2. Solar cell



3. Solar cooker

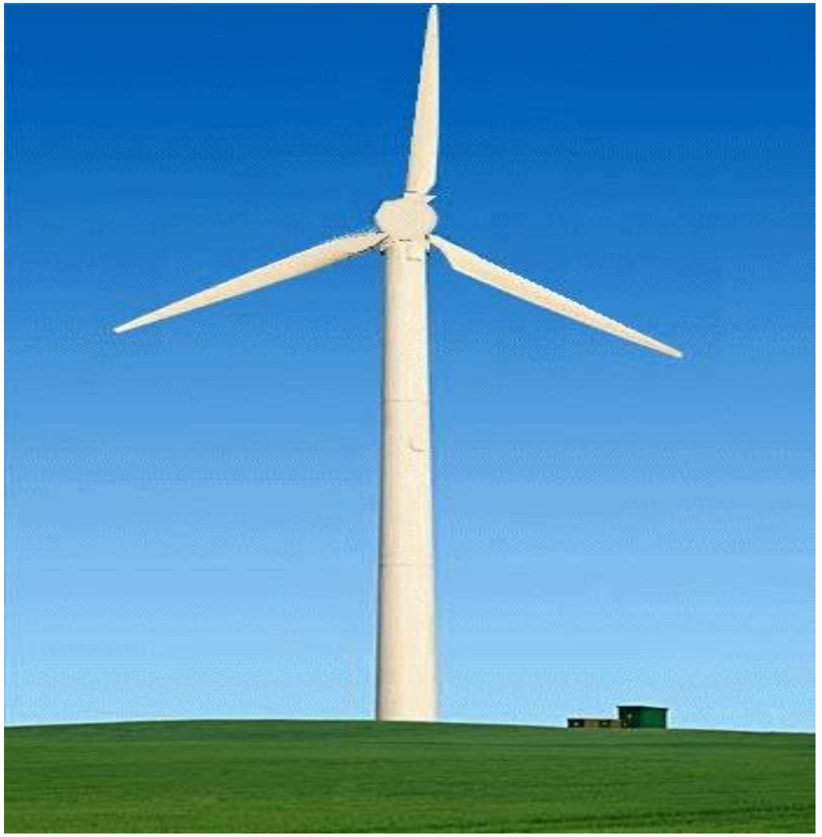
4.Solar Pond

5. Solar power plant

6. Solar Green House

Renewable energy Sources: Wind Energy

- Due to the virtue of motion, wind possesses kinetic energy which is called "Wind Energy"
- **The kinetic energy of the winds can be harnessed using windmills.**
- **The blades of the windmills are continuously rotating due to the force of the striking wind**
- **The rotational motion of the blades drives a number of machines like water pumps, flour mills, and electric generators.**
- **A large number of windmills can be installed to create a wind farm to produce more electrical energy**



- **These wind farms are located in coasted region, open grassland, hilly region where the wind is strong and steady.**
- **The minimum wind speed should be 15 km/hr**
- **The largest wind farm in our country is Kanyakumari, Tamil Nadu generating 380 MW of electricity**
- **Highly pure, no pollution, cheap**

Wind Energy

$$P = \frac{1}{2}\rho A V^3$$

Where P = power, rho = density, A = area of blade (e.g., area of circle), and V = velocity of wind.

Determine the power in the wind if the wind speed is 20 m/s and the blade length is 50 m. The air density is 1.23 kg/m^3.

Kinetic energy to …… Mechanical energy

The area is given by, $A = \pi r^2$

A = π × 2500

= 7850 m

The wind power formula is given as,

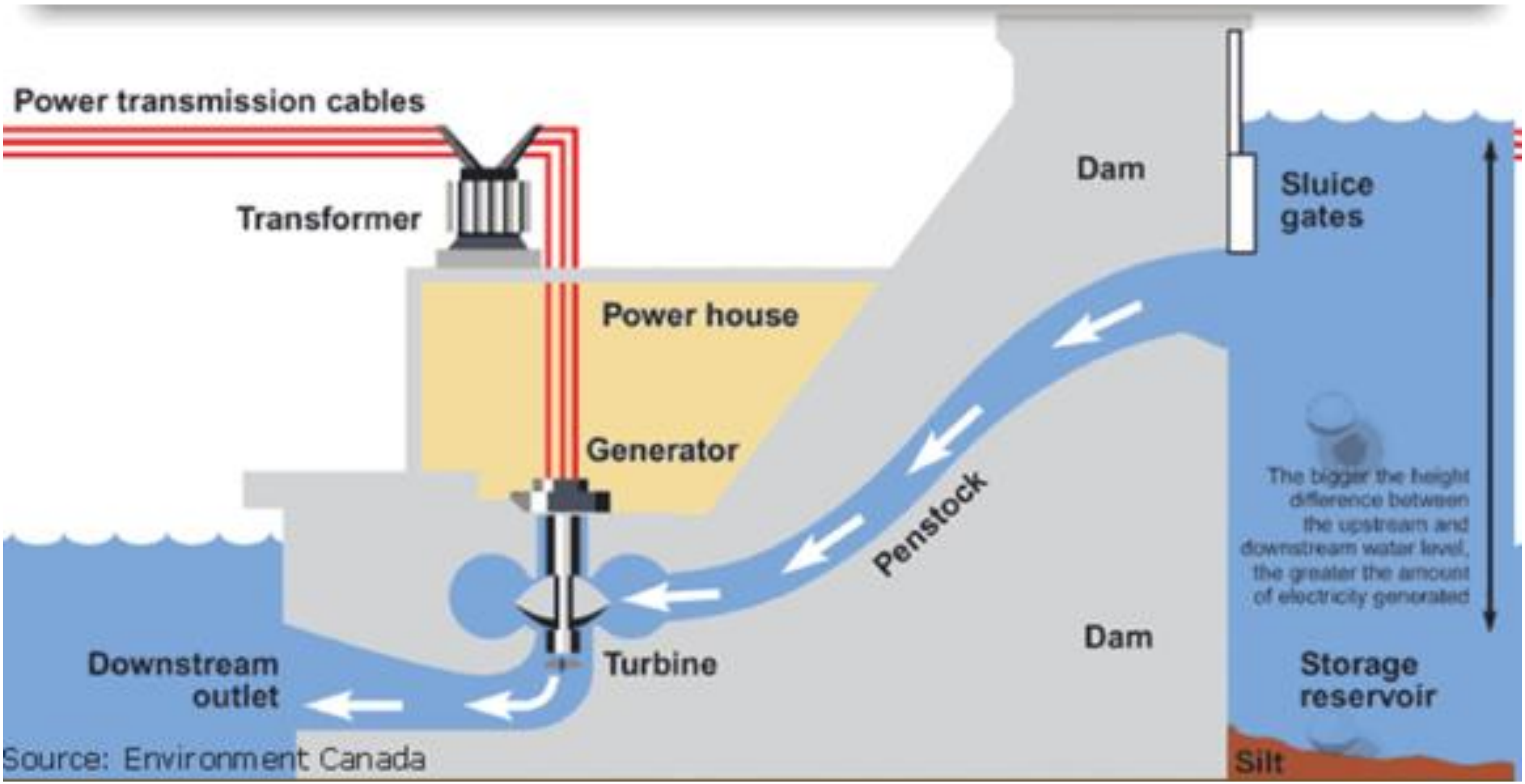
$$P = \frac{1}{2}\rho A V^3$$

$$P = \frac{1}{2}(1.23)(7850)20^3$$

P = 38622 W

Hydro power

The water stored in a dam is allowed to fall from a height. The blades of the turbine located at the bottom of the dam move very fast with the fast-moving water. The moving blades of the turbine rotates the generator and produce electricity



If an object is dropped from a height of 10 m. If the mass is 5 kg, then calculate the kinetic energy just before hitting the Earth.

Hydro power

Hydro Power plants convert __________ energy of falling water into electricity. Fill in the gap.

A Potential

B tidal

C thermal

D Chemical

The stored energy (potential energy) of the water is converted into kinetic energy by making them fall on the turbines. The turning of the turbines (mechanical energy) is then converted to generate electricity (electrical energy).

- India is the 7th largest producer of hydroelectric power in the world.
- As of 30 April 2017, India's installed utility-scale hydroelectric capacity was 44,594 MW, or 13.5% of its total utility power generation capacity.
- India's hydroelectric power potential is estimated at 148,700 MW at 60% load factor.
- The hydro-electric power plants at Darjeeling and Shivanasamudram were among the first in Asia.

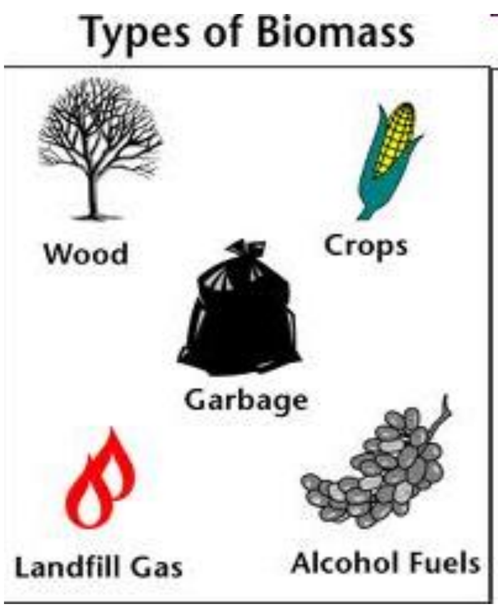
Energy from Biomass

Biomass is the Organic matter produced by the plants and animals which includes wood, crop residues, cattle dung, manure agricultural waste etc

It can be produced form

1. **Energy plantations :** sugarcane, sugar beet, aquatic weeds, potato etc – produces gas fermentation
2. **Petro-crops:** Latex-containing plants like EUPHORBIAS and OIL PALMS which are rich in carbohydrate and can produce OIL LIKE substance under HT and HP. Produce gasoline
3. **Agri- and urban waste biomass:** crop residues, coconut shells, peanut hulls, cotton stalks produce energy by burning. Poultry waste, cow dung etc can be used.

Pyrolysis of wood yield methanol which can be used as an additive. Gasoline mixed with 20% of methanol is known as **Gasohol.**



Alcohols like ethanol and methanol can be produced by fermentation and can be used as a fuel. Carbohydrate rich substance like sugar cane and corn can be used to produce bio fuels.

Natural Resources

Life on this planet earth depends upon a large number of things and services provided by the nature, which are known as Natural resources. Thus water, air, soil, minerals, coal, forests, crops and wild life are all examples of natural resources.

The natural resources are of two kinds:

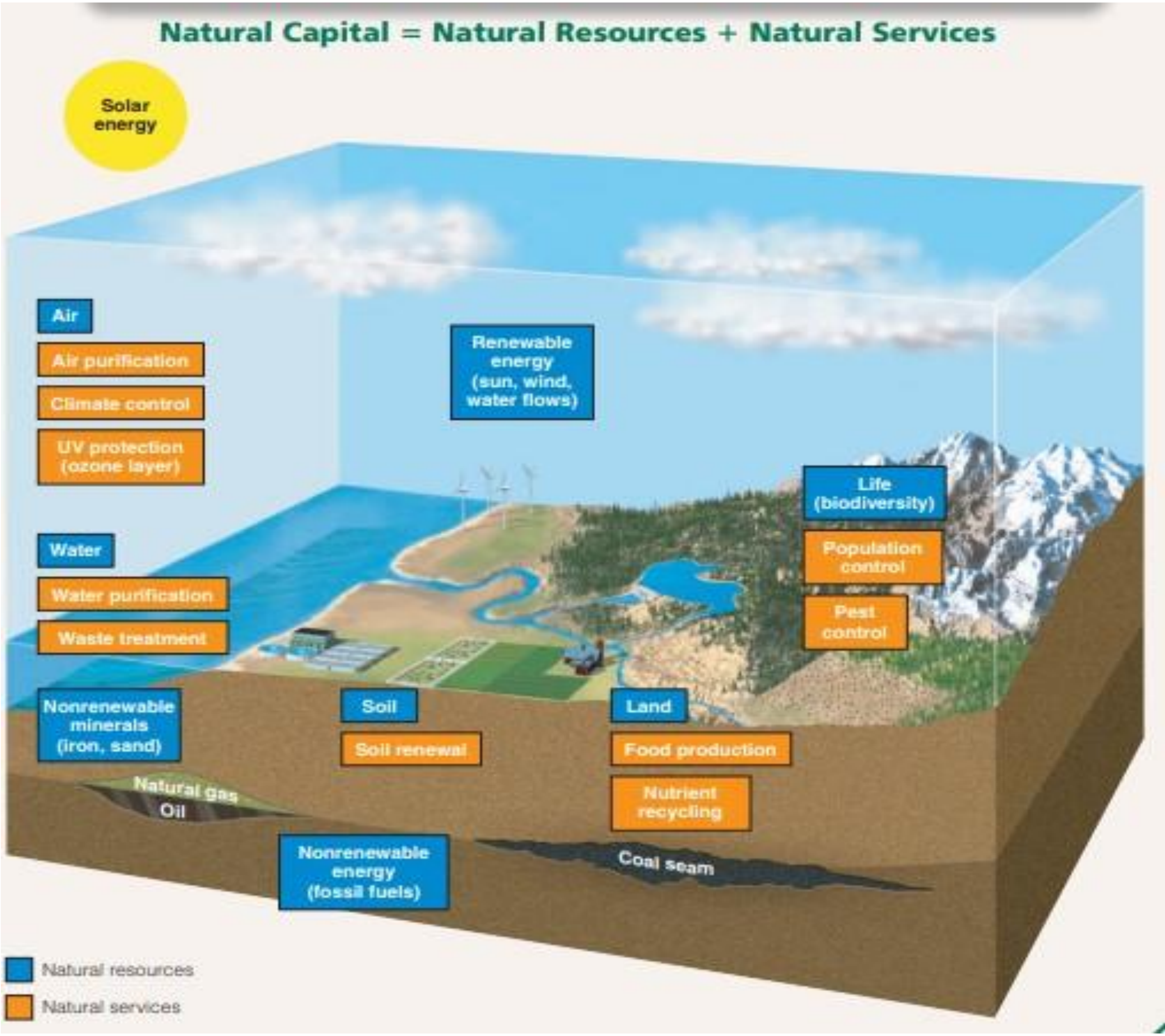
- Renewable resources which are inexhaustive and can be regenerated within a given span of time e.g. forests, wildlife, wind energy, biomass energy, tidal energy, hydro power etc. Solar energy is also a renewable form of energy as it is an inexhaustible source of energy.
- Non-renewable resources which cannot be regenerated e.g. Fossil fuels like coal, petroleum, minerals etc. Once we exhaust these reserves, the same cannot be replenished.

Even our renewable resources can become non-renewable if we exploit them to such extent that their rate of consumption exceeds their rate of regeneration. For example, if a species is exploited so much that its population size declines below the threshold level then it is not able to sustain itself and gradually the species becomes endangered or extinct.

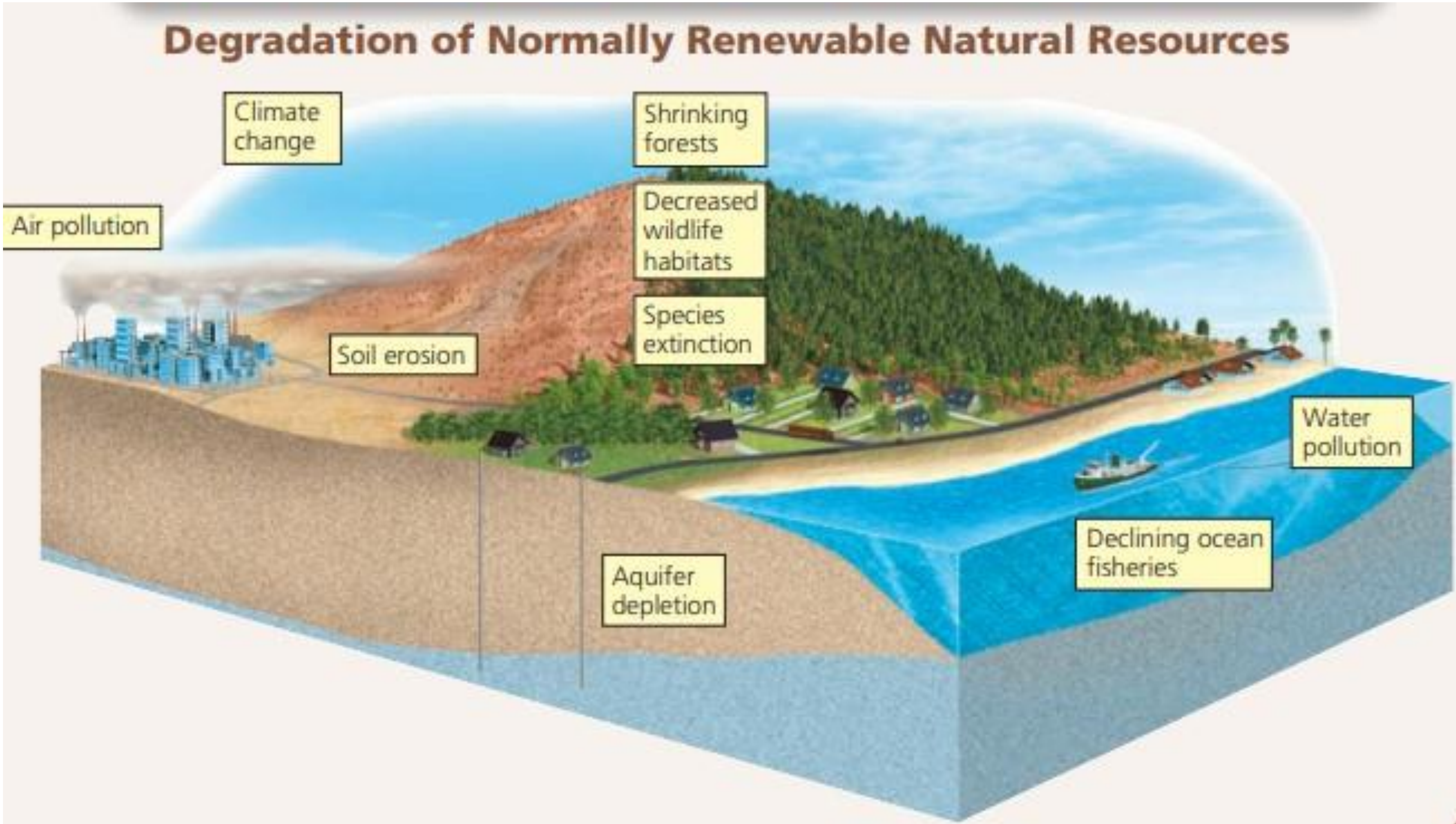
Natural Resources

The major natural resources are

(i) Forest resources
(ii) Water resources
(iii) Mineral resources
(iv) Food resources
(v) Energy resources
(vi) Land resources
(vii) Air resource
(viii) Soil resource



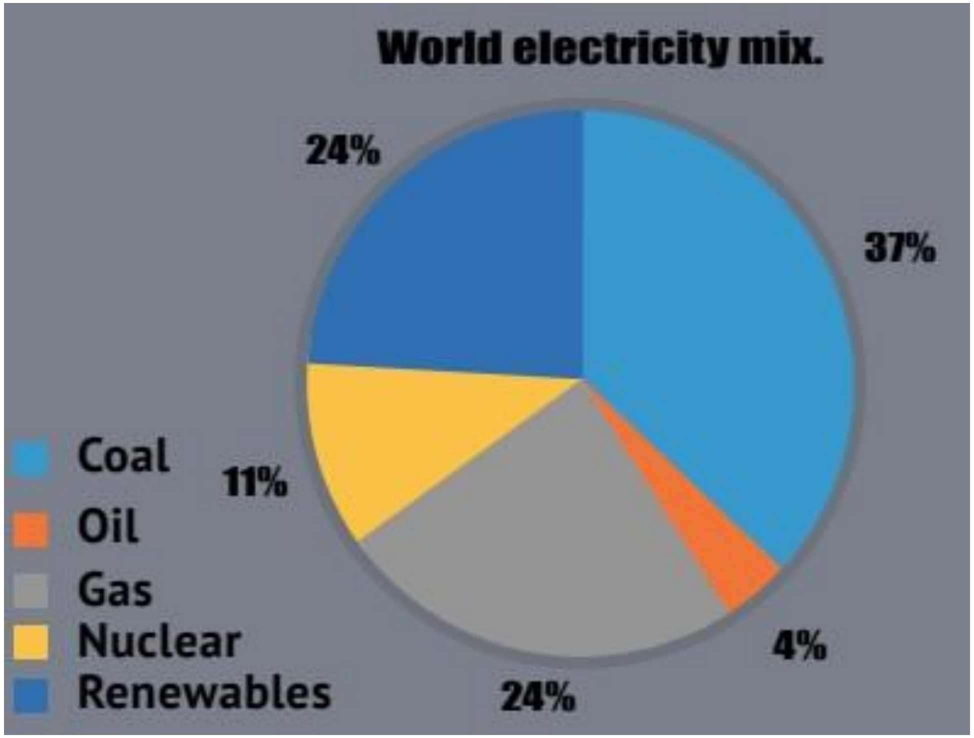
Natural Resources



Clean Coal Technologies

Clean Coal Technologies (CCTs) are technologies designed to enhance both the efficiency and the environmental acceptability of coal throughout the stages of the coal life cycle i.e. 1) conditioning of coal before use, 2) efficient technology choices during combustion, and 3) post-combustion carbon capture.

Coal is the world's most abundant and widely distributed fossil fuel source. Coal-generated electricity is still a dominant source of energy(~37%) around the world, and it is believed that coal-generated energy will remain part of the global energy mix in the near future.In this light, adoption of CCTs becomes eminent to ensure that future of coal based fuel becomes more sustainable



Clean Coal Technologies

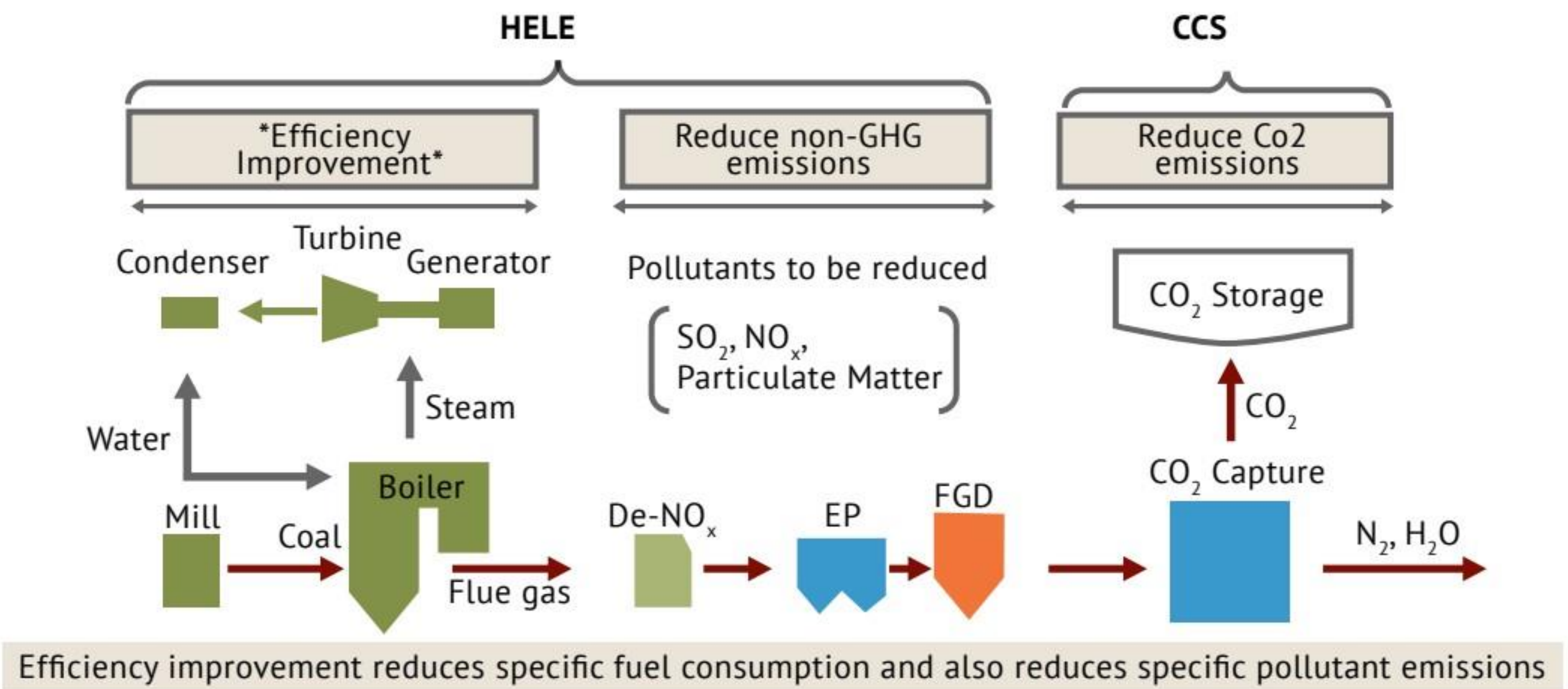
CCTs can be broadly divided into two categories: **High-Efficiency Low Emission (HELE) technologies** (they increase the efficiency of coal-fired power plants and help in reducing CO_2 and other GHG emissions) which generally operate during pre-combustion and combustion stage and
Carbon Capture, Use & Storage (CCUS) technologies which operate during both pre and post-combustion stages

Important HELE Technologies: Pre-combustion preparatory technologies

Coal Washing (also called as Coal Beneficiation): This method removes unwanted minerals by mixing crushed coal with a liquid and allowing the impurities to separate and settle. It reduces the amount of ash in raw coal to facilitate combustion and increase the energy content per tonne.

Clean Coal Technologies

Pre-combustion preparatory technologies:



Low NO_x burners: Any fuel that is burned in high enough temperatures will form NO_x (a cause of ground-level ozone). One of the best ways to reduce NO_x is to keep it from forming in the first place. These burners reduce the creation of nitrogen oxides, by restricting oxygen and manipulating the combustion process.

Clean Coal Technologies

Combustion methodologies for efficiency improvement:

Fluidized bed combustion (FBC): In a FBC boiler, pulverized coal (and other fuels) is suspended on jets of pressurized air. FBC boilers typically allow the fuels to stay inside the boiler much longer than other boilers, which ensures more complete combustion. Also, FBC boiler temperatures are far lower than conventional boilers (1400° F, rather than almost 3,000° F), so NOx formation is minimized. Additionally, limestone can be mixed in with the fuel and the mixing in the air makes sulfur removal very effective

Coal Gasification: It bypasses the conventional coal-burning process altogether by converting coal into a gas. With integrated gasification combined cycle (IGCC) systems, steam and hot pressurized air or oxygen combine with coal in a reaction that forces carbon molecules apart. The resulting syngas, a mixture of carbon monoxide, hydrogen, CO2 and water vapour, is then cleaned and burned in a gas turbine to make electricity. Since IGCC power plants create two forms of energy (steam from the gasification process apart from syngas as fuel), they have the potential to reach a fuel efficiency of 50 percent.

Clean Coal Technologies

Combustion methodologies for efficiency improvement:

Supercritical and ultra-supercritical power plants: Traditional Thermal Power plants i.e. Subcritical (below the critical temperature and pressure at which the liquid and gas phases of water coexist in equilibrium) power plants have an efficiency (i.e. amount of power they can generate from one tonne of coal) of around 35%. For a higher efficiency, Supercritical (above the critical temperature and pressure at which the liquid and gas phases of water coexist in equilibrium) and ultra-supercritical coal-fired technologies have been developed. These technologies can achieve an efficiency up to the level of 45% (Ultra-supercritical).

Supercritical power plants have become the system of choice in most industrialized countries, as a 1% point improvement in the efficiency of a conventional coal plant results in a 2-3% reduction in CO_2 emissions. Despite this, subcritical thermal power plants account for about 97% of the world's coal-fired capacity.

Clean Coal Technologies

CARBON CAPTURE, UTILISATION AND STORAGE (CCUS)

Capture technologies separate CO_2 from other gases which may be done in three different ways:

Pre-combustion capture: It refers to capturing CO_2 generated as an undesired co-product of an intermediate reaction of a conversion process. For example, *the CO_2 generated in the gasification process can then be captured and separated (using physical and chemical adsorption processes and advanced solvent systems), transported, and ultimately sequestered*.

Post-combustion capture: It involves the separation of CO_2 from waste gas streams after the conversion of the carbon source to CO_2 – for example, via combustion of fossil fuels or digestion of wastewater sludge. It includes methods like absorption in solvents, high-pressure membrane filtration, adsorption by solid sorbents, including porous organic frameworks, and cryogenic separation, etc

Oxy-fuel combustion: It can only be applied to processes involving combustion, such as power generation in fossil-fuelled plants, cement production and the iron and steel industry. Here, fuel is burned with pure oxygen to produce flue gas with high CO_2 concentrations and free from nitrogen and its compounds.

Clean Coal Technologies

CARBON CAPTURE, UTILISATION AND STORAGE (CCUS)

Storage: Suitable storage sites for captured carbon include former gas and oil fields, deep saline formations (porous rocks filled with very salty water), coal bed formations, ocean bed etc.

Utilization: As an alternative to storage, captured CO_2 can be used as a commercial product, either directly or after conversion. Examples of utilisation include –

Food and drink industry: CO_2 is commonly used as a carbonating agent, preservative, packaging gas and as a solvent for the extraction of flavours and in the decaffeination process.

Pharmaceutical industry: where CO_2 can be used as a respiratory stimulant or as an intermediate in the synthesis of drugs.

Concrete building materials: CO_2 can be used to cure cement, or in the manufacture of aggregates.

Enhanced oil and coal-bed methane recovery: where the carbon dioxide is injected into depleting oil or gas reserves to increase the amount of recovery.

Production of chemicals, plastics and fuels such as methanol, urea, polymers, syngas etc.

Mineral carbonation: It is a chemical process in which CO_2 reacts with a metal oxide such as magnesium or calcium to form carbonates.

Biofuels production: CO_2 can be used to cultivate microalgae used for the production of biofuels.

Carbon Sequestration

Carbon sequestration – the practice of removing carbon from the atmosphere and storing it – is one of the many approaches being taken to tackle climate change.

Climate change is an important problem. Therefore, every potential solution is important if we're to stop unprecedented climate change.

Alongside a transition to clean energy systems and decarbonising high-emission practices – such as construction or transport – humankind is making a concerted effort to remove carbon from our atmospheres, by adapting the ways we construct, consume, travel and generate power. But methods like carbon sequestration show how we can work *with* the natural environment to tackle the climate crisis.

Carbon Sequestration

Sinks:

- Carbon sequestration can be accomplished by pumping carbon into **'carbon sinks,'** or areas that absorb carbon.
  - **Natural sinks** - oceans, forests, soil, etc.
  - **Man-made sinks** - depleted oil reserves, unmineable mines, etc.
- For decades, the oil and gas industries have used carbon capture to improve oil and gas recovery.
- We have only recently begun to consider capturing carbon for environmental reasons.
- Carbon capture and storage (CCS) consists of three major steps:
  - *capturing and separating CO_2 from other gases*
  - *transporting the captured CO_2 to a location for storage, and*
  - *keeping CO_2 out of the atmosphere by storing it underground or deep in the ocean.*

Carbon Sequestration

Types of carbon sequestration:

➢ Ocean Sequestration

- ✓ Carbon is stored in the oceans via direct injection or fertilization.
- ✓ Large amounts of CO_2 from the atmosphere is absorbed, released, and stored by the oceans.
- ✓ This can be accomplished in two ways: by increasing the productivity of ocean biological systems through iron fertilisation, and by injecting CO_2 into the deep ocean.
- ✓ Iron dumping stimulates phytoplankton production, which leads to increased photosynthesis from these microorganisms, which aids in CO_2 absorption.

➢ Geological carbon sequestration

- ✓ Natural pore spaces in geologic formations serve as long-term carbon dioxide storage reservoirs.
- ✓ CO_2 can be stored in oil reservoirs, gas reservoirs, unmineable coal seams, saline formations, and organic-rich shale formations.
- ✓ Geologic sequestration is thought to have the most immediate application potential.

➢ Terrestrial Sequestration

- ✓ Terrestrial carbon sequestration is the process by which CO_2 from the atmosphere is absorbed by trees and plants via photosynthesis and stored as carbon in soils and biomass (tree trunks, branches, foliage, and roots).
- ✓ Soils and vegetation, which act as natural carbon sinks, store a large amount of carbon.
- ✓ Carbon uptake in these natural sinks can be increased by increasing carbon fixation through photosynthesis, slowing or reducing organic matter decomposition, and changing land-use practices.

Carbon Sequestration

Methods of Carbon Sequestration

Natural Carbon Sequestration

It is the process by which nature has achieved a carbon dioxide balance in our atmosphere that is suitable for life. Plants and animals both expel carbon dioxide at night.

Nature provided carbon sinks or sponges in the form of trees, oceans, the earth, and the animals themselves.

All organic life on Earth is carbon-based, and when plants and animals die, much of the carbon returns to the ground, where it has little effect on global warming.

Artificial Carbon Sequestration

Artificial carbon sequestration refers to a variety of processes that capture and bury carbon emissions at the point of production (e.g., factory chimneys).

Ocean sequestration is one proposed method in which carbon dioxide is injected deep into the ocean, forming CO_2 lakes.

The CO_2 will, in theory, stay deep due to the pressure and temperature of the surrounding water, gradually dissolving into it over time.

Another example is geological sequestration, which involves pumping carbon dioxide into underground chambers such as old oil reservoirs, aquifers, and coal seams that cannot be mined.

Carbon Sequestration

Advantages and Disadvantages of Carbon Sequestration

Advantages

- ✓ Planting trees and managing their growth has been shown to reduce the number of harmful particulates in the air.
- ✓ Carbon sequestered is carbon that does not enter the atmosphere.
- ✓ ***Reduced carbon in the atmosphere reduces the greenhouse gas effect and mitigates the effects of climate change.***

Disadvantages

- ➢ Carbon dioxide has the potential to be stored deep underground. Hydrostatic pressure acts at depth to keep it liquid.
- ➢ Faults in reservoir design, rock fissures, and tectonic processes may all act to release the gas stored in the reservoir into the ocean or atmosphere.
- ➢ If regulation required the use of CCS (Carbon Capture and Storage) technology, the financial costs of modern coal technology would nearly double.
- ➢ The cost of CCS technology varies depending on the type of capture technology used and the location in which it is implemented, but costs tend to rise with CCS capture implementation.