

Energy sources

“Energy” is a great word, which is defined as the ability or capacity to do work. The word energy has been derived from the Greek word ‘en’ means ‘in’ and ‘ergon’ means ‘work’ / ‘en-ergon’ means work content. Later en-ergon was simplified to “Energy”.

We use energy to do work and make all movements. When we eat, our body’s transforms the food into energy to do work. When we run or walk or do some work, we ‘burn’ energy in our bodies. Cars, planes, boats, machinery etc. also transform energy into work. Work means movement or lifting something, warming something, lighting something. There are many sources of energy that help to run the various machines invented by man.

Energy is measured in BTU (British Thermal Unit) or Joule.

Kinds of energy:

- a) Kinetic energy: It is the energy of motion
- b) Potential energy: It is the energy due to position or energy stored

Types of energy:

In the environment, energy exists in many forms such as solar energy, wind energy, chemical energy, electrical energy, mechanical energy, nuclear energy, thermal energy, bio-energy, etc.

All these forms of energy can be broken either into kinetic or potential energy.

Growing energy needs

Global energy consumption patterns

Transportation consumes about 24% of the energy, 40% for industry, 30% for domestic and commercial purposes and remaining 6% for other uses including agriculture. The top 20 richest countries of the world consumes 80% of the natural gas 65% of the oil and 50% of the coal produced every year while these countries have only one fifth of the world’s population. U.S.A is the largest energy consumer in the world.

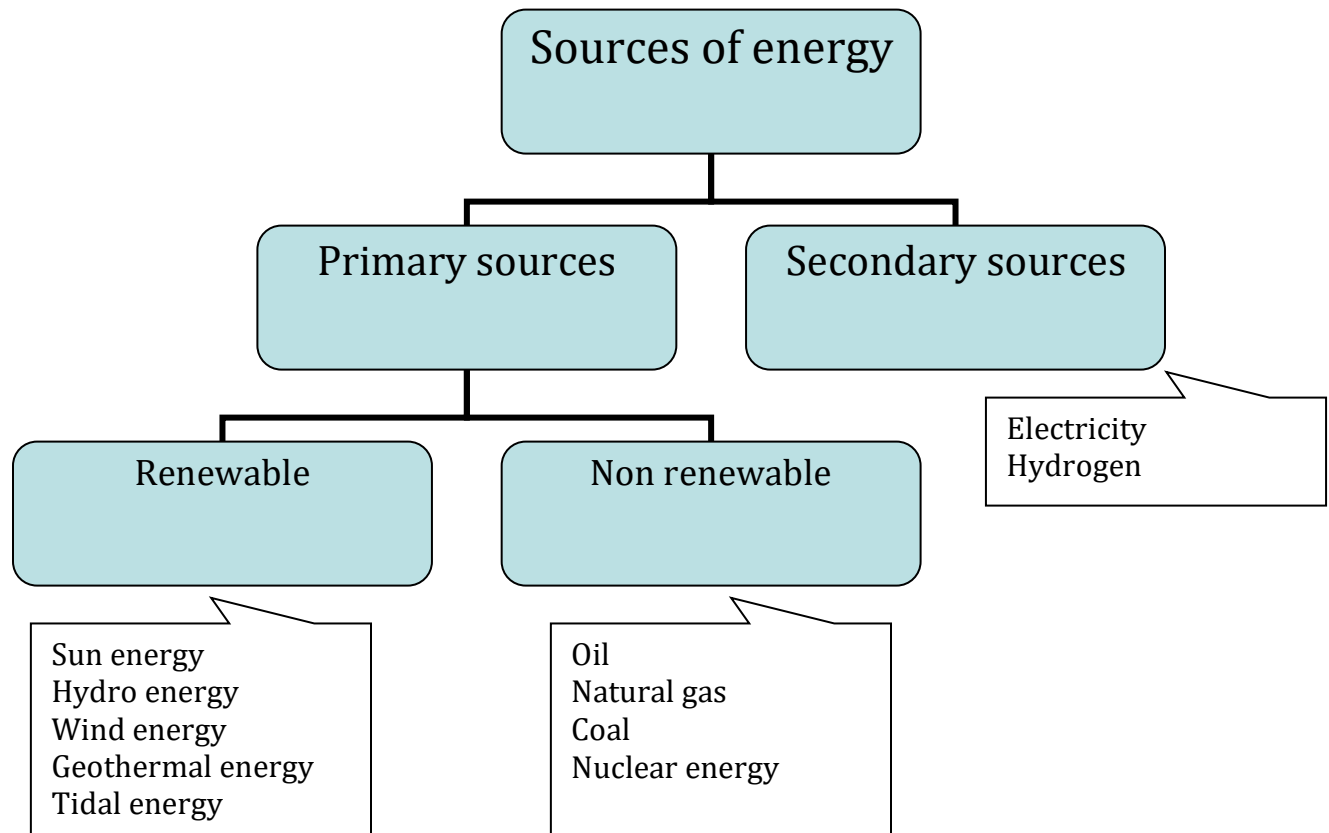
One third of the world’s population is about two billion people, lack access to adequate energy supplies; they mainly depend on fuel wood, dung, coal, charcoal and kerosene for cooking and heating.

Energy Status of India

India ranks sixth position in the worlds total energy consumption. India’s energy status is not promising. Presently, the country consumes about 100 million tones of coal and 325 million tones of oil annually. Official report estimates that **40 billion tones of coal** are available in India’s deposits against the world coal reserve of **27,350 billion metric tons**. India’s oil deposits are about **400 million tones** as against the world oil reserve of **7, 50,000 million tones**. Gas reserves of our country are about **100 million cubic meters**, as against world’s reserves of **63,000 million cubic meters**. Here, one can conclude that the energy Scenario of India’s bank.

Sources of energy

Energy resources are broadly classified as primary and secondary



Primary sources: Energy resources are mined or otherwise obtained from the environment

Ex:

- a) Fossil fuels: Coal, lignite, crude oil, Natural gas etc
- b) Nuclear fuels: Uranium, Thorium used in fission reaction
- c) Hydro energy: It is energy of falling water, used to turn a turbine
- d) Geo thermal: The heat from the underground stream
- e) Solar energy: Electromagnetic radiation from the sun
- f) Wind energy: The energy from moving air used by wind mills
- g) Tidal energy: The energy associated with the rise and fall of the waves in ocean waters

Renewable / Non conventional / Inexhaustible energy sources: are those which get replenished after their consumption and are not in common use. These can reproduce themselves in nature and can be harvested continuously through planning and proper management. Eg: Solar energy, Wind energy

Non renewable / conventional / Exhaustible energy sources: are those which do not get replenished after their consumption and are in common use. These are available in limited amount and develop takes over a longer period of time. Eg: Thermal power, Nuclear power

Difference between conventional and non-conventional energy sources:

Sl. No.	Conventional	Non-conventional
1.	Technologies are well established	Technologies are commercially not well established
2.	Energy plants are larger in size	Energy plants are in smaller in size
3.	Energy sources are very high in density	Energy sources are very low in density
4.	Energy plants have more pollution problems	Energy plants have less pollution problems
5.	Storage of energy sources are easy	Storage of energy sources are uneconomical
6.	Lower in generation cost	Higher in generation cost

Examples of Non renewable energy sources

Fossil fuels: Fossils fuels (coal, oil, natural gas) are energy rich substances that have formed from the remains of organisms that lived 200 to 500 million years ago. During the stage of the Earth's evolution, large amount of dead organic matter had collected. Over million of years, this matter was buried under layers of sediment and converted by heat and pressure into coal, oil and natural gas.

Chemically, fossil fuels largely consist of hydrocarbons, which are compounds of hydrogen and carbon.

Majority of fossil fuels are being used in transportation, industries heating and generation of electricity.

- Crude petroleum is refined into gasoline; diesel and jet fuel that power the world's transportation system.
- Coal is mostly used in the generation of electricity (thermal power).
- Natural gas is used for commercial and domestic purposes like heating, air conditioning and as fuels for stoves and for other heating appliances.

Environmental effects of using Fossil fuels:

a. Acid rain: When fossil fuels are buried, Sulphur, Nitrogen and Carbon combine with oxygen to form compounds known as oxide. These oxides when released into the atmosphere, they react with water form and result in the formation of Sulhuric acid, Nitric acid and Carbonic acid. These acids can harm biological quality of forests, soils, lakes and streams.

b. Fly ash particles: Ash particles are the burnt fuel materials. However with strict imposition of Government regulations, barren lands are provided to trap these particles but still it leads to soil and ground water pollution. Petro and natural gas generate less ash particles than coal, diesel or gasoline.

c. Global warming: Carbon dioxide is a major by product of fossil combustion and this gas is known as green hour gas. Green hour gas absorbs solar heat reflected off the earth's surface and retains this heat, keeping the Earth warm and habitat for living organisms. Rapid industrialization between 19th and 20th centuries however has resulted in increasing fossils fuel emissions, Increasing the percentage of carbon dioxide by about 28%. This drastic increase has led to global warming that could cause environmental problems, including disrupted weather patterns and polar ice cap melting.

d. Direct burning of coals results in emission of particle matter causing air pollution.

e. Climate change is due to usage of fossil fuels.

f. Mining them caused environmental pollution

g. Bio-diversity is affected

Examples of Renewable energy sources

Solar energy: The solar energy originates from the thermonuclear fusion reaction taking place in the Sun. It is one of the potential non-conventional energy source which provides earth with two major forms of energy, Heat and Light energy. The earth continuously receives energy from the Sun, part of which is absorbed while the remaining is emitted back into space.

In India, solar photovoltaic systems are being installed by Department of Non-Conventional energy resources for lighting, running of TV sets, water pumping etc. In India, there has been steady rise in demand for solar photovoltaic system. Solar cells are used to convert the solar radiation directly and no mechanical movement of parts is need. The reliability of the operation is extraordinarily high. Even under severe space conditions a maintenance free life span of ten or more years has been achieved. Only disadvantage is that, its cost is very high.

Advantages of solar energy

1. Solar energy is free and it is available locally in abundance.
2. Solar energy is pollution free.
3. Systems are easy to install, generate and maintain.
4. System can be specifically designed according to individual requirements.
5. Supply of hot water is instant and un-interrupted
6. Recurring fuel costs are zero

Disadvantages of solar energy

1. Solar energy can be easily diffused
2. Solar energy varies with time and weather conditions
3. Need a large area of solar panels to get the required amount of power and expensive to build solar power stations.

Alternative to fossil fuels: Bio-energy and Nuclear energy**Bio-energy (Biomass)**

Biomass is the term used to describe the organic matter produced by photo synthesis that exists on the Earth's surface. The source of all energy in biomass is the Sun, the biomass acting as a kind of chemical energy store.

Biomass use in the development world

More than two billion people in the developing world use biomass for the majority of their household energy needs. Biomass is also used widely used for non-domestic appliances.

Traditionally the extraction of energy from biomass is split into three distinct categories:

1. **Solid biomass:** The use of trees, crop residues animal and human waste, house hold or industrial residues for direct combustion to provide heat.
2. **Biogas:** it is obtained an aerobically (without air) digesting the organic material to produce ethane. Animal waste and municipal waste are two common feed stocks for anaerobic digestion.
3. **Liquid bio-fuels:** They are obtained by subjecting organic materials to one of the various chemical or physical processes to produce a usable, combustible liquid fuel. Vegetable oils are the materials to manufacture the Bio fuels.

1. Solid biomass**Activities including Commercial utilization of Solid biomass**

In India, sugar mills are rapidly turning to bagasse, the leftover of cane after it is crushed and its juice extracted to generate electricity. This is mainly done to clean up the environment and cut down power cost. According to current estimates, about 3500 MW of power can be generated from bagasse in the existing 430 sugar mills of the country. The advantages of this biomass can be locally sourced.

Benefits of Solid biomass energy:

- * Renewable or recyclable energy source (Stored solar energy)
- * Less waste directed to landfills.
- * Decrease reliance on imported energy sources.
- * Potential rural development and job creation.
- * can generate renewable electricity when the Sun is not shining and the wind is not blowing.

2. Biogas

Biogas is obtained by an aerobically (without air) digesting organic material to produce a combustible gas known as methane. Animal waste and municipal waste are two common feed stocks for an aerobic digestion.

At present biogas technology provides an alternative source of energy in rural India for cooking. It is particularly useful for village households that have their own cattle. Through a simple process cattle dung is used to provide the gas. The residual dung is used as manure.

3. Liquid bio-fuels (Energy of future for transportation)

i). Ethanol, ii). Biodiesel, iii). Fuel cells

i. Ethanol

- Ethanol is a fuel made from sugars found in plants.

- Earlier, corn was being turned into an alcohol fuel called Ethanol.
- Nowadays, Ethanol is being used as a clean burning fuel for many vehicles.

Advantages

- Ethanol is cleaner than gasoline and does not pollute the air
- Ethanol is non-toxic and is also bio-degradable; it breaks down quickly into harmless substances if it is spilled.
- Made from plants, comes from renewable energy source
- All engines which use gasoline can use Ethanol without making any changes to this engines

ii. Bio-diesel

Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils and animal fats for use in diesel vehicles. Biodiesel's physical properties are similar to those of petroleum diesel, but it is a cleaner burning alternative. Using biodiesel in place of petroleum diesel reduces emissions.

Advantages

- Biodiesel fuel is a renewable energy source unlike petroleum based diesel.
- Less polluting than petroleum diesel.
- The lack of sulfur in 100% biodiesel extends the life of catalytic converters.
- The lubricating property of the biodiesel may lengthen the life time of engines.

Disadvantages

- At present, Biodiesel fuel is about one and half times more expensive than petroleum diesel fuel.
- It requires energy to produce biodiesel fuel from crops, plus there is the energy of sowing, fertilizing and harvestine.
- As Biodiesel cleans the dirt from the engine, this dirt can then get collected in fuel filter, thus blocking it. So, filters have to be changed after the first several hours of biodiesel use.
- Biodiesel fuel distribution infrastructure needs improvement.

iii. Fuel cells

- A fuel cell is device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent.
- Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used.
- Fuel cells are different from batteries in the way they require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these inputs are supplied.
- The electricity produced can be used to power cars, buses, laptops and mobile phones.

Structure

- Fuel cells consists of 2 electrodes, a negative anode and positive cathode
- Electrodes are separated by a solid or liquid electrolyte
- Electrically charged particles move between the 2 electrodes
- Catalyst are often used to speed up the reactions at the electrodes
- Electricity is generated when oxygen and hydrogen combine to form water

Advantages

- The fuel cell produces no greenhouse gases or other air pollutants.
- High efficiency conversion: Fuel cells convert chemical energy directly into electricity without the combustion process.

- Quiet operation: The nature of operation is extremely quiet in operation. This allows fuel cells to be used in residential or built up areas where the noise pollution is undesirable.
- Safer than gasoline

Disadvantages

- Storage and distribution of the hydrogen fuel. Hydrogen gas is difficult to contain and most methods add considerable weight to a vehicle.
- The operation of cells in very cold weather is a problem, since water is always present in and around the cell.
- Transporting and dispensing the gas will also require new methods.
- Presently the cost of fuel cells is not competitive.

Nuclear energy

Nuclear energy: It is obtained during fission (disintegration) or fusion (union) reaction of selected radioactive materials, which yields large amount of heat energy.

- In nuclear fission, the nucleus of certain isotopes (eg. Uranium 235) with large mass numbers are split into lighter nuclei on bombardment by neutrons. It releases a large amount of energy through chain reactions
- In nuclear fusion, two isotopes of a light elements are forced together at extreme high temperatures, until they fuse to form a heavier nucleus releasing enormous amount of energy.

Nuclear power appears to be the only hope for large scale energy requirements when fossil fuels are exhausted. The reserves of nuclear fuels is about ten times more than fossil fuels and its major advantage is that even small quantities can produce enormous amounts of energy. For example, a ton of uranium – 235 can produce an energy equivalent 3 million tones of coal or 12 million barrels of oil.

Nuclear energy has been successfully used in the generation of electricity in spaceships, marine ships, chemical and food-processing industry.

Nuclear energy advantages and disadvantages**Advantages**

- The space required is less when compared to other conventional power plants of comparable capacity
- A nuclear power plant consumes very small quantity of fuel. The fuel transportation cost is less and large storage facilities are not needed.
- Increase in reliability of operation
- Functioning of the plant is not affected by the adverse weather conditions

Disadvantages

- The initial cost of the power plant is high
- Not suited for varying conditions
- The radioactive wastes, if not disposed carefully, will have an adverse effect on inhabitants.
- Maintenance cost of the plant is high

Environmental impact assessment (EIA)

The environmental effects are normally defined through the term environmental impacts which may be caused or induced by set of human action or nature itself. The impacts of the environment are assessed through Environmental impact assessment or environmental impact analysis.

Environmental impact assessment is defined as an activity designed to identify and predict the impact of legislative proposals, policies, programmes, projects and operational procedures on the biogeophysical environment and on the health and well being of human beings and to interpret and communicate information about the impact.

Who prepares an EIA?

Depending on the EIA system, responsibility for producing an EIA will be assigned to one of two parties: (1) the government agency or ministry, or (2) the project supporter. If EIA laws permit, either party may opt to hire a consultant to prepare the EIA or handle specific portions of the EIA process, such as public participation or technical studies.

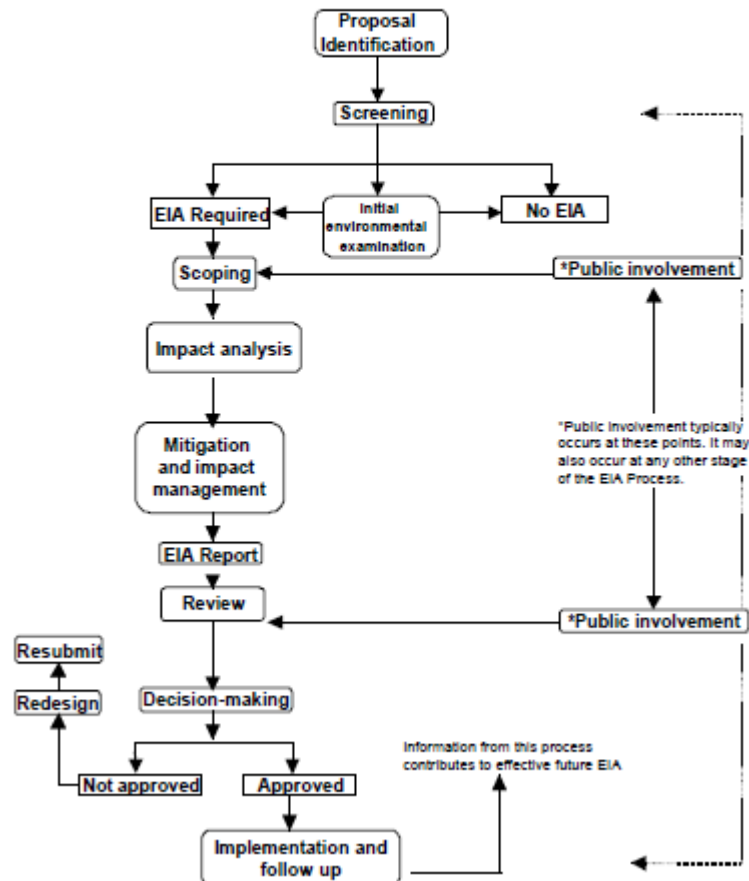
The major objective or goals of EIA are

- a) Resource conservation
- b) Waste minimization
- c) Use efficient equipment
- d) Recovery of by product
- e) Recycle and reuse

Benefits of EIA

- Promoting integrated environment and development decision making.
- Reduced time and cost of project implementation.
- Facilitating the design of environmentally sustainable policies and plans.
- Cost saving modifications in project planning.
- Consideration of a large range of alternative.
- Increased project acceptance.
- Avoiding environmental impacts and violations of laws and regulations.
- Reduction of waste treatment expenses.
- Maintenance of biodiversity.
- Reduced resources utilization.
- Improved human health.
- Mechanism for public engagement to sustainability.

FLOW CHART OF EIA PROCESS

Generalised EIA
Process Flowchart

Steps in EIA process or step by step procedure of conducting EIA

The EIA process following steps is

- **Screening** – To determine whether or not a proposal should be subject to EIA and if so at what level of detail.
- **Scoping** – To identify the important issues, impacts and prepare terms of reference for EIA.
- **Impact analysis** – To identify and predict the likely environmental, social and other related effects of the proposal.
- **Mitigation and impact management** – To establish measures to prevent reduce or compensate for impacts.
- **Reporting** – To prepare the information necessary for decision making.
- **Review** – To check the quality of the EIA report, whether the report meets its terms, provides a satisfactory assessment.
- **Decision making** – To approve or reject the proposal and set conditions.
- **Follow up** – To monitor, manage and audit impacts of project implementation
- **Public involvement** – To inform and consult with participating public professional groups, NGOs, local authorities, general community etc.

Multiple choice questions:

1. Which of the following is the major source of thermal pollution

- a. Nuclear power plants
- b. Coal fired power plants**
- c. Solar power generation
- d. Bio gas generation

2. Non-renewable sources of energy contributes _____ percentage of world's energy

- a. 100%
- b. 91%**
- c. 85%
- d. 75%

3. A long term atmospheric impact of burning fossil fuel is

- a. Oxygen consumption
- b. Global warming**
- c. Reduction in photosynthesis
- d. All

4. Solar photo voltaic systems are more suitable for

- a. Domestic lighting
- b. Street lighting
- c. Small power plants
- d. All**

5. Potential energy is

- a. Energy of post
- b. Energy of position**
- c. Energy of motion
- d. Energy in a place

6. Thermal energy is

- a. Due to heat radiation**
- b. Due to falling body
- c. Due to motion
- d. Due to light

7. The device that can directly convert hydrogen energy to electrical energy by reaction with oxygen is known as

- a. Electric cell
- b. Hydrogen cell
- c. Oxygen cell
- d. Fuel cell**

8. Biomass contains compounds of

- a. Hydrogen
- b. Sulphur
- c. Carbon**

d. Sodium

9. Formation of water by the chemical combination of hydrogen and oxygen

a. Absorbs energy

b. Release energy

c. Conserves energy

d. None

10. Which of the following is not a fossil fuel

a. Gas

b. Oil

c. Peat

d. Uranium

11. Coal is a dirty fuel to burn mainly because it emits

a. O_2

b. N_2

c. H_2

d. SO_2

12. Ash is a byproduct of combustion of

a. Crude petroleum

b. Coal

c. Uranium

d. None

13. Natural gas consists mainly of

a. Ethane

b. Propene

c. Butane

d. Methane

14. Current annual production of coal would last for the next

a. 200 years

b. 1000 years

c. 25 years

d. 10 years

15. Nuclear fission reaction involves the bombardment of U_{235} by

a. Electrons

b. Neutrons

c. Protons

d. Alpha radiation

16. Hydrogen energy can be tapped through

a. Heat pumps

b. Fuel cells

c. Photovoltaic cells

d. Gasifiers

17. Nuclear wastes is active for

- a. 5 years
- b. 10 years
- c. 50 years
- d. Centuries**

18. Which of the following is considered as an alternate fuel?

- a. CNG**
- b. Kerosene
- c. Coal
- d. Petrol

19. Solar radiation consists of

- a. UV
- b. Visible light
- c. Infrared
- d. All of these**

20. The most important fuel used by nuclear power plant is

- a. U235**
- b. U238
- c. U245
- d. U248

21. Biogas is produced by

- a. Microbial activity**
- b. Harvesting crop
- c. Both (a) & (b)
- d. All of these

22. Oil and gas are preferred because of

- a. Easy transportation**
- b. Cheap
- c. Strong smell
- d. None of the above

23. Biomass power generation uses

- a. Crops
- b. Animal dung
- c. Wood
- d. All of these**

24. Which of the following is not a renewable source of energy?

- a. Fossil fuels**
- b. Solar energy
- c. Tidal wave energy
- d. Wind energy

25. Which of the following source of energy is less ecofriendly?

- a. Biogas
- b. Wind
- c. Solar
- d. Nuclear**

26. Identify the non-renewable source of energy from the following

- a. Coal**
- b. Fuel cells
- c. Wind power
- d. Wave power

27. Electromagnetic radiation can cause

- a. Plague
- b. Malaria
- c. Cancer**
- d. Dengue fever

28. Wind farms are located in

- a. River basin
- b. Plain area
- c. Hilly area**
- d. Valley area

29. Wind energy generation depends on

- a. Direction of wind
- b. Velocity of wind**
- c. Humidity
- d. Precipitation

30. With a minimum resource maximum energy can be created by

- a. Solar radiation
- b. Wind
- c. Nuclear fuels**
- d. Tidal waves

31. Direct conversion of solar energy is attained by

- a. Solar photo voltaic system**
- b. Solar diesel hybrid system
- c. Solar thermal system
- d. Solar air heater

32. In hydropower plants power is generated by

- a. Hotsprings
- b. Wind
- c. Sun
- d. Water**

33. Problems of Hydrogen fuel cell is

- a. Storage and distribution**

- b. Availability of hydrogen
- c. Creates pollution
- d. None of the above

34. Nuclear power is being produced from

- a. Carbon-14
- b. Nuclear fission**
- c. Petroleum combustion
- d. Natural gas

35. Biomass energy in green plants is produced in presence of

- a. Carbon dioxide
- b. Water
- c. Sunlight
- d. All of the above**

36. Fossil fuels are converted into energy by

- a. Burning**
- b. Cooling
- c. Sublimation
- d. Melting

37. Highest producer of Oil and petroleum is

- a. Middle East countries**
- b. America
- c. China
- d. India

38. Cow dung can be used as

- a. Manure
- b. Production of Biogas
- c. fuel
- d. All of the above**

39. The source of Electromagnetic radiation is

- a. Sun**
- b. Wind
- c. Tide
- d. Water

40. Biogas is gaseous fuel composed mainly of

- a. Methane and carbon dioxide**
- b. Methane and hydrogen sulphide
- c. Methane and carbon monoxide
- d. None of the above

41. Photovoltaic energy is the conversion of sunlight into

- a. Physical energy
- b. Chemical energy**

- c. Mechanical energy
- d. All of the above

42. A fuel cell, in order to produce electricity, burns

- a. Carbon
- b. Sulphur
- c. Hydrogen**
- d. All of the above

43. Both power and manure is provided by

- a. Coal
- b. Wind mill
- c. Biogas plants**
- d. Tidal energy

44. Lignite, bituminous and anthracite are different ranks of

- a. Coal**
- b. Wood
- c. Mineral
- d. All of the above

45. Global atmospheric temperatures are likely to be increased due to

- a. Mining
- b. Radioactive waste
- c. Solar radiation
- d. Burning of fossil fuel**

46. The process used for generation of energy from nuclear power plant is

- a. Omission
- b. Fusion
- c. Fission**
- d. None of the above

47. Coal, petroleum and natural gas are grouped under

- a. Non-Renewable**
- b. Renewable
- c. Inexhaustible
- d. Conventional

48. The organic matters which are used in the generation of Bio-gas is called

- a. Biomass**
- b. Incineration
- c. Ethanol
- d. Vermi-composting

49. The main constituent of biogas is

- a. Water
- b. Sulphur
- c. Calcium

d. Methane

50. _____ can be used as biofuel which is alternative to gasoline

- a. Fuel cell
- b. Biodiesel
- c. Ethanol**
- d. LPG

51. _____ is obtained by an aerobically (without air) digesting organic material

- a. Biomass
- b. Biofuel
- c. Biogas**
- d. None of the above

52. Fossil fuel largely consists of

- a. Oxygen
- b. Carbon dioxide
- c. Sulphur
- d. Hydrocarbons**

53. _____ energy associated with the rise and fall of the waves in ocean waters

- a. Wind
- b. Tidal**
- c. Geothermal
- d. Hydroelectric

Answer the following questions:

1. Justify the necessity of developing non-conventional sources of energy.
2. Difference between conventional and non-conventional energy.
3. Discuss about the benefits caused by renewable resources with examples.
4. Explain the nuclear energy along with its merits and de-merits.
5. List out the advantages and disadvantages of solar energy and wind energy.
6. Discuss Hydrogen fuel cells and nuclear fission as source of energy of the future.
7. Discuss Ethanol and Fuel cells as alternative sources of energy for transportation.
8. What is Bio-diesel?
9. Compare the merits and demerits of coal, oil and natural gas energy. Give examples.
10. What are fossil fuels? Describe briefly the different alternatives to fossil fuels.
11. Write the environmental effects of fossil fuels.
12. List alternative sources of energy to fossil fuels. Describe advantages of any two sources of energy
13. With a help of flow chart, discuss the step by step procedure of conducting EIA.

14. Define Environmental Impact Assessment. Explain step by step procedure to conduct EIA.
15. Describe the need for conducting Environmental Impact Assessment. What are the objectives and benefits of EIA.