UNIT 2: NATURAL RESOURCES: PROBLEMS & PROSPECTS

Natural resources

A ***natural resource*** is anything people can use which comes from nature. People do not make natural resources, but gather them from the earth. Examples of natural resources are air, water, wood, crude oil, solar energy, wind energy, hydro-electric energy, coal, and minerals. Refined oil is not a natural resource, for example, because people make it. ***Natural resources*** (economically referred to as ***land*** or ***raw materials***) occur naturally within environments that exist relatively undisturbed by mankind, in a natural form. A natural resource is often characterized by amounts of biodiversity existent in various ecosystems. Natural resources are derived from the environment. Natural resources are very important to a human lifestyle. Some examples of natural resources include the following: air, wind and atmosphere, Plants, Animals, Coal, fossil fuels, rock and mineral resources, Forestry, Range and pasture, Soils, Water, oceans, lakes, groundwater and rivers etc.

Classification of natural resources

[1] On the basis of origin, resources may be divided into: (i) *Biotic* - Biotic resources are obtained from the biosphere, such as forests and their products, animals, birds and their products, fish and other marine organisms. Mineral fuels such as coal and petroleum are also included in this category because they formed from decayed organic matter (ii) *Abiotic* - Abiotic resources include non-living things. Examples include land, water, air and ores such as gold, iron, copper, silver etc.

[2] On the basis of their stage of development, natural resources may be referred to in the following ways: (i) *Potential Resources* - Potential resources are those that exist in a region and may be used in the future. For example, petroleum may exist in many parts of India, having sedimentary rocks but until the time it is actually drilled out and put into use, it remains a potential resource (ii) *Actual Resources* are those that have been surveyed, their quantity and quality determined and are being used in present times. The development of an actual resource, such as wood processing depends upon the technology available and the cost involved.

[3] With respect to renewability, natural resources can be categorized as follows: (i) *Renewable resources* are ones that can be replenished or reproduced easily. Some of them, like sunlight, air, wind, etc., are continuously available and their quantity is not affected by human consumption. A renewable resource grows again or comes back again after we use it. For example, sunlight, water, and trees are renewable resources (ii) *Non-renewable resources* are formed over very long geological periods. Minerals and fossil fuels are included in this category. Since their rate of formation is extremely slow, they cannot be replenished once they get depleted. Of these, the metallic minerals can be re- used by recycling them. But coal and petroleum cannot be recycled. A non-renewable resource is a resource that does not grow or come back, or a resource that would take a very long time to come back. For example, coal is a non-renewable resource.

[4] On the basis of availability, natural resources can be categorized as follows: (i) *Inexhaustible natural resources*- Those resources which are present in unlimited quantity in nature and are not likely to be exhausted easily by human activity are inexhaustible natural resources e.g. sunlight, air etc. (ii) *Exhaustible natural resources*- The amount of these resources are limited. They can be exhausted by human activity in the long run e.g. coal, petroleum, natural gas etc.

FOREST RESOURCES

Types of Forest Resources in India:

Because of unique geographical locations and climatic diversities, the forest types of India are highly variable. A total of fourteen major classes of forest are found in diverse region of the Indian territories.

There are as follows:

1. Tropical dry deciduous forest
2. Tropical moist deciduous forest
3. Tropical evergreen forest
4. Tropical semi evergreen forest
5. Tropical rainforest
6. Subtropical forest
7. Temperate broad leaved forest
8. Temperate conifer forest
9. Subalpine forest
10. Alpine forest
11. Desert thorny forest
12. Coastal sand dune forest
13. Estuarine evergreen forest
14. Grasslands

All these forest types are further subdivided to subclass/association for further characterization. At present, approx. 23 per cent of India's land area is classified as forest. India has about 64 million hectare of forest cover (of which 59% forest is dense, 40% is open and 1% is coastal mangrove). It is further repeated that 65 per cent of the India's forest wealth is administered solely by the government; another 27 per cent reserved for community and indigenous groups, (through joint forest management) and remaining 8 per cent of forest land is managed by private individuals on farms. The average stocking level of forest in India is 74 cubic meter per hectare much lower than 113 cubic meter per hectare in other developing countries. The pressure on India's forest come from a variety of sources, including—the increase in population, from 390 million in 1950 to 1 billion in 2001, the loss of the 4.5 million hectares forest area since 1950 through agricultural conversion and other uses, the high percentage (78%) of forest subject to heavy grazing, exposure of half of all forests to risk from fires, shifting cultivation affect over 10 million hectares and encroaching of forest area by environmental victims/refuges. The demand of timber and fuel-wood has increased tremendously over past couple of decades and thus pressure of wealth cover is extremely high. In spite of such constrains, during 1990-2000, India is the only country in south Asia with a positive increase in forest cover of 38,000 hectares. Deforestation is global concern, over 60% of the original natural forest has been cleared and the remaining forest is threatened by logging, mining and other large scale development projects. The rate of deforestation in tropics is extremely high. Being a tropical country with high population growth, India showed massive de-forestation.

During past 50 years more than 40% forest cover has been lost during this period. This kind of deforestation is connected with severe loss of biodiversity. It is estimated that the active ingredients for 25% of the world's prescriptive drugs are substances derived from plants, most of which grow in tropical forests and the estimated value of such commercial drugs is around $100 billion per year.

A large population of tribals all over the world are forest dependent. In many countries they are deprived of forest wealth due to eviction from the native areas as a consequence of various developmental projects viz., multipurpose dam, industrial development, urbanization and so on. In India, Narmada dam project alone caused the displacement of over 86,000 people. Mining in forest cover hill tracts also causes the displacement of fairly a good numbers of village settlement in different states of India. The devastating effects of deforestation in India leads to soil loss, water deficit, forest loss, biodiversity loss and associated local climate changes. These events leads to immense expenditure for management. The degradation cost of India is estimated to be around 16,400 crores every year. Forest fire in India is around 3 million hectare per year with a loss of forest cover valuing around Rs 440 crores. On the whole, in India, forests contribute 1.7 per cent of GDP of the country excluding the fuel-woods and other material values.

Importance of Forest Resources:

In general forests have three important functions viz., protective function, productive function and accessory function. The productive function includes the fact that forests are the sources of various materials of human livelihood support system. The protective functions include the fact that forests are performing a number ecological support system viz., climate control, soil conservation, drought and cyclone mitigation. In addition, there are other functions too, viz., the significance of forest in recreation, aesthetics, wildlife conservation. It is an estimate that during the lifetime of a typical grown tree, 200,000 US$ worth of ecological benefits can be available annually. The benefits includes oxygen production, CO_2 sink, air purification, soil fertility enhancement, soil erosion control, water recycling, humidity control, and wild-life habitat management. Only 10,000 years ago, agriculture began at the expenses of deforestation, and consequently global forest cover reduced to only 25 to 35% on an average. In many areas of tropics forests are disappearing and fragmented.

Forest Resources in India: Use, Over Exploitation, Causes and Effects

In India, forests form approx. 23 percent of the total land area. A forest is a natural, self-sustaining community characterized by vertical structure created by presence of trees. Trees are large, generally single-stemmed, woody plants. Forest can exist in many different regions under a wide range of conditions, but all true forests share these physical characteristics. Because a forest is a natural community, no forest is static in time. That is, because forest communities respond to outside influences, most forests are in a state of constant flux. Depending upon the systems within which forest communities exist, such factors might include rainfall, fire, wind, glaciation, seismic activity, flooding, animal activity, insulation, and so on. At any time, a forest is a collection of past responses to outside influences and internal competitive interactions. Therefore, the present status of any forest, indeed of any natural community, reflects what has gone on before.

Use and Over Exploitation:

A forest is a biotic community predominantly of trees, shrubs and other woody vegetation, usually with a closed canopy. This invaluable renewable natural resource is beneficial to man in many ways.

The direct benefits from forests are:

(a) Fuel Wood:

Wood is used as a source of energy for cooking purpose and for keeping warm.

(b) Timber:

Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

(c) Bamboos:

These are used for matting, flooring, baskets, ropes, rafts, cots etc.

(d) Food:

Fruits, leaves, roots and tubers of plants and meat of forest animals form the food of forest tribes.

(e) Shelter:

Mosses, ferns, insects, birds, reptiles, mammals and micro-organisms are provided shelter by forests.

(f) Paper:

Wood and Bamboo pulp are used for manufacturing paper (Newsprint, stationery, packing paper, sanitary paper)

(g) Rayon:

Bamboo and wood are used in the manufacture of rayon (yarns, artificial silk-fibres)

(h) Forest Products:

Tannins, gums, drugs/ medicines, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and fauna of forests.

The indirect benefits from forests are:

(a) Conservation of Soil:

Forests prevent soil erosion by binding the soil with the network of roots of the different plants and reduce the velocity of wind and rain — which are the chief agents causing erosion.

(b) Soil-improvement:

The fertility of the soil increases due to the humus which is formed by the decay of forest litter.

(c) Reduction of Atmospheric Pollution:

By using up carbon dioxide and giving off oxygen during the process of photosynthesis, forests reduce pollution and purify the environment.

(d) Control of Climate:

Transpiration of plants increases the atmospheric humidity which affects rainfall and cools the atmosphere.

(e) Control of Water flow:

In the forests, the thick layer of humus acts like a big sponge and soaks rain water preventing run-off, thereby preventing flash-floods. Humus prevents quick evaporation of water, thereby ensuring a perennial supply of water to streams, springs and wells.

Deforestation:

Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area. Of great concern is the rate at which deforestation is occurring. Currently, 12 million hectares of forests are cleared annually. Almost all of this deforestation occurs in the moist forests and open woodlands of the tropics. At this rate all moist tropical forest could be lost by the year 2050, except for isolated areas in -Amazonia, the Zaire basin, as well as a few protected areas within reserves and parks.

Causes of Deforestation:

(1) Population Explosion:
Population explosion poses a grave threat to the environment. Vast areas of forest land are cleared of trees to reclaim land for human settlements (factories, agriculture, housing, roads, railway tracks etc.) growth of population increases the demand for forest products like timber, firewood, paper and other valuable products of industrial importance, all necessitating felling of trees.
(2) Forest Fires:
Fires in the forests may be due to natural calamities or human activities:
(a) Smoldering of the humus and organic matter forming a thick cover over the forest floor (i.e. ground fires).
(b) Dried twigs and leaves may catch fire (i.e. surface fires).
(c) In densely populated forests, tree tops may catch fire by heat produced by constant rubbing against each other (i.e. crown fires).
(d) Human activities like clearing forest for habitation, agriculture, firewood, construction of roads, railway tracks and carelessness (throwing burning cigarette stubbs on dried foliage).
Fire destroys fully grown trees, results in killing and scorching of the seeds, humus, ground flora and animal life.
(3) Grazing Animals:
Trampling of the forest soil in the course of overgrazing by livestock has four reaching effects such as loss of porosity of soil, soil erosion and desertification of the previously fertile forest area.
(4) Pest Attack:
Forest pests like insects etc. destroy trees by eating up the leaves, boring into shoots and by spreading diseases.
(5) Natural Forces:
Floods, storms, snow, lightening etc. are the natural forces which damage forests.

Effects of Deforestation:

Forests are closely related with climatic change, biological diversity, wild animals, crops, medicinal plants etc.
Large scale deforestation has many far-reaching consequences:
(a) Habitat destruction of wild animals (tree-using animals are deprived of food and shelter.)
(b) Increased soil erosion due to reduction of vegetation cover.
(c) Reduction in the oxygen liberated by plants through photosynthesis.
(d) Increase in pollution due to burning of wood and due to reduction in Car- bon-dioxide fixation by plants.
(e) Decrease in availability of forest products.
(f) Loss of cultural diversity
(g) Loss of Biodiversity
(h) Scarcity of fuel wood and deterioration in economy and quality of life of people residing near forests.
(i) Lowering of the water table due to more run-off and thereby increased use of the underground water increases the frequency of droughts.
(j) Rise in Carbon dioxide level has resulted in increased thermal level of earth which in turn results in melting of ice caps and glaciers and consequent flooding of coastal areas.

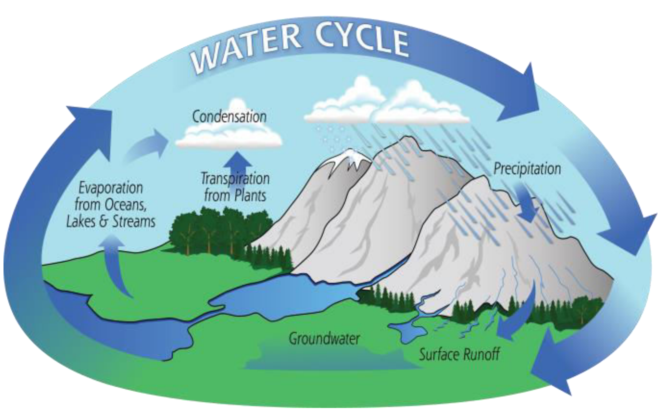
WATER RESOURCES IN INDIA

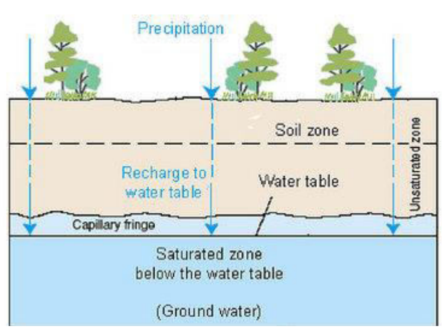
1). India accounts 2.45% of world surface area
2). 4% of world water resource
3). 16% of population
4). Total water available from precipitations 4000 cubic km.
5). Surface water and replenish able water is 1869 cubic km

SURFACE WATER RESOURFCES
There are four major sources of surface water: River, lake, ponds, tanks. There is about 1869 cu, km of water is available and only 690 cu. km is usable.

GROUND WATER RESOURCES
Total available ground water is 432 cu. Km approx.
Water utilization Surface water (Agriculture= 89% domestic=9% industrial 2%).

DEMAND FOR IRRIGATION and other uses can be met by proper **WATER CONSERVATION AND MANAGEMENT through (i)** Adopt laws and acts to conserve water (ii) Use water saving methods and technology (iii) prevent water pollution (iv) Watershed development (v) Rainwater harvesting (v) Water recycling and reuse (vi) Prevention of runoff, storage and recharge of groundwater through percolation tanks, recharge sells (vii) Bring balance between natural availability and utility (viii) Construction of check dams, plantation (ix) Making compulsory to the public to make rainwater harvesting before constructing building etc.





Water resources are under major stress around the world. Rivers, lakes, and underground aquifers supply fresh water for irrigation, drinking, and sanitation, while the oceans provide habitat for a large share of the planet's food supply. Today, however, expansion of agriculture, damming, diversion, over-use, and pollution threaten these irreplaceable resources in many parts of the globe. Providing safe drinking water for the more than 1 billion people who currently lack it is one of the greatest public health challenges facing national governments today. In many developing countries, safe water, free of pathogens and other contaminants, is unavailable to much of the population, and water contamination remains a concern even for developed countries with good water supplies and advanced treatment systems. And over-development, especially in coastal regions and areas with strained water supplies, is leading many regions to seek water from more and more distant sources. Nearly 97 percent of the world's water supply by volume is held in the oceans. The other large reserves are groundwater (4 percent) and icecaps and glaciers (2 percent), with all other water bodies' together accounting for a fraction of 1 percent. The water table is the top of the saturated zone. It may lie hundreds of meters deep in deserts or near the surface in moist ecosystems. Water tables typically shift from season to season as precipitation and transpiration levels change, moving up during rainy periods or periods of little transpiration and sinking during dry phases when the rate of recharge (precipitation minus evaporation and transpiration that infiltrates from the surface) drops. In temperate regions the water table tends to follow surface topography, rising under hills where there is little discharge to streams and falling under valleys where the water table intersects the surface in the form of streams, lakes, and springs. Above the water table lies the unsaturated zone, also referred to as the vadose zone, where the pores (spaces between grains) are not completely filled with water. Water in the vadose zone is referred to as soil moisture. Although air in the vadose zone is at atmospheric pressures, the soil moisture is under tension, with suctions of a magnitude much greater than atmospheric pressure. This fluid tension is created by strong adhesive forces between the water and the solid grains, and by surface tension at the small interfaces between water and air. The same forces can be seen at work when you insert a thin straw (a capillary) into water: water rises up in the straw, forming a meniscus at the top. When the straw is thinner, water rises higher because the ratio of the surface area of the straw to the volume of the straw is greater, increasing the adhesive force lifting the water relative to the gravitational force pulling it down. This explains why fine-grained soils, such as clay, can hold water under very large suctions. Water flows upward under suction through small pores from the water table toward plant roots when evapotranspiration is greater than precipitation. After a rainstorm, water may recharge the groundwater by saturating large pores and cracks in the soil and flowing very quickly downward to the water table.

Millions of people worldwide depend on groundwater stocks, which they draw from aquifers—permeable geologic formations through which water flows easily. Very transmissive geologic formations are desirable because water levels in wells decline little even when pumping rates are high, so the wells do not need to be drilled as deeply as in less transmissive formations and the energy costs of lifting water to the surface are not excessive. Under natural conditions many aquifers are artesian: the water they hold is under pressure, so water will flow to the surface from a well without pumping. Aquifers may be either capped by an impermeable layer (confined) or open to receive water from the surface (unconfined). Confined aquifers are often artesian because the confining layer prevents upward flow of groundwater, but unconfined aquifers are also artesian in the vicinity of discharge areas. This is why groundwater discharges into rivers and streams. Confined aquifers are less likely to be contaminated because the impermeable layers above them prevent surface contaminants from reaching their water, so they provide good-quality water supplies The pore structure of soils, sediment, and rock is a central influence on groundwater movement.

Hydrologists quantify this influence primarily in terms of (i) porosity: the proportion of total volume that is occupied by voids, like the spaces within a pile of marbles. Porosity is not a direct function of the size of soil grains—the porosity of a pile of basketballs is the same as a pile of marbles. Porosity tends to be larger in well sorted sediments where the grain sizes are uniform and smaller in mixed soils where smaller grains fill the voids between larger grains. Soils are less porous at deeper levels because the weight of overlying soil packs grains closer together; (ii) permeability: how readily the medium transmits water, based on the size and shape of its pore spaces and how interconnected its pores are. Materials with high porosity and high permeability, such as sand, gravel, sandstone, fractured rock, and basalt, produce good aquifers. Low-permeable rocks and sediments that impede groundwater flow include granite, shale, and clay. Groundwater recharge enters aquifers in areas at higher elevations (typically hill slopes) than discharge areas (typically in the bottom of valleys), so the overall movement of groundwater is downhill.

Water Pollution

Many different types of contaminants can pollute water and render it unusable. Pollutants regulated in under national drinking water standards (legally enforceable limits for public water systems to protect public health as prescribed by Central Pollution Control Board or CPCB) include: (i) **Microorganisms** such as cryptosporidium, giardia, and fecal coliform bacteria; (ii) **Disinfectants and water disinfection byproducts** including chlorine, bromate, and chlorite; (iii) **Inorganic chemicals** such as arsenic, cadmium, lead, and mercury etc; (iv) **Organic chemicals** such as benzene, dioxin, and vinyl chloride; (v) **Radionuclides** including uranium and radium etc. These pollutants come from a wide range of sources. Microorganisms are typically found in human and animal waste. Some inorganic contaminants such as arsenic and radionuclides such as uranium occur naturally in geologic deposits, but many inorganic and most major organic pollutants are emitted from industrial facilities, mining, and agricultural activities such as fertilizer and pesticide application. Government of India enacted Water Act 1974 for control of water pollution and CPCB was also created under this Act. Water-related illnesses fall into four major categories: (i) **Waterborne diseases**, including cholera, typhoid, and dysentery, are caused by drinking water containing infectious viruses or bacteria, which often come from human or animal waste; (ii) **Water-washed diseases**, such as skin and eye infections, are caused by lack of clean water for washing; (iii) **Water-based diseases**, such as schistosomiasis, are spread by organisms that develop in water and then become human parasites. They are spread by contaminated water and by eating insufficiently cooked fish; (iv) **Water-related insect vectors**, such as mosquitoes, breed in or near water and spread diseases, including dengue and malaria. This category is not directly related to water supply or quality.

MINERAL RESOURCES

A mineral is a pure inorganic substance that occurs naturally in the earth's crust. More than two-thousand minerals have been identified and most of these are inorganic, which are formed by the various combinations of elements. However, a small proportion of the earth's crust contains organic materials; consist of single elements such as gold, silver, diamond, and sulfur. **Over 100 minerals are mined.**

Categories of Mineral Resources
Mineral resources can be divided into two major categories (1) Metallic Mineral Resources: can be ferrous or non-ferrous (2) Non-metallic Mineral Resources. **Metallic Minerals** are metals that are hard substance and conduct heat and electricity with characteristics of luster or shine. For example Gold, Silver, Tin, Copper, Lead, Zinc, Iron, Nickel, Chromium, and Aluminum etc.
Characteristics of Metallic Minerals: (i) Metallic Minerals present a metallic shine in their appearance (ii) Contains metals in their chemical composition (iii) Potential source of the metal that can be got through mining (iv) Metallic minerals contain metal in raw form. Metallic minerals are further classified into Ferrous and Non-ferrous metallic minerals. **Ferrous Minerals** are those minerals that contain iron, for example, Iron ore, manganese, and Chromites etc. **Non-Ferrous Minerals** are those minerals which do not contain iron, for example, gold, silver, copper, and lead etc. **Nonmetallic minerals** are a special group of chemical elements from which no new product can be generated if they are melted. For example sand, gravel, gypsum, halite, Uranium, dimension stone etc.

Characteristics of Nonmetallic Mineral Resources: (i) Nonmetallic minerals are minerals which are either present a non-metallic shine or luster in their appearance (ii) These minerals do not contain extractable metals in their chemical composition.

Use of Minerals
The use of minerals depends upon its deposits. Some countries are rich in mineral deposits, while others have no deposits. The greatest use of minerals depends on its properties. For instance, Aluminum is light, strong and durable in nature, so it is used for aircraft, shipping, and car industries. Minerals are used in almost all industries. Gold, silver, and platinum are used in the jewelry industry. Copper is used in coin industry and for making pipes and wire. Silicon obtained from quartz is used in the computer industry.

Conservation of Mineral Resources
The total volume of consumable minerals resources is just 1% of all the minerals present in the earth's crust. However, the consumption rate is so high that these mineral resources which are nonrenewable will get exhausted very soon. Here are some of the measures to conserve minerals: (i) Use of minerals in a planned and sustainable manner (ii) Recycling of metals (iii) Use of alternative renewable substitutes (iv) Technology should be improved to use the low-grade ores profitably.

Negative impacts of mineral mining *(i)* Pollution of aquifers (ii) Destruction of vegetation (iii) Subsidence of land (iv) Lowering of water table (v) Respiratory & other illness to workers.

FOOD RESOURCES

India is the third largest producer of cereals, with only China and the USA ahead of it. India occupies the first position in milk production and is the third largest producer of fish and second largest producer of inland fisheries in the world. The fisheries sector also provides livelihood to some 11 million people involved fully/partially in fisheries and on subsidiary activities connected with the sector. India ranks first in respect of cattle and buffalos and second in goats, third in sheep and seventh in poultry population in the world. Approximately 1.3 billion people are so poor that they cannot afford proper nutrition. Green Revolution (GR) involves the production of more food per acre of cropland by using modern cultivation methods, and the new high yielding varieties of crops. Norman Borlaug 1940-1950's credited with the start of G.R. and worked with wheat; finally awarded Nobel Prize in 1970 for his work. Problems associated with green revolution are (i) Critics argue that developing countries now rely on imported technologies (ii) High energy costs associated with the higher crop yields (requires fossil fuels) (iii) Environmental problems associated with inorganic fertilizers and pesticides.

Food and Nutrition are required for (A) Carbohydrates: Sugars and starches metabolized by cellular respiration to produce energy (in the form of ATP); (B) Proteins: Large, complex molecules composed of amino acids that perform critical roles in body (hair nails and muscles are made of protein), there are 20 different amino acids (aa) required for human nutrition, the Human can synthesize 10-11 of these on it's own, humans lack the ability to synthesize the other aa's called "essential amino acids", they are Isoleucine, leucine, lysine, methionine, phenyalanine, threonine, tryptophan, valine, histadine, and, in children arginine; (C) Lipids: Include fats and oils and are metabolized by cellular respiration to produce energy; (D) Vitamins (help regulate metabolism)and Minerals (ingested in the form of salts dissolved in water) .

Food Sources Share:
- **76% of food – Food grains**
- **17% - Grazing livestock**
- **7% - Fisheries**

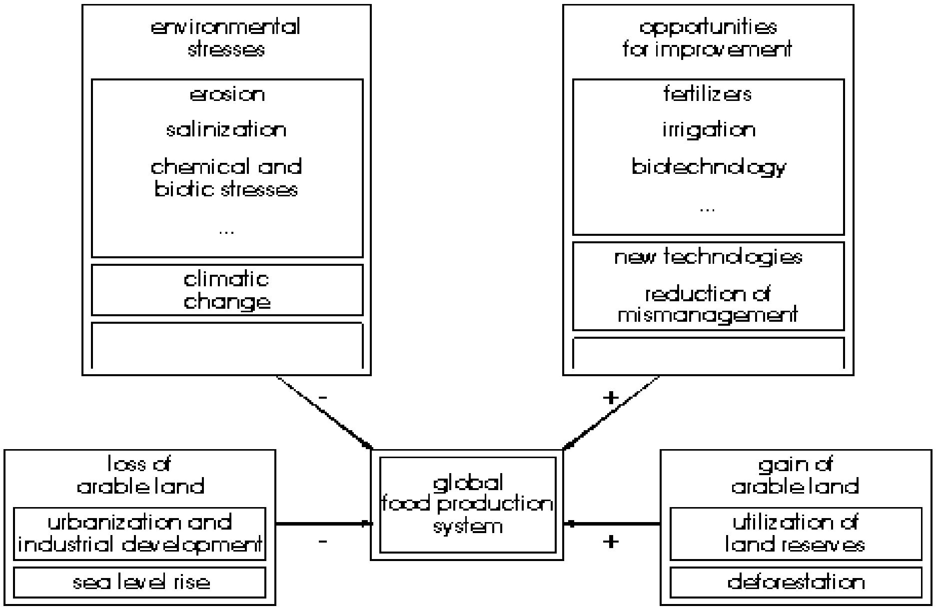
Food availability for end user:
- **2 kg per person a day**
- **700 million – Not enough to eat**
- **12 million – Children die of hunger**

Organic Farming:
- **Non-chemical fertilizers & pesticides agriculture**
- **Based on crop rotation, animal and green manure**
- **Biological control of pests**

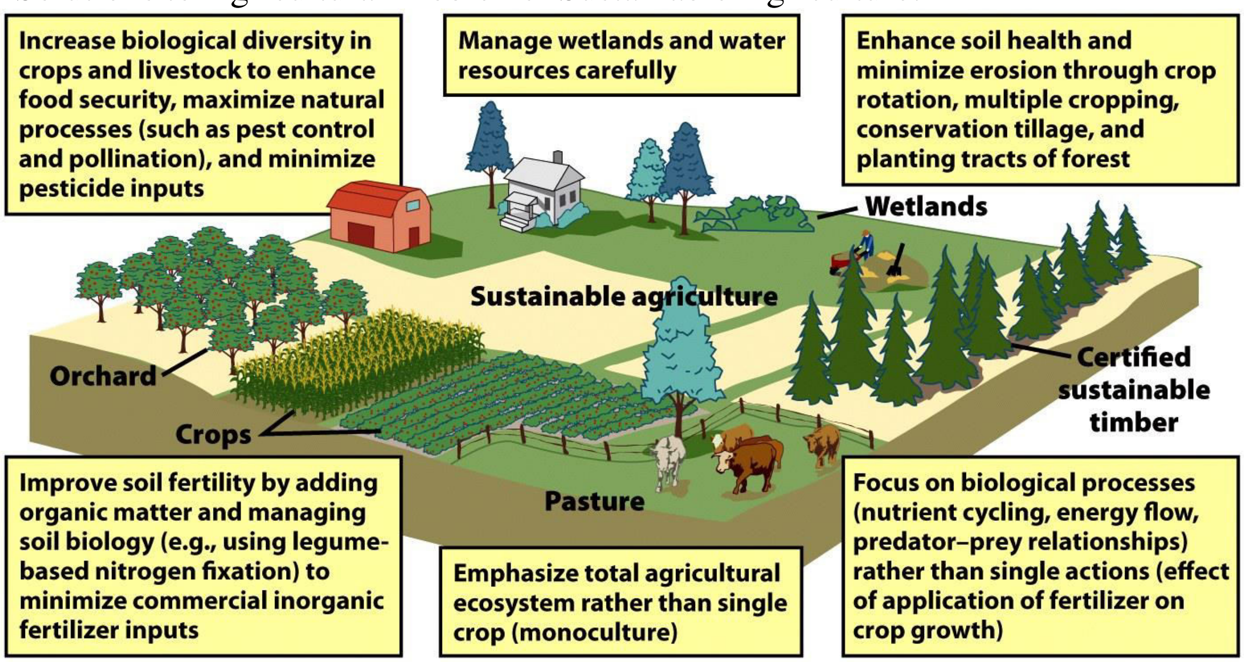
Fishes come from:
- **55% from Ocean**
- **33% from aquaculture**
- **12% from fresh water fishing**

There is decline in food grain production because of: (i) Rising temperatures (ii) Falling water tables and droughts (iii) Ethanol production (iv) More grain is going towards feeding livestock as more people eat meat especially in China as their incomes rise.

Factors affecting global food production system:



Solutions to Agricultural Problems- Sustainable Agriculture:



Methods and procedures to improve food production: (i) Management of Natural Predator-prey relationships instead of pesticides (lady bug and aphids); (ii) Better Crop selection (insect resistant varieties); (iii) Crop rotation and conservation tillage; (iv) Supplying nitrogen with legumes; (v) Organic agriculture; (vi) Integrated Pest Management (IPM): Limited use of pesticides with sustainable agriculture practices; (vii) Enhancement of production via Application of Genetic engineering: Manipulation of genes by taking specific gene from a cell of one species and placing it into the cell of an unrelated species; (viii) Pollution (air, water & soil) reduction to improve quality of food etc.

ENERGY RESOURCES

India's energy-mix comprises both non-renewable (coal, lignite, petroleum and natural gas) and renewable energy sources (wind, solar, small hydro, biomass, cogeneration bagasse etc.). Information on reserves of non-renewable sources of energy like coal, lignite, petroleum, natural gas and the potential for generation of renewable energy sources is a pre- requisite for assessing the country's potential for meeting its future energy needs.

Non-Renewable energy sources in India

India has a good reserve of coal and lignite. As in 2011, estimated reserves of coal was around 286 billion tones, an addition of 9 billion over the last year. Coal deposits are mainly confined to eastern and south central parts of the country. The states of Jharkhand, Orissa, Chhattisgarh, West Bengal, Andhra Pradesh, Maharashtra and Madhya Pradesh account for more than 99% of the total coal reserves in the country. The total estimated reserve of coal in India as on 31.03.10 was around 277 billion tonnes. The estimated reserves of crude oil and natural gas in India as on 31.03.2011 stood at 757 million tonnes (MT) and 1241 billion cubic meters (BCM), respectively.

Renewable energy sources in India

There is high potential for generation of renewable energy from various sources- wind, solar, biomass, small hydro and cogeneration bagasse. The total potential for renewable power generation in the country as on 31.03.11 is estimated at 89760 MW. This includes an estimated wind power potential of 49132 MW (55%), SHP (small-hydro power) potential of 15,385 MW (17%), Biomass power potential of 17,538 MW(20%) and 5000 MW (6%) from bagasse-based cogeneration in sugar mills.

<u>Classification of Energy Resources on the basis of availability</u>:

(a) **Primary energy resources:** These are obtained directly from the environment, the example includes: (1) Fossil fuels such as coal natural gas etc. (2) Nuclear fuels such as Uranium, Thorium etc. (3) Hydro energy (4) Solar energy (5) Wind energy (6) Geothermal energy (7) Ocean energy such as tidal energy, wave energy (8) Biomass energy such as gobar gas (9) Hydrogen energy

(b) **Secondary energy resources:** They are derived from primary energy resources as they do not exist in nature. The examples are: (1) Petrol, diesel, kerosene oil. (2) CNG and LPG (3) Electrical energy based on coal, diesel gas.

(c) **On the basis of being older and newer:**

1. **Conventional Energy Resources**-the examples are: 1. Fossil fuel; 2. Nuclear energy; 3. Hydro energy

2. **Non-conventional Energy Resources** -For example includes-1. Solar energy, 2. Wind energy, 3. Geothermal energy, 4. Ocean energy, 5. Biomass energy, 6. H2 energy.

(d) **On the basis of renewable and non-renewable energy resources**

1) **Non-renewable energy resources:** From the last few decades oils and natural gases together with hydro-electricity and natural sources occupy the first position in producing energy to mankind. The major problem, we are facing today is the fastest extinction of conventional resources of energy. Excessive use of fossil fuels leads to environmental pollution, out of which CO2 emission is of immense concern. Thus it is important for us to exploit fuels in a balanced way to avoid any future shortage.

2) **Renewable energy resources:** These eco-friendly energy resources have the greatest potential to substitute the depleting non-renewable energy resources as alternative sources of energy in the long run. There is stress on environment friendly, decentralized energy system. Scientists have advanced a plan to power 100% of the world's energy with wind, hydroelectric, and solar power by the year 2030, recommending renewable energy subsidies and a price on carbon reflecting its cost for flood and related expenses.

Wind energy: ***This type of energy harnesses the power of the wind to propel the blades of wind turbines. These turbines cause the rotation of magnets, which creates electricity. Wind towers are usually built together on wind farms.*** The ability of a turbine to generate electric power is measured in Watts (The rate of energy transfer equivalent to 1 Ampere of electric current flowing under a pressure of 1 Volt at unity power factor). Watts being a small unit of power, kilowatts (kW = 1000 Watts) and Mega Watts (MW = 1 million Watts) are the most commonly used units to describe the generating capacity of wind turbines and any power generating unit in general. Electricity production and consumption are most commonly measured in kilo watt hours (kWh). A kilowatt-hour means one kilowatt (1,000 Watts) of electricity produced or utilized in an hour (To light up a 100 Watts bulb for 10 hours requires 1 Kilowatt-hour of electricity). Watt-hour is the electrical energy unit of measure equal to 1 Watt of power supplied to, or taken from, an electric circuit steadily for 1 hour. The power produced by a wind turbine depends on the turbine's size and the wind speed through the rotor. In India, we have the commercial large wind turbines from 225 kW to 2.5 MW. In the global market, 6 MW wind turbines are operating and turbines of 10 MW are in laboratory stage. Wind speed and a wind turbine size are the factors that determine the power generation capacity of a wind turbine installation. Usually, wind resource assessment is done prior to a wind system's construction. The power (energy/second) available in the wind will be given by the formula Power = 0.5 x rotor swept area (m2) x density (kg/m3) x velocity3 (m/s).

Advantages/ prospectus

- Wind power produces no water or air pollution that can contaminate the environment, because there are no chemical processes involved in wind power generation. Hence, there are no waste by-products, such as carbon dioxide.
- Power from the wind does not contribute to global warming because it does not generate greenhouse gases.
- Wind generation is a renewable source of energy, which means that we will never run out of it.
- Wind towers can be beneficial for people living permanently, or temporarily, in remote areas. It may be difficult to transport electricity through wires from a power plant to a far-away location and thus, wind towers can be set up at the remote setting.
- Farming and grazing can still take place on land occupied by wind turbines.
- Those utilizing wind powers in a grid-tie configuration will have backup power in the event of a power outage.
- Because of the ability of wind turbines to coexist within agricultural fields, sitting costs are frequently low.

Constraints / limitations/ disadvantages

- Wind is unpredictable; therefore, wind power is not predictably available. When the wind speed decreases less electricity is generated. This makes wind power unsuitable for base load generation.
- Wind farms may be challenged in communities that consider them an eyesore or

obstruction.

- Wind farms, depending on the location and type of turbine, may negatively affect bird migration patterns, and may pose a danger to the birds themselves (primarily an issue with older/smaller turbines).
- Wind farms may interfere with radar creating a hole in radar coverage and so affect national security.
- Tall wind turbines have been proven to impact Doppler weather radar towers and affect weather forecasting in a negative way. This can be prevented by not having the wind turbines in the radar's line of sight.

***Hydroelectric energy**: In hydro energy, the gravitational descent of a river is compressed from a long run to a single location with a dam or a flume. This creates a location where concentrated pressure and flow can be used to turn turbines or water wheels, which drive a mechanical mill or an electric generator. In some cases with hydroelectric dams, there are expected results.*

Advantages/ prospectus

- Hydroelectric power stations can promptly increase to full capacity, unlike other types of power stations. This is because water can be accumulated above the dam and released to coincide with peak demand.
- Electricity can be generated constantly, so long as sufficient water is available.
- Hydroelectric power produces no primary waste or pollution.
- Hydropower is a renewable resource.
- Much hydroelectric capacity is still undeveloped, such as in Africa.
- The resulting lake can have additional benefits such as doubling as a reservoir for irrigation, and leisure activities such as water sports and fishing, for example Kielder Water in Northumberland, UK.

Constraints / limitations/ disadvantages

- The construction of a dam can have a serious environmental impact on the surrounding areas. The amount and the quality of water downstream can be affected, which affects plant life both aquatic, and land-based. Because a river valley is being flooded, the local habitats of many species are destroyed, while people living nearby may have to relocate their homes.
- Hydroelectricity can only be used in areas where there is a sufficient and continuing supply of water.
- Flooding submerges large forests (if they have not been harvested). The resulting anaerobic decomposition of the carboniferous materials releases methane, a greenhouse gas.
- Dams can contain huge amounts of water. As with every energy storage system, failure of containment can lead to catastrophic results, e.g. flooding
- Dams create large lakes that may have adverse effects on Earth tectonic system possibly causing intense earthquakes.
- Hydroelectric plants rarely can be erected near load centers, requiring long transmission lines.

***Solar energy**: Solar power involves using solar cells to convert sunlight into electricity, using sunlight hitting solar thermal panels to convert sunlight to heat water or air, using sunlight*

hitting a parabolic mirror to heat water (producing steam), or using sunlight entering windows for passive solar heating of a building. It would be advantageous to place solar panels in the regions of highest solar radiation. The average solar radiation in the United States is 4.8 kW·h/(m²·day), but reaches 8–9 kWh/m²/day in parts of the Southwest. The National Solar Mission was launched on the 11th January, 2010 by the Prime Minister. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive research & development (R&D); and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022. Mission will create an enabling policy framework to achieve this objective and make India a global leader in solar energy. Further, Government has revised the target of Grid Connected Solar Power Projects from 20,000 MW by the year 2021-22 to 100,000 MW by the year 2021-22 under the National Solar Mission and it was approved by Cabinet on 17th June 2015.

Application of Solar Energy:

1. **Solar water heater:** Its construction consists of a flat plate collector and a storage tank. The solar radiations fall on it are absorbed by a collector and then transferred to the circulating water. It is used in hospitals, hotels, houses and in some industries also.
2. **Solar cooker:** It is comprised of an insulated metal box filled with a flat glass cover. The inner surface of the metal box is blackened. When the container is kept in the sunlight, the solar radiations are absorbed and consequentially the foods get cooked.
3. **Solar drying:** The agricultural goods are dried using solar heat by keeping them in a cabinet. It is used for drying vegetables, fruits, milk etc.
4. **Solar furnace:** The temperature in a furnace is very high as solar radiation is concentrated using lenses in the furnace.
5. **Solar greenhouse:** A green house is a closed chamber covered by transparent glass or plastic. It acts as a solar radiation collector to utilize solar energy for growing plants.

Advantages/ prospectus

- Solar power imparts no fuel costs.
- Solar power is a renewable resource. As long as the Sun exists, its energy will reach Earth.
- Solar power generation releases no water or air pollution, because there is no combustion of fuels.
- In sunny countries, solar power can be used in remote locations, like a wind turbine. This way, isolated places can receive electricity, when there is no way to connect to the power lines from a plant.
- Solar energy can be used very efficiently for heating (solar ovens, solar water and home heaters) and day lighting.
- Coincidentally, solar energy is abundant in regions that have the largest number of people living off grid — in developing regions of Africa, Indian subcontinent and Latin America. Hence cheap solar, when available, opens the opportunity to enhance global electricity access considerably, and possibly in a relatively short time period.
- Passive solar building design and zero energy buildings are demonstrating significant energy bill reduction, and some are cost- effectively off the grid.
- Photovoltaic equipment cost has been steadily falling and the production capacity is rapidly rising.
- Distributed point-of-use photovoltaic systems eliminate expensive long-distance electric

power transmission losses.

- Photovoltaic are much more efficient in their conversion of solar energy to usable energy than bio-fuel from plant materials.
- Its use is eco-friendly as it never creates pollution.
- The equipments do not require any attention during their working e.g solar cooker.
- The food cooked with the help of solar energy remains nutritional.
- The maintenance cost remains negligible in most of the equipments.
- Containers to store fuel are not required and its initial cost remains cheaper.
- In lieu of storage vessels, it requires less space on the floor.
- It has a noiseless operation.

Constraints / limitations/ disadvantages

- Solar electricity is currently more expensive than grid electricity.
- Solar heat and electricity are not available at night and may be unavailable because of weather conditions; therefore, a storage or complementary power system is required for off-the-grid applications.
- Solar cells produce DC which must be converted to AC (using a grid tie inverter) when used in currently existing distribution grids. This incurs an energy loss of 4–12%.
- The chemicals used to manufacture cells, and byproducts can be extremely hazardous.
- The energy payback time — the time necessary for producing the same amount of energy as needed for building the power device — for photovoltaic cells is about 1–5 years, depending primarily on location.
- It does not work during night and during cloudy days and becomes useless in the rainy seasons.
- All sort of food cannot be cooked in the solar cooker.
- Solar cooking takes more time. It does not help when food is required urgently.

Biomass, agricultural or bioenergy: Biomass production involves using garbage or other renewable resources such as corn or other vegetation to generate electricity. When garbage decomposes, the methane produced is captured in pipes and later burned to produce electricity. Vegetation and wood can be burned directly to generate energy, like fossil fuels, or processed to form alcohols. Sugar cane residue can be used as a bio-fuel. Biomass energy or bioconversion refers to the direct burning of wood, agricultural waste manure, waste paper and converting them to a fuel. As biomass energy is obtained through the process of photosynthesis it is considered to be the indirect form of solar energy. Plantation of more trees and other crops should be considered important to get biomass energy either for direct burning or for conversion to alcohol or methane. Alcohol is produced by fermentation of grains. Wood and farm wastes are renewable natural resources. An aerobic digestion of sewage sludge and animals manure is a biomass utilizing method and produces nutrient rich compost which is a good organic fertilizer, which can be used for growing forage for animals and do not cause any adverse environmental consequence. The burning of dung destroys essential nutrients like N and P. It is therefore, more useful to convert biomass into biogas and biofuels. Biogas is mixture of following gases- (a) CH_4(40%), (b) $C0_2$, (c) H_2, (d) N_2. Biogas plants are of mainly following types- (a) Floating gas holder type (b) Fixed dome type (c) KVIC type.

Biogas plant is a unit which converts organic waste matter (living biomass) into useful gaseous fuel (methane and carbon dioxide) and organic fertilizer as byproduct in the form of slurry. The most common feed material in family size biogas plants is cattle dung. The potential is about 12 million family type biogas plants based on estimated availability of cattle dung in the country. The Ministry is implementing a National Biogas and Manure Management Programme (NBMMP), for setting up of family type biogas plants, since 1981-82. A total of 4.31 million family type biogas plants have been setup in the country. The Government is giving (i) Central subsidy; (ii) Turn-key job fee linked with five years' free maintenance warranty; (iii) Financial Support upto 50% of the applicable total cost, subject to sharing of 50% of the cost of repair by the beneficiary concerned for repair of old non-functional plants of more than 5 years; (iv) Training of users, masons and entrepreneurs; (v) Administrative charges to State Government Departments and agencies implementing the programme; (vi) Regional level Biogas Development and Training Centres; (vii) Publicity, Communication/ Extension. The Central subsidy is given in fixed amounts for different categories of areas/ States/ Regions. It varies from Rs. 4000/- to Rs. 8000/- per plant for general category States & Rs. 14,700/- per plant for North Eastern Regions States including Sikkim except plain areas of Assam. The cost of biogas plant varies from place to place and size of the plant. Average cost of 2 cubic meter size biogas plant is about Rs. 17,000/- . It is generally high about 30 per cent more in hilly areas and about 50 per cent more in North Eastern Region States. The Ministry launched another Programme on Biogas based Distributed/Grid Power Generation in January 2006 (2005-06) so as to set up reliable decentralized power generating units(3KW to 250KW) in rural areas in the country. The per KW Central Financial Assistance (CFA) of Rs. 40,000 (3-20 KW), Rs. 35,000 (>20 to 100 KW) and Rs. 30,000 (>100 to 250 KW) is available for the installation of biogas based power generation units. The programme is implemented through nodal departments/ agencies of the states/ UTs, KVIC, institutions and Biogas Development and Training Centres (BDTCs) of MNRE. During the year 2008-09, the Ministry took up a new initiative to demonstrate an Integrated Technology-package in entrepreneurial mode on medium size (200-1000 cum/day) biogas fertilizer plants (BGFP) for generation, purification/enrichment, bottling and piped distribution of biogas. Installation of such plants aims at meeting stationary and motive power, cooling, refrigeration and electricity needs in addition to cooking and heating requirements.

Biomass is organic material of recent origin that can be used as a source of energy. It generally includes crops and other plants, as well as agricultural, forest, sawdust and agro-industrial waste. Electricity that is produced as a result of utilizing surplus biomass sources into energy is considered biomass power. Biomass combusted in a boiler produces steam. This steam drives a turbine generator that produces electricity. This electricity will be fed into the high voltage transmission grid to be transported to end-users. Generating power through the use of biomass represents the cost-effective and cleanest way to provide renewable electricity in biomass potential regions with high levels of biomass resources and its processing activity. Furthermore, use of this resource helps become more energy independent and use of a locally derived fuel provides employment and direct economic benefit to local communities. The estimated power potential from surplus agro residues in the country is about 17,000 MW. In addition about 5000 MW of power can be produced, if the sugar mills in the country switch over to modern techniques of cogeneration. Electricity produced from biomass is considered to be carbon neutral and therefore helps to combat global warming. The CO2 that the facility will release would have been produced as the plants and trees naturally decomposed in the forest without the benefit of electricity production. Biomass power generating units produce a significant economic benefit to the area surrounding the plant. A 10 MW biomass power project can create approximately employment for 100 workers during the 18-month construction phase, 25 full-time workers employed in the operation of the facility, and 35 persons in the collection, processing, and transportation of biomass material. The principal source of biomass are rice husk, woody biomass such as Julie flora, casurina, other agro residues such as stalks/cobs/shells, sugarcane trash, cotton stalks, mustard stalks, groundnut shells etc. If there are no issues in fuel collection, investors and fund, then it is possible to develop a project in a fast track mode in 18 months period. The capital cost of installation of bagasse based co-generation projects is in the range of Rs. 4.5 to Rs. 5.0 Crore/MW depending upon technical, financial and operating parameters. Costs of generation are expected to vary from Rs. 3.50 to Rs. 4.00/kwh. With high oil price, increased competition among equipments suppliers, and with CDM revenue, preferential tariff, Renewable Purchase Obligation (RPO) and Renewable Energy Certificates biomass projects are an attractive investment option. However, there are still many barriers and risks in project development.

Advantages/ prospectus

- Biomass production can be used to burn organic byproducts resulting from agriculture.
- Biomass is abundant on Earth and is renewable. Biomass is found throughout the world, a fact that should alleviate energy pressures in third world nations.
- When methods of biomass production other than direct combustion of plant mass are used, such as fermentation and pyrolysis, there is little effect on the environment. Alcohols and other fuels produced by these alternative methods are clean burning and are feasible replacements to fossil fuels.
- Since CO_2 is first taken out of the atmosphere to make the vegetable oil and then put back after it is burned in the engine, there is no net increase in CO_2. However, there are still the emissions due to fossil fuel used in growing and producing bio-fuel.
- Vegetable oil has a higher flash point and therefore is safer than most fossil fuels.
- Transitioning to vegetable oil could be relatively easy as bio-diesel works where diesel works, and straight vegetable oil takes relatively minor modifications.
- The world already produces more than 100 billion gallons a year for the food industry, so we have experience making it.
- Alga culture has the potential to produce far more vegetable oil per acre than current plants.
- Infrastructure for bio-diesel around the World is significant and growing.

Constraints / limitations/ disadvantages

- Direct combustion of any carbon-based fuel leads to air pollution similar to that from fossil fuels.
- Some researchers claim that when biomass crops are the product of intensive farming, ethanol fuel production results in a net loss of energy after one accounts for the fuel costs of petroleum and natural-gas fertilizer production, farm equipment, and the distillation process.
- Direct competition with land use for food production and water use. As this decreases food supply, the price of food increases world wide.
- Current production methods would require enormous amounts of land to replace all gasoline and diesel. With current technology, it is not feasible for bio-fuels to replace the demand for petroleum.
- Even with the most-optimistic current energy return on investment claims, in order to use 100% solar energy to grow corn and produce ethanol (fueling machinery with ethanol, distilling with heat from burning crop residues, using NO fossil fuels at all), the consumption of ethanol to replace only the current U.S. petroleum use would require three quarters of all the cultivated land on the face of the Earth.
- It provides eco-friendly clean fuel
- Without storage tank, it can be supplied directly to the homes from plant.

- Pathogens and parasites cannot come in contact of faecal material as the degestion of waste takes place in closed chamber.
- It is a good substitute of chemical fertilizers as per year its production is around 200 million tonnes.

***Geothermal energy*: Geothermal energy harnesses the heat energy present underneath the Earth. Two wells are drilled. One well injects water into the ground to provide water. The hot rocks heat the water to produce steam. The steam that shoots back up the other hole(s) is purified and is used to drive turbines, which power electric generators. When the water temperature is below the boiling point of water a binary system is used. A low boiling point liquid is used to drive a turbine and generator in a closed system similar to a refrigeration unit running in reverse. There are also natural sources of geothermal energy some can come from volcanoes, geysers, hot springs, and steam vents.** Geothermal energy is the heat stored in earth crust. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma. India is in Low Geothermal Potential region with low/medium heat enthalpy (medium range of 100-180 oC and less than 100 oC is low enthalpy). Also Geothermal electricity generation is site and technology specific in India. As per the submitted reports of resource assessment Geological Survey of India (GSI) has identified estimated geothermal potential of 10,000 MW in India. The geothermal energy stored in the earth crust is available at a depth of about 3-4 km and estimated to be 43 x 106 EJ corresponding to about 1194 x 106 TWh. Because its source is the almost unlimited amount of heat generated by the Earth's core; even in geothermal areas dependent on a reservoir of hot water, the volume taken out can be re-injected, making it a sustainable energy source. Land requirement in geothermal power plant is very less i.e. 0.75 - 1.2 acres/ MW as compared with solar which requires 5-8 acres/ MW. The heat from the earth's core continuously flows outward. It transfers (conducts) to the surrounding layer of rock, the mantle. When temperatures and pressures become high enough, some mantle rock melts, becoming magma. Then, because it is lighter (less dense) than the surrounding rock, the magma rises (convects), moving slowly up toward the earth's crust, carrying the heat from below. Sometimes the hot magma reaches all the way to the surface, where we know it as lava. But most often the magma remains below earth's crust, heating nearby rock and water (rainwater that has seeped deep into the earth) - sometimes as hot as 700 degrees F. Some of this hot geothermal water travels back up through faults and cracks and reaches the earth's surface as hot springs or geysers, but most of it stays deep underground, trapped in cracks and porous rock. This natural collection of hot water is called a geothermal reservoir. Geothermal energy is clean. Energy can be extracted without burning a fossil fuel such as coal, gas, or oil. Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces, and very little if any, of the nitrous oxide or sulfur-bearing gases. Binary plants, which are closed cycle operations, release essentially no emissions. Geothermal energy is available 24 hours a day, 365 days a year. The cost of geothermal power plant is site and technology specific, the average rough capital cost on not exceeding basis stands 25-30 Cr per MW.

***Tidal & ocean energy*: Tidal power can be extracted from Moon-gravity-powered tides by locating a water turbine in a tidal current, or by building impoundment pond dams that admit-or-release water through a turbine. The turbine can turn an electrical generator, or a gas compressor, that can then store energy until needed. Coastal tides are a source of clean, free, renewable, and sustainable energy.** Ocean renewable energy or marine renewable energy are

terms used to describe all forms of renewable energy derived from the sea including wave energy, tidal energy, ocean current energy, salinity gradient energy and ocean thermal gradient energy. Wave energy describes energy generated from the power of waves near their surface. Several different types of wave energy conversion devices extract power from motion of waves. These include single point absorbers. The power take off device within these systems converts the motion of the waves into electrical energy. Wave power can also be captured through oscillating water columns, which trap waves in a column and change the air pressure in the upper portion which drives a turbine. Wave power can also be captured through an overtopping device, which traps waves in a floating pool, which is then released through turbines to generate power. India is expected to have 40,000 MW of Wave energy potential. The tidal cycle occurs every 12 hours due to the gravitational force of the moon. The difference in water height from low tide and high tide is potential energy. Similar to traditional hydropower generated from dams, tidal water can be captured in a barrage across an estuary during high tide and forced through a hydro-turbine during low tide. To capture sufficient power from the tidal energy potential, the height of high tide must be at least five meters (16 feet) greater than low tide. There are only approximately 20 locations on earth with tides this high and India is one of them. The Gulf of Cambay and the Gulf of Kutch in Gujarat on the west coast have the maximum tidal range of 11m and 8m with average tidal range of 6.77m and 5.23m respectively. India is expected to have 9,000 MW of Tidal energy potential.
Marine current is ocean water moving in one direction. This ocean current is known as the Gulf Stream. Tides also create currents that flow in two directions. Kinetic energy can be captured from the Gulf Stream and other tidal currents with submerged turbines that are very similar in appearance to miniature wind turbines. As with wind turbines, the constant movement of the marine current moves the rotor blades to generate electric power.
Ocean thermal energy conversion (OTEC), uses ocean temperature differences from the surface to depths lower than 1,000 meters, to extract energy. A temperature difference of only 20°C can yield usable energy. Research focuses on two types of OTEC technologies to extract thermal energy and convert it to electric power: closed cycle and open cycle. In the closed cycle method, a working fluid, such as ammonia, is pumped through a heat exchanger and vaporized. This vaporized steam runs a turbine. The cold water found at the depths of the ocean condenses the vapor back to a fluid where it returns to the heat exchanger. In the open cycle system, the warm surface water is pressurized in a vacuum chamber and converted to steam to run the turbine. The steam is then condensed using cold ocean water from lower depths. OTEC has a potential installed capacity of 180,000 MW in India. Due to its high (94 percent) capacity factor, OTEC's consistent power source is best compared to other base load (firm) power generators such as oil, coal, nuclear, integrated gasification combined cycle (IGCC), and gas/oil combined cycle. Although OTEC has a higher initial capital cost, its "free" fuel and very low operating expenses make it attractive over the plant's life. OTEC is fueled by an infinite supply of solar energy stored in the ocean's top layer. Even after the sun goes down, OTEC can tap the stored solar energy and generate power 24 hours a day, 365 days a year. Energy supplies from renewable sources such as solar and wind, are not consistent and predictable. Geothermal energy is very site specific, and biomass renewable energy consumes precious agricultural resources. There are no emissions associated with OTEC and no any impact on air quality.

Coal based energy: Constraints / limitations/ disadvantages

- Petroleum-powered vehicles are very inefficient. Only about 30% of the energy from the fuel they consume is converted into mechanical energy. The rest of the fuel-source energy is inefficiently expended as waste heat. The heat and gaseous pollution emissions harm our environment.

- The inefficient atmospheric combustion (burning) of fossil fuels in vehicles, buildings, and power plants contributes to urban heat islands.
- After extraction it causes contamination in the water when the leakage takes place.
- Its burning produces C02 and enhances the green house effect.
- All combustion processes produce the pollutants like NO, S02 CO, N02, C02 smog, etc.
- Petroleum contributes to acid rain and urban pollution.
- The combustion of fossil fuels leads to the release of pollution into the atmosphere. According to the Union of Concerned Scientists, a typical coal plant produces in one year:
    - 3,700,000 tons of carbon dioxide (CO2), the primary cause of global warming.
    - 10,000 tons of sulfur dioxide (SO2), the leading cause of acid rain.
    - 500 tons of small airborne particles, which result in chronic bronchitis, aggravated asthma, and premature death, in addition to haze-obstructed visibility.
    - 10,200 tons of nitrogen oxides (Nox), (from high-temperature atmospheric combustion), leading to formation of ozone (smog) which inflames the lungs, burning lung tissue making people more susceptible to respiratory illness.
    - 720 tons of carbon monoxide (CO), resulting in headaches and additional stress on people with heart disease.
    - 220 tons of hydrocarbons, toxic volatile organic compounds (VOC), which form ozone.
    - 170 pounds (77 kg) of mercury, where just $1/70$ of a teaspoon deposited on a 25-acre (100,000 m^2) lake can make the fish unsafe to eat.
    - 225 pounds (102 kg) of arsenic, which will cause cancer in one out of 100 people who drink water containing 50 parts per billion.
    - 114 pounds (52 kg) of lead, 4 pounds (1.8 kg) of cadmium, other toxic heavy metals, and trace amounts of uranium.
- Dependence on fossil fuels from volatile regions or countries creates energy security risks for dependent countries. Oil dependence in particular has led to war, major funding of radical terrorists, monopolization, and socio-political instability.
- Fossil fuels are non-renewable, un-sustainable resources, which will eventually decline in production and become exhausted, with dire consequences to societies that remain highly dependent on them. (Fossil fuels are actually slowly forming continuously, but we are using them up at a rate approximately 100,000 times faster than they are formed.)
- Extracting fossil fuels is becoming more difficult as we consume the most accessible fuel deposits. Extraction of fossil fuels is becoming more expensive and more dangerous as mines get deeper and oil rigs must drill deeper, and go further out to sea.
- Extraction of fossil fuels results in extensive environmental degradation, such as the strip mining and mountaintop removal of coal.

Nuclear energy

From Fission: Nuclear power stations use nuclear fission to generate energy by the reaction of uranium-235 inside a nuclear reactor. The reactor uses uranium rods, the atoms of which are split in the process of fission, releasing a large amount of energy. The process continues as a chain reaction with other nuclei. The energy heats water to create steam,

which spins a turbine generator, producing electricity.

Advantages/ prospectus

- The energy content of a kilogram of uranium or thorium, if spent nuclear fuel is reprocessed and fully utilized, is equivalent to about
  3.5 million kilograms of coal.
- The cost of making nuclear power, with current legislation, is about the same as making coal power, which is considered very inexpensive (see Economics of new nuclear power plants). If a carbon tax is applied, nuclear does not have to pay anything because nuclear does not emit greenhouse gasses such as CO_2 nor toxic gases NO, CO, SO_2, arsenic, etc. that are emitted by coal power plants.
- Nuclear power does not produce any primary air pollution or release carbon dioxide and sulfur dioxide into the atmosphere. Therefore, it contributes only a small amount to global warming or acid rain.
- Raw material extraction is much safer for nuclear power compared to coal. Coal mining is the second most dangerous occupation in the United States. Nuclear energy is much safer per capita than coal derived energy.
- For the same amount of electricity, the life cycle emissions of nuclear is about 4% of coal power. Depending on the report, hydro, wind, and geothermal are sometimes ranked lower, while wind and hydro are sometimes ranked higher (by life cycle emissions).
- According to a Stanford study, fast breeder reactors have the potential to power humans on earth for billions of years, making it sustainable.
- The improper operation of a nuclear reactor with no containment vessel can be catastrophic in the event of an uncontrolled power increase in the reactor. For example, the Chernobyl disaster in the Ukraine (former USSR) affected large areas of Europe by moderate radioactive contamination; parts of the Ukraine and Belarus continue to be affected by radioactive fallout.
- Transuranic waste produced from nuclear fission of uranium is poisonous and highly radioactive. Breeder reactors could burn this waste as fuel, fissioning transuranics into much faster-decaying fission products which stabilize at a relatively low level of radioactivity in 100–500 years, but recycling plutonium as MOX fuel in current light water reactors merely transmutes between isotopes of plutonium and offers little reduction in radioactivity.

Without nuclear reprocessing, whole spent fuel bundles containing transuranic waste must be stored in spent fuel pools, dry cask storage, or a geological repository.

- There can be connections between nuclear power and nuclear weapon proliferation, since many reactor designs require large-scale uranium enrichment facilities.
- Some claim that uranium ore is a limited resource and estimate that current supplies will fail to meet demand in 2026, provided no other deposits are discovered. This claim is strongly disputed; also, breeder reactors would extract about 100 times as much energy from the same amount of uranium.

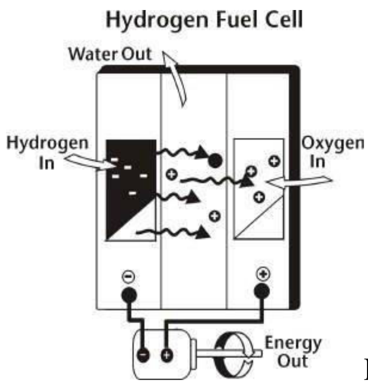
- The limited liability for the owner of a nuclear power plant in case of a nuclear accident differs per nation while nuclear installations are sometimes built close to national borders.
- Since nuclear power plants are typically quite large power plants, and are, fundamentally, thermal engines, waste heat disposal becomes more difficult at higher ambient temperature. Thus, at a time of peak demand for power for air-conditioning, a power reactor may need to be shut down or operate at a reduced power level, as do large coal-fired plants, for the same reasons.

Hydrogen energy as future energy: Hydrogen can be manufactured at roughly 77 percent thermal efficiency by the method of steam reforming of natural gas. When manufactured by this method it is a derivative fuel like gasoline; when produced by electrolysis of water, it is a form of chemical energy storage as are storage batteries, though hydrogen is the more versatile storage mode since there are two options for its conversion to useful work: (1) a fuel cell can convert the chemicals hydrogen and oxygen into water, and in the process, produce electricity, or (2) hydrogen can be burned (less efficiently than in a fuel cell) in an internal combustion engine. As an alternative fuel hydrogen is ideal, producing little or no emissions, with a plentiful supply available. But hydrogen produced by conventional means is not renewable or carbon neutral. Wind power is a totally renewable energy source with no greenhouse gas emissions, but due to its unpredictability, has problems integrating with national grids. Combined together, wind and hydrogen can cancel out their inherent defects and be an effective tool in the battle against carbon dioxide and global warming. Hydrogen Energy can be the Perfect Energy Source for the Future. Hydrogen can be considered as a clean energy carrier similar to electricity. Hydrogen can be produced from various domestic resources such as renewable energy and nuclear energy. In the long-term, hydrogen will simultaneously reduce the dependence on foreign oil and the emission of greenhouse gases and other pollutants. Hydrogen can be considered as the simplest element in existence. Hydrogen is also one of the most abundant elements in the earth's crust. Hydrogen as a gas is not found naturally on Earth and must be manufactured. This is because hydrogen gas is lighter than air and rises into the atmosphere as a result. Natural hydrogen is always associated with other elements in compound form such as water, coal and petroleum. Hydrogen has the highest energy content of any common fuel by weight. On the other hand, hydrogen has the lowest energy content by volume. It is the lightest element, and it is a gas at normal temperature and pressure.

Hydrogen Production : Since hydrogen does not exist on Earth as a gas, it must be separated from other compounds. Two of the most common methods used for the production of hydrogen are electrolysis or water splitting and steam reforming. Steam reforming is currently the least expensive method for producing hydrogen. It is used in industries to separate hydrogen atoms from carbon atoms in methane. Because methane is a fossil fuel, the process of steam reforming results in greenhouse gas emissions which is linked to global warming. The other method for the production of hydrogen is electrolysis. Electrolysis involves passing an electric current through water to separate water into its basic elements, hydrogen and oxygen. Hydrogen is then collected at the negatively charged cathode and oxygen at the positive anode. Hydrogen produced by electrolysis is extremely pure, and results in no emissions since electricity from renewable energy sources can be used. Unfortunately, electrolysis is currently a very expensive process. There are also several experimental methods of producing hydrogen such as photo-electrolysis and biomass gasification. Scientists have also discovered that some algae and bacteria produce hydrogen under certain conditions, using sunlight as their energy source.

Uses of Hydrogen: Currently, hydrogen is mainly used as a fuel in the NASA space program. Liquid hydrogen is used to propel space shuttle and other rockets, while hydrogen fuel cells power the electrical systems of the shuttle. The hydrogen fuel cell is also used to produce pure water for the

shuttle crew.
Hydrogen Fuel Cell: Fuel cells directly convert the chemical energy in hydrogen to electricity, with pure water and heat as the only byproducts. Hydrogen-powered fuel cells are not only pollution-free, but a two to three fold increase in the efficiency can be experienced when compared to traditional combustion technologies.



Fuel cells can power almost any portable devices that normally use batteries. Fuel cells can also power transportation such as vehicles, trucks, buses, and marine vessels, as well as provide auxiliary power to traditional transportation technologies. Hydrogen can play a particularly important role in the future by replacing the imported petroleum we currently use in our cars and trucks.
The Future of Hydrogen: In the future, hydrogen will join electricity as an important energy carrier, since it can be made safely from renewable energy sources and is virtually non-polluting. It will also be used as a fuel for ‗zero-emissions' vehicles, to heat homes and offices, to produce electricity, and to fuel aircraft. Hydrogen has great potential as a way to reduce reliance on imported energy sources such as oil. Before hydrogen can play a bigger energy role and become a widely used alternative to gasoline, many new facilities and systems must be built. The hydrogen is produced through a wind electrolysis system. The hydrogen is compressed up to pipeline pressure, and then fed into a transmission pipeline. The pipeline transports the hydrogen to a compressed gas terminal where the hydrogen is loaded into compressed gas tube trailers. A truck delivers the tube trailers to a forecourt station where the hydrogen is further compressed, stored, and dispensed to fuel cell vehicles.

Thus, Hydrogen is a clean fuel with highest energy content in terms of mass (120.7 MJ/kg). It is possible to use hydrogen directly in engines, mix with diesel and CNG and also in fuel cells to directly produce electricity. Hydrogen can be used for power generation and also as a fuel in automobiles. Hydrogen has been used as a fuel in spacecrafts. When burnt, hydrogen produces water as a by-product. It is, therefore, not only an efficient energy carrier but a clean and environmentally benign fuel as well. Hydrogen can substitute petrol and diesel can and therefore, reduces our dependence on imports. Hydrogen energy is at present only at the Research, Development and Demonstration (RD&D) stage. The Ministry of New and Renewable Energy (Government of India) is supporting a broad based RD&D projects on different aspects of hydrogen energy technologies including hydrogen production, its storage and utilization for stationary, motive and portable power generation applications using internal combustion engines and fuel cell technologies.

Advantages/ prospectus

- Hydrogen is colorless, odorless and entirely non-polluting, yielding pure water vapor (with minimal NOx) as exhaust when combusted in air. This eliminates the direct production of exhaust gases that lead to smog, and carbon dioxide emissions that enhance the effect of global warming.

- Hydrogen is the lightest chemical element and has the best energy-to-weight ratio of any fuel (not counting tank mass).
- Hydrogen can be produced anywhere; it can be produced domestically from the decomposition of water. Hydrogen can be produced from domestic sources and the price can be established within the country.

Constraints / limitations/ disadvantages

- Other than some volcanic emanations, hydrogen does not exist in its pure form in the environment, because it reacts so strongly with oxygen and other elements.
- It is impossible to obtain hydrogen gas without expending energy in the process. There are three ways to manufacture hydrogen;
    - By breaking down hydrocarbons — mainly methane (steam reforming). If oil or gases are used to provide this energy, fossil fuels are consumed, forming pollution and nullifying the value of using a fuel cell. It would be more efficient to use fossil fuel directly.
    - By electrolysis of water — The process of splitting water into oxygen and hydrogen using electrolysis. It has been calculated that it takes 1.4 joules of electricity to produce 1 joule of hydrogen.
    - By reacting water with a metal such as sodium, potassium, or boron. Chemical by-products would be sodium oxide, potassium oxide, and boron oxide. Processes exist which could recycle these elements back into their metal form for re- use with additional energy input, further eroding the energy return on energy invested.
- There is currently modest fixed infrastructure for distribution of hydrogen that is centrally produced, amounting to several hundred kilometers of pipeline. An alternative would be transmission of electricity over the existing electrical network to small-scale electrolyzers to support the widespread use of hydrogen as a fuel.
- Hydrogen is difficult to handle, store, and transport. It requires heavy, cumbersome tanks when stored as compressed hydrogen, and complex insulating bottles if stored as cryogenic liquid hydrogen. If it is needed at a moderate temperature and pressure, a metal hydride absorber may be needed. The transportation of hydrogen is also a problem because hydrogen leaks effortlessly from containers. In Vehicles, Fossil fuels like Petroleum and natural gas is used to power most transportation.

National Action Plan on Climate Change (NAPCC)

National Action Plan on Climate Change (NAPCC) is a comprehensive action plan which outlines measures on climate change related adaptation and mitigation while simultaneously advancing development. The 8 Missions form the core of the Plan, representing multi-pronged, long termed and integrated strategies for achieving goals in the context of climate change. The Eight Missions are:

(1) National Solar Mission

- Make solar energy competitive with fossil-based energy options.
- Launch an R&D programme facilitating international co-operation to enable the creation of affordable, more convenient solar energy systems.
- Promote innovations for sustained, long-term storage and use of solar power.

(2) National Mission for Enhanced Energy Efficiency

- The Energy Conservation Act of 2001 provides a legal mandate for the implementation of energy efficiency measures through the mechanisms of The Bureau of Energy Efficiency (BEE) in the designated agencies in the country.
- A number of schemes and programmes have been initiated which aim to save about 10,000 MW by the end of the 11th Five-Year Plan in 2012.

(3) National Mission on Sustainable Habitats

- Make habitats sustainable through improvements in energy efficiency in buildings, management of solid waste and a modal shift to public transport.
- Promote energy efficiency as an integral component of urban planning and urban renewal through its initiatives.

(4) National Water Mission

- Conserving water, minimizing wastage, and ensuring more equitable distribution and management of water resources.
- Optimizing water use efficiency by 20% by developing a framework of regulatory mechanisms.

(5) National Mission for Sustaining the Himalayan Ecosystem

- Empowering local communities especially Panchayats to play a greater role in managing ecological resources.
- Reaffirm the measures mentioned in the National Environment Policy, 2006.

(6) National Mission for a Green India

- To increase ecosystem services including carbon sinks.
- To increase forest and tree cover in India to 33% from current 23%.

(7) National Mission for Sustainable Agriculture

- Make Indian agriculture more resilient to climate change by identifying new varieties of crops (example: thermally resistant crops) and alternative cropping patterns.
- Make suggestions for safeguarding farmers from climate change like introducing new credit and insurance mechanisms and greateraccess to information.

(8) National Mission on Strategic Knowledge on Climate Change

- Work with the global community in research and technology development by collaboration through different mechanisms. It also has its own research agenda supported by climate change related institutions and a Climate Research Fund.
- Encourage initiatives from the private sector for developing innovative technologies for mitigation and adaptation.

LAND RESOURCES

In India per capita land availability has declined from 0.89 ha in 1951 to 0.3 ha in 2001. The per capita availability of agriculture land has declined from 0.48 ha in 1951 to 0.14 ha in 2001. More than 40% of the farmers in India were found to be reporting poor yields not due to sub-standard seeds, irrigation problems etc. but due to degrading land quality. It is estimated that 5 million tonnes of topsoil is eroded every year and 20 % of such land is so damaged that it is categorized as wasteland. 23% of usable land degraded

Causes of land degradation:

- **Deforestation**
- **Agricultural mismanagement**
- **Urbanization**
- **Implications**
- **Soil erosion**
- **Pollution**
- **Disturbed natural cycles**
- ***Other problems***
- **Water logging**
- **Soil salinity**
- **Desertification- *'Skin disease'(i)* 1/3 of world land affected; (ii) 1/5 of world's population threatened.**
- ***Urbanization :*** **50% population in Urban areas, Big cities - large ecological footprints, 2 mha land for waste disposal, Urban home gardens – Sao Paulo & Cuba.**

Measures to check it

- **UN convention (1994) – 180 countries signed**
  Can be controlled through
- **Aero-seeding over shifting sand dunes**
- **Introduction of salinity tolerant species**
- **Early warning system**