

❖ **Environment:** Environment is derived from the French word *Environner*, which means to encircle or surround. Environment is defined as the sum total of water, air, land and the inter-relationships that exist among them and with the human beings, other living organisms and materials.

❖ **Multi-disciplinary nature of environmental Science**

Environment is complex and has multifarious aspects.

Environmental sciences deal with working of earth, its life support systems, its interactions, influences, its problems, solutions. Keeping in view the complex nature of environment knowledge and information from various disciplines of science, social science, law and engineering have to be included in environmental studies to understand it completely.

- **Life sciences** like botany, zoology, microbiology, genetics and bio technology etc help in understanding the biotic components and their interactions.
- **Physical sciences** like physics, Chemistry, Earth Science, Oceanography etc help in understanding physical and chemical structure of abiotic components of environment along with mass and energy transfer.
- **Mathematics, statistics, computer science** serve as effective tools in environmental modeling.
- Subjects like economics, management and sociology provide the inputs for dealing with the socio economic aspects associated with various developmental activities.
- **Civil engineering, Nanotechnology, Chemical engineering** provides technical solutions to environment pollution control and waste management.
- **Environmental laws** provide the guidelines and legal measures for effective management and protection of environment.
- **Environmental education and mass communication** are two important subjects that are instrumental in disseminating environmental awareness.
- **Environmental ethics** provide the guidelines for sustainable life style.

Environmental Sciences, therefore, is a multi-disciplinary subject where we deal with different aspects using holistic approach.

❖ **Scope of environmental Sciences**

Environment is not a single subject; it is an integration of several subjects that include both science and social studies. To understand all the different aspects of our environment, we need to understand biology, chemistry, physics, geography, resources management, economics, and population issues. Thus, the scope of environmental studies extremely wide and covers some aspects of nearly every major discipline. They may be summarized as follows

- Natural resources-their conservation and management
- Ecology and management
- Environmental pollution and control
- Social issues in relation to development and environment
- Human population and environment

These are the basic aspects of environmental studies which have a direct relevance to every section of the society

Environmental Sciences can also be highly specialized concentrating on more technical aspects like environmental engineering and environmental management etc

In recent years the scope of the subject is increased dramatically world over. Several career options have emerged in this field.

They are categorized as

- **Research & Development (R&D) in environment:** Environmental personnel have a key role to play in examining various environmental problems and to carry out R & D activities for developing eco-friendly technologies.
- **Green advocacy:** In order to deal with cases related to environment, there is a need of environmental lawyers.
- **Green marketing:** Environmental auditors and managers have a key role to ensure the quality of products. Environmental friendly products are given ISO 14000 certification or eco mark
- **Green media:** To create environmental awareness through media, environmentally educated persons are required.
- **Environmental consultancy:** Non-governmental organizations, industries are engaging environmental consultants for tackling environment related problems.

❖ Importance and need of Public awareness for environment

Environmental studies is very important because

- **Environmental studies deals with most mundane problems of life** where each individual matters like dealing with safe and clean drinking water, hygienic living conditions, clean and fresh air, fertile land, healthy food and sustainable development.
- **Environment is one subject that is actually global as well as local in nature:** It has been well recognized that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but are global issues and hence must be tackled with international efforts and cooperation.
- **There are some environmental problems which are of localized importance.** e.g. Impact of mining or hydro-electric project in an area, problems of disposal and management of solid waste, river and lake pollution, soil erosion, water logging and salinity of soil, fluorosis problem in local population etc. For dealing with local environmental issues we have to think and act locally.

It is absolutely essential to create awareness about environment because-

- **Environment belongs to all and is important to all:** Whatever is the occupation or age of a person, he will be affected by environment and also he will affect the environment by his deeds.
- **Problems due to Wake of Development:** Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed world.
- **Explosively Increase in Population:** World census reflects that one in every seven persons in this planet lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land.
- **Rapidly changing technologies lead to abandoned wastes:** In the modern era of development there is a greater inclination for adopting latest product of technological advancement and discarding the older one as obsolete. Example: Cars, mobile phones, computers, i-pads, electronic goods adding lot of e-waste.
- **Our fast and energy demanding life style pollutes the environment:** To people have become increasingly dependent on machines to get the work done fast and make life more comfortable for us. But all these machines are energy demanding. Over dependence on machines not only increase resource depletion but also directly or indirectly affect our health. Example: The radiations from

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mobile towers, cell phones, toxic gases released from industries, polluted water etc can seriously affect human health.

- **Crazy consumerism leads to environmental degradation:** There is a sharp increase in consumerism. With increasing buying capacity people have started over consumption. It is good to have a good standard of living but the wasteful life style of people leads to environmental degradation.
- **The earth has a definite capacity to tolerate pollutants and sustain populations.** Beyond that earth cannot assimilate wastes and support life. It is very important that everyone should know about how earth's life supporting system works, what is the structure of its system, what are the principles on it works etc.
- **The goals of sustainable development cannot be achieved by any government at its own level until the public has a participatory role in it.** Public participation is possible only when the public is aware about the ecological and environmental issues. The public has to be educated about the fact that if we are degrading our environment we are actually harming our own selves. This is because we are a part of the complex network of environment where every component is linked up.
- It is very important to make people aware about the harmful effects of environmental pollution on human health and they should know how their activities influence the environment.
- **Environmental Concern at International Level:** Environmental issues received international attention about 45 years back in Stockholm conference, held on 5th June, 1972. Science then we celebrates **World Environment Day** on **5th June**.
Earth Summit-Rio de Janeiro 1992
World summit-Johannesberg 2002
- Nobel Peace prize 2004 - **Wangari Mathai**- green belt movement
- Nobel Peace prize 2007 - Dr. R. K. Pachauri(India) and US Vice-president Al Gore - **Intergovernmental Panel on Climate Change (IPCC)**
- **Environmental Concern at National Level:**
- **Mrs. Indira Gandhi** – Concept of environmental protection
- **Mrs. Menaka Gandhi** – Wild life protection.
- **Justice Kuldeep Singh**-the Green Judge who gave directives to Indian Government to make all curricula environment-oriented.
- **M.C. Mehta**- the green advocate-filed a Public Interest Litigation (PIL) vs. Union of India to give a mandate for creating environmental among all citizens of India.
- **Sh. Rajender Singh** (Magasaysay awardee) - Water Man of India -water conservation
- **Sh. Sunderlal Bahuguna** - “Chipko Movement” and “Tehri Bachao Andolan”.
- **Smt .Medh Patkar and Ms.Arundhati roy-Narmada Bachao Andolan**
- **India has introduced a concept of eco-labeling of consumers products as eco-mark i.e earthen pitcher**
- There is a Chinese proverb for environmental protections as **“If you plan for year plant rice, if you plan for 10 years plant tree and if you plan for 100 years educate all”** This indicates the importance of environmental education for the well being of the nation and universe.
- **“What is the use of beautiful building as there is no place to put it on planet”**

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If we want to live in a clean, healthy, aesthetically beautiful, safe and secure environment for a long time and wish to hand over the same to our children, grand children and great grand children, it is most essential to understand the basics of environment.

NATURAL RESOURCES:

Any stock or reserve that can be drawn from nature is a natural resource. Natural resources are two kinds.

Renewable resources: These are in exhaustive and can be regenerated within a given span of time.

E.g. Forests, wind energy, biomass energy etc.

Non renewable resources: These are exhaustive and cannot be regenerated within a given span of time.

E.g. Fossil fuels like coal, petroleum, natural gas

FOREST RESOURCES:❖ **Major uses of forests**

Forests have its own Commercial and Environmental uses.

❖ **Commercial uses-** raw materials like timber, pulpwood, ply wood, wax, fuel wood, rubber, gum, sediments, minerals, drugs, medicines, fruits, beverages, resins, non edible oils, railway sleepers, packing materials etc.

- Half of the timber cut each year is used as a fuel for heating and cooking
- One third of the wood harvest is used for building materials as lumber, plywood and hardwood, particle board and chipboard.
- One sixth of the wood harvest is converted into pulp and used for paper industry.
- Many forest lands are used for mining, agriculture, grazing, and recreation and for development of dams.

A typical tree produces commercial goods worth about Rs.30,000/- where as provides ecological services worth more than Rs.10,00,000/-

❖ **Ecological uses-**

- **Production of Oxygen-** trees produce oxygen by photosynthesis and are considered as earth's lungs.
- **Reducing Global warming-** the main green house gas CO₂ is absorbed by the forests as a raw material for photosynthesis. The forest canopy acts as sink for CO₂ gas and controls Global warming.
- **Wildlife habitat-** forests are homes for about 7 million species of flora and fauna.
- **Regulation of hydrological cycle-** forest watershed acts as big sponges, absorbing rainfall, slowing down runoff and slowly releasing the water for recharge of springs. Moisture in the air also helps in evapo-transpiration.
- **Soil conservation-** Forests bind the soil particles tightly with their roots and prevent soil erosion. They also acts as wind-breaks and controls soil-erosion.
- **Pollution moderator-** Forests can absorb toxic gases and keeps air pure. They prevent air and noise pollution.

Deforestation, major causes and consequences:

Deforestation- Large scale cutting down of trees in the forests is known as deforestation.

Major causes for deforestation are-

1. **Shifting cultivation-** practice of slash and burn agriculture and clearing forests for shifting cultivation.
2. **Fuel requirements-** increasing demands of fuel wood by the growing population and increasing the pressure on the forests.
3. **Raw material for industrial use-** wood, plywood, timber, pulp, rubber is some of the raw materials used to manufacture goods. These materials are extracted from forests on a large scale.
4. **Development projects-** Major projects like hydroelectric power, dams, road construction, mining etc are creating massive destruction of forests.
5. **Growing food needs-** to meet the demand for food from the growing population, agricultural lands and settlements are created by clearing forests.
6. **Over grazing-** poor people depend on wood as a fuel leading to loss of tree cover and cleared lands turns into grazing lands. Overgrazing by cattle also leads to degradation of these lands.
7. **Commercial logging:** which supplies the world market with woods such as teak destroys trees as well as opening up forest for agriculture. Cutting of trees for fire wood and building material, the heavy lopping of foliage for fodder and heavy grazing of saplings by domestic animals like goats.
8. **The cash crop economy:** Raising cash crops for increased economy.
9. **Forest fires-** they may be natural or manmade.

Major consequences-

1. It threatens the existence of wildlife due to destruction of natural habitat.
2. Biodiversity is lost and genetic diversity is eroded.
3. Hydrological cycle gets effected and affects rainfall.
4. Soil fertility will be lost due to soil erosion
5. In hilly areas, it leads to landslides.
6. Capacity to absorb carbon dioxide decreases and the rate of global warming increases.

WATER RESOURCES:**What is an aquifer? Mention its types.**

Aquifer- it is a layer of sediment or rock that is highly permeable and contains water. Eg:-Layers of sand and gravel are good aquifers crystalline rocks are not because they have low permeability.

It is of two types-

1. **Unconfined Aquifer-** they are overlaid by permeable earth materials and they are recharged by water going down from above in the form of rainfall and snow melt.
2. **Confined aquifer-** they are sand-wiched between two impermeable layers of rock or sediments and are recharged in areas away from the well under the ground.

❖ **Effects of ground water usage-** Excess usage of ground water without recharge, creates the following problems

1. **Subsidence-** when the rate of withdrawal is increasing without recharge of water table, then the sediments in the aquifer gets compacted. This phenomenon is called ground water subsidence. It creates structural damage in buildings, fractures in pipes, reversing the flow of canals and tidal flooding.
2. **Lowering of water table-** mining of ground water is carried out in few areas for irrigation of crop fields. It causes a sharp decline in agricultural production due to decrease in water table. It also decreases soil fertility.

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3. **Water –logging:-** over irrigation causes excess water to accumulate underground and forms a continuous column with the water table. Due to this the pores present on the top soil, through which the soil exchange the gases, will be drenched with water and soil-air gets depleted. This process is known as water-logging. It causes-

- Increase in water table level and roots of the plants do not get sufficient air for respiration.
- Mechanical strength of the soil declines and crop yield fails.

It can be controlled by-

- Preventing excess irrigation.
- Sub-surface drainage technology
- Bio-drainage with trees like eucalyptus

❖ BIG DAMS-BENEFITS & PROBLEMS

BENEFITS OF DAMS

Ecological:

- Reduction of floods and famines
- Promotion of productivity in lower areas

Socio economic:

- Employment
- Generating electricity
- Drinking water supply
- Irrigation water supply
- Promotion of Navigation and fishery

PROBLEMS OF DAMS

Ecological:

- Deforestation and loss of bio diversity
- Water logging and salinity
- Flashfloods
- Change in water flow and siltation
- Reservoir induced seismicity(RIS)

Socio economic:

- Submergence of villages and fertile lands
- Displacement of native people
- Resettlement issues
- Outbreak of vector borne diseases

Dams may face problems upstream or downstream as listed below:

Upstream problems

1. Displacement of tribal people
2. Loss of non-forest land
3. Loss of forests, flora and fauna
4. Landslides, sedimentation and siltation occurs
5. stagnation and water logging around reservoirs retards plant growth
6. Breeding of vectors and vector-borne diseases
7. Reservoir Induced Seismicity (RIS) causes earthquakes
8. Navigation and aquaculture activities can be developed in the dam area

Downstream problems

1. Water logging and salinity due to over irrigation
2. Reduced water flow and silt deposition in rivers
3. Salt intrusion at river mouth
4. Since the sediments carrying nutrients gets deposited in the reservoir, the fertility of the land along the river gets reduced
5. Due to structural defects or faulty design of the dam may cause sudden dam failure leading to collapse and destruction to life and property.

FOOD RESOURCES:**❖ Environmental impact of modern agriculture –fertilizer and pesticides-**

To meet the growing demand for food supply due to increase in population, there is a tremendous increase in the food production and it is a result of “Green revolution”. It makes use of hybrid seeds, single crop vegetation, using high-tech equipments and lots of energy. Simultaneously, it gave a negative impact on environment. They are as follows-

1. **Impacts of HYV (High Yield varieties)** - it includes monoculture method, i.e. the same genotype is grown over vast areas. If any pathogen attacks the crop, large scale devastation of crops takes place.
2. **Fertilizer related problems-**
 - **Micronutrient imbalance-** excess use of fertilizer, which include N,P, K as nutrients, causes imbalance in the soil of the crop. For example- excess use of fertilizer in Punjab caused imbalance of Zn in the soil and it is affecting the productivity.
 - **Nitrate pollution-** if Nitrogen based fertilizers are used more than required, the excess nitrates gets leached into the deep soil. These nitrates if crosses the permissible limits of 25mg/L in ground waters, it causes a health hazard called- “Blue Baby syndrome” or methaemoglobinemia. This disease causes effects in infant growth.
 - **Eutrophication-** it is a process which increases the salinity of the water bodies by over nourishment due to excess percentage of N, P fertilizers accumulated through the water runoff. It causes a linked ecological problem.
 - **Eutrophication** —————>**Increase in algal blooms in water bodies** —————>**Completes life cycle very fast & die** —————> **Dead matter consumes more DO in water during decomposition** —————> **Decrease in DO effects flora & fauna** —————> **Develops Anaerobic conditions.** —————> **Only pathogenic bacteria survives killing other organisms**————> **Food chain in Aquatic ecosystem will be in threat**
3. **Pesticide related problems-** In agriculture, first generation pesticides includes- Sulphur, arsenic, mercury, lead etc. DDT (Dichloro diphenyl trichloroethane) existed as a second generation pesticide. It was surpassed due to its hazards and later in 1940s synthetic pesticides came into existence. Following are the pesticide related problems-
 - **Super-Pests-** The pest which survive and are immune even after pesticide spray are known as super pests. This resistance to pesticides by the pests gives rise to highly resistant generations.
 - Some of the pesticides may kill the non-target pests along with the target pests.
 - **Biological magnification-** It is a process in which the concentration of the non-biodegradable material or pesticide accumulates in the food chain. As human beings

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occupy the highest position in the tropic level, they get highly bio-magnified which is harmful.

4. **Water-logging**- over irrigation causes excess water to accumulate underground and forms a continuous column with the water table. Due to this the pores present on the top soil, through which the soil exchange the gases, will be drenched with water and soil-air gets depleted. This process is known as water-logging. It causes-

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It can be controlled by-

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5. **Salinity problem**- evaporation of excess waters used for agriculture causes precipitation of salts on the top soil. It creates salinity problem in the soils. Saline soils are characterized by accumulation of soluble salts like sodium chloride, sodium sulphate, calcium chloride, magnesium chloride etc. these sodic salts also increases the pH of the soils and decreases the soil fertility.

It can be controlled by-

- Using good quality water.
- Underground network of drainage pipes for flushing out the salts.
- Sub-surface drainage system is being controlled by CSSRI- central soil salinity research institute.

ENERGY RESOURCES:

A source of energy is an important resource to generate power. Energy sources are of two types-

1. **Renewable resources**- a source which can be regenerated continuously in nature and are inexhaustible.
Eg:- Solar energy, wind energy, tidal energy, hydropower, ocean thermal energy, geothermal energy, biomass energy, biogas, biofuels, hydrogen etc.
2. **Non-renewable resources**- a source which on consumption cannot be regenerated on exhausted.
Eg:- coal, petroleum, nuclear fuels etc.

RENEWABLE SOURCES OF ENERGY-**SOLAR ENERGY-**

- Solar energy can be harnessed by means of a photovoltaic cell.
- It converts solar energy into electrical energy.
- It is one of the cleanest form of energy to generate power.
- India is now moving fast in this area to meet the power demand as part of MAKE IN INDIA.
- A typical solar cell consists of a semiconducting material like Silicon or germanium doped significantly with Boron or Phosphorous.
- Gallium arsenide or cadmium sulphide are some of the materials used in the PV cells.

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- Solar cells are used in calculators, electronic watches, traffic signals, water pumps etc. they are also used in artificial satellites for electricity generation. They are more used in remote areas where conventional electricity supply is rare.
- In Andhra Pradesh, Tirumala tirupathi devasthanam (TTD) is using a large solar power plant to generate power. It is used for cooking food on a large scale for the pilgrims.
- Other devices which harness solar energy are solar cookers, solar heat collectors, solar water heaters, solar furnace, solar power plants etc.

WIND ENERGY-

- High speed winds have a lot of energy in them as kinetic energy due to their motion.
- The driving force for these winds is sun. And the wind energy is harnessed by wind mills.
- The blades of wind mill keep on rotating due to the force of the wind of speed 15km/hr.
- the rotational motion of the blades drives a number of machines like water pumps, flour mills and electric generators.
- A large number of wind mills are installed in cluster called wind farms. At present, India is generating about 1100 MW of electricity.
- Kanyakumari in TamilNadu is generating 380 MW of electricity.

HYDROPOWER-

- Water flowing in a river is collected by constructing a big dam where water is stored and allowed to flow from a height.
- The blades of the turbine located at the bottom of the dam move with the fast moving water which in turn rotate the generator and produce electricity.
- The hydropower potential of India is around 4×10^{11} KWhours.
- Top five countries in generating hydropower are China, Canada, Brazil, US, Russia.
- Nagarjuna sagar is one of the major hydropower projects in Andhra Pradesh.

TIDAL ENERGY-

- Tides are produced by gravitational forces of sun and moon and contain high amount of energy.
- The high tide and low tide refer to the rise and fall of water in the oceans.
- A difference of several meters is required between the height of high and low tide to spin the turbines.
- The tidal energy is harnessed by constructing a tidal barrage.
- During, high tide, the sea-water flows into the reservoir of the barrage and turns the turbine and rotates the motor in the generator to produce electricity.
- During low tide, the sea level is low and the water stored in the reservoir flows out into the sea level and again turns the turbine. Canada, France are using this form of energy.

OCEAN THERMAL ENERGY-

- The energy available due to the difference in temperature of water at the surface of the tropical oceans and at deeper levels is called Ocean Thermal Energy (OTE).
- A difference of 20-25 C is required between surface water and deeper water of the ocean for operating OTE.
- The warm surface water of ocean is used to boil a liquid like ammonia.

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- The high pressure vapors of the liquid formed by boiling are used to turn the turbine of the generator and produce electricity.
- The colder water from the deeper ocean is pumped to cool and condense the vapors into liquid. Thus the process keeps on going for 24 hours a day.

GEOHERMAL ENERGY-

- The energy harnessed from the hot rocks present inside the earth is called geothermal energy.
- High temperature and high pressure steam fields exist below the earth's surface.
- This heat comes from the fusion of radioactive material present in the rock.
- These plants are found in USA, New Zealand etc.

BIOMASS-

Biomass is the organic matter produced by the plants or animals which includes wood, crop residues, cattle dung, manure, sewage, agricultural wastes etc. it is of following types-

- a. **Energy plantations-** certain crops plants of potato, cereals etc may produce energy either by burning or by getting converted into burnable gas or may be converted into fuels by fermentation.
- b. **Petro-crops-** latex containing plants like oil palms are rich in hydrocarbons and can yield oil like substance at high temperature and pressure. This oily material is burnt in diesel engine or may be refined as gasoline. These plants are known as petro crops.
- c. **Agricultural and urban waste biomass-** crop residues, coconut shells, agricultural wastes produce energy by burning.

 BIOGAS-

It is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide. It is produced by anaerobic degradation (breakdown of organic matter by bacteria in absence of oxygen) of animal wastes in the presence of water.

- It is non-polluting, clean and low cost fuel.
- It won't have any storage problem
- It is of two types- floating gas-holder type and fixed-biome type.
- Ministry of Non-conventional energy sources had been promoting Biogas program in India.

BIOFUELS-

Biomass can be converted into alcohols like ethanol and methanol. Ethanol can be produced from carbohydrate rich substances. It burns clean and non-polluting. Gasohol is a mixture of ethanol and gasoline (petrol) used in India, Brazil and Zimbabwe. Methanol is also a useful biofuel.

HYDROGEN AS A FUEL-

- Hydrogen as a fuel has high calorific value and can serve as an excellent fuel.
- It is a non-polluting gas and can be produced easily.
- It can be produced by photolysis of water.
- It is inflammable and explosive in nature.
- It is safe to handle and light in nature.
- It needs to be stored in bulk.
- It is used a liquid in spaceships.
- It is also used in hydrogen-oxygen fuel cell as a fuel to generate electricity.

❖ **NON-RENEWABLE SOURCES OF ENERGY-**

COAL- Coal is the most abundant fossil fuel in the world. Ancient plants along the rivers will be buried after death into the soil and due to heat and pressure gets converted into peat and coal.

There are three types of coal mainly- anthracite, bituminous, lignite. Anthracite coal has maximum carbon % and highest calorific value.

It is an important fuel to generate electricity in a Thermal power plant. About 54% of electricity is generated from thermal power plant which is dependent on coal as the main fossil fuel. The main drawback of using coal as fossil fuel is the release of gases CO_x, NO_x, SO_x into the atmosphere.

PETROLEUM- it is obtained by fractional distillation of crude oil. It is a cleaner fuel than coal and leaves no residue.

LPG- (liquefied petroleum gas)- it mainly contains n-butane with minor fractions of propane and ethane. Petroleum gas is converted into liquid form under pressure as LPG. It is an odorless gas and an important domestic cooking fuel. It has foul smell due to ethyl mercaptan gas added to it to identify the leakage.

NATURAL GAS-

It is composed of methane (95%) along with propane and ethane. It is present as a layer below crude oil layer under the sea bed. It is formed by the decomposition remains of dead animals and plants buried under the earth. It is transported through pipelines and posses a high calorific value. It is used as a domestic and industrial fuel. It is used in thermal power plants for generating electricity. It is used as a source of hydrogen gas in fertilizer industry and as a source of carbon in tire industry.

It can be converted into two main forms-

CNG- Compressed natural gas- it is being used as an alternative to petrol and diesel for transport of vehicles. It is produced by compressing natural gas at a high pressure.

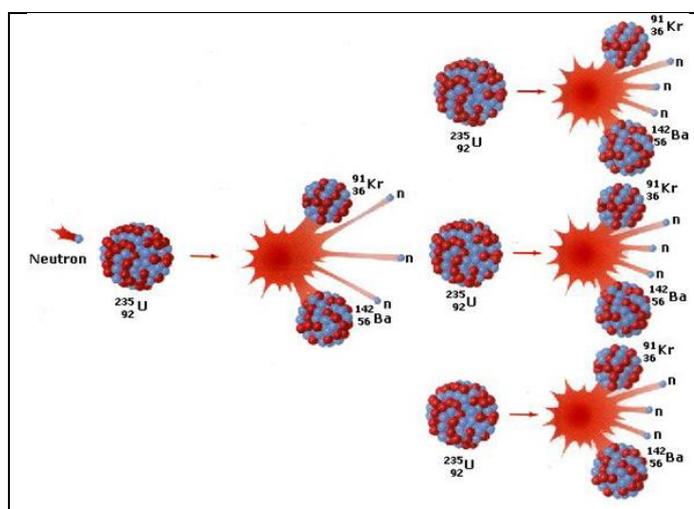
It is majorly used in cities like Delhi, Ahmadabad, Vijayawada etc.

SNG-Synthetic natural gas- it is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas.

NUCLEAR ENERGY-

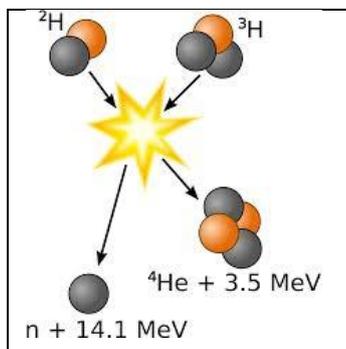
Nuclear energy is generated in two different forms-

i. Nuclear fission- it is the nuclear cleavage of heavy nucleus into two or more lighter nuclei by the bombardment of neutrons. It releases high amount of energy through a sustainable chain reaction. The reaction is carried out in a nuclear power plant to generate electricity.

**Nuclear fission reaction**

Nuclear reactors in India-

- Kalpakkam nuclear reactor (Tamil Nadu)
- Kaiga Atomic power plant (Karnataka)
- Tarapur nuclear reactor (Maharashtra)
- Pokhran test centre (Rajasthan)
- Narora nuclear reactor (Uttar Pradesh)



ii. **Nuclear fusion-** It is the process of combination of two lighter nuclei to form a heavy nucleus. It releases high amount of energy of order 10^7k . And they are also known as thermonuclear reactions.

The main criteria to set up a nuclear power plant are-

- Geographical location of the plant with clear idea on long term and short term effects.
- Proper disposal of the wastes from the laboratory involving the use of isotopes.