

UNIT II: ENERGY

Energy is the power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines. There are different forms of energy like Chemical energy, Electrical energy, heat energy, light energy, mechanical energy, and nuclear energy. Energy sources are of two kinds, Renewable and Non-Renewable.

Renewable resource: A renewable resource is a resource which is replaced naturally and can be used again. Examples are: oxygen, fresh water, solar energy, timber, and biomass. Renewable resources may also include goods commodities such as wood, paper and leather. Different types of Renewable energy are solar power, Wind power, Hydro power, Geothermal power, Biomass etc. They are ecofriendly.

Solar power

Solar power is the technology of obtaining usable energy from the light of the sun. Solar energy has come into use where other power supplies are absent, such as in places far off from the national electrical grid and in space. Solar energy is currently used in a number of applications:

- Heat (hot water, building heat, solar cooking)
- Electricity generation (photovoltaic and solar thermal and other heat engines)
- Desalination of seawater (taking the salt out so it can be used for drinking or growing crops).
- Lighting

Wind power

Wind power is using the energy of wind to do something useful. Wind has been used since ancient times to move ships, and for hundreds of years to pump water or grind corn and grain into flour, now it is usually changed into electricity using wind turbines.

Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator. In windmills (a much older technology) wind energy is used to turn mechanical machinery to do physical work, like crushing grain or pumping water.

Wind power is used in large scale wind farms for national electrical grids as well as in small turbines for providing electricity to a farm house or *off-grid* locations. Wind energy is common, renewable, and usable in many places, clean, and works against the greenhouse effect if used to replace fossil-fuels.

But they have some problems. Some people do not like the tall towers that can be seen from far away, and close to houses they can make a flickering shadow and have a small amount of noise. Some of the early wind farms were built where birds migrated every year, and they had small, fast-spinning blades that often killed birds. Some people still think all wind farms do that, but newer wind turbines are much bigger, with slower-moving blades and do not have that problem.

Wind mills do not make power when the wind is stopped or just a light breeze, so back-up power is still needed or electricity needs to be moved from a distant place where the wind is blowing. Another idea is to put the turbines on kites, and fly them very high where the wind is always blowing.

Hydropower

Hydropower is changing the energy of moving water into more useful forms. Even in ancient history hydropower was used for irrigating crops and milling of grain into flour, and later for textile manufacture (making cloth) and running sawmills to cut wood.

Today the largest use of hydropower is for a dam that can use the falling water to make electricity. This electricity can be moved hundreds of miles through wires, so industry no longer needs to be very close to the water for power.

Geothermal

Geothermal energy uses the heat from deep underground to make electricity. It can be used to produce steam which goes up a pipe, which then pushes a turbine. It is best used in places where the Earth's crust is not real thick. Once it is built, it is clean energy, but it requires deep wells. These areas often have volcanoes or earthquakes in the area, and sometimes adding or removing water deep underground might be enough to cause an earthquake. Some small earthquakes may have been caused this way.

Non-renewable Resource

A **non-renewable resource** (also called a finite resource) is a resource that does not renew itself at a sufficient rate for sustainable economic extraction in meaningful human time-frames. An example is carbon-based, organically-derived fuel. The original organic material, with the aid of heat and pressure, becomes a fuel such as oil or gas. Earth minerals and metal ores, fossil fuels (coal, petroleum, natural gas) and Nuclear Power.

Earth minerals and metal ores

Earth minerals and metal ores are examples of non-renewable resources. The metals themselves are present in vast amounts in Earth's crust, and their extraction by humans only occurs where they are concentrated by natural geological processes (such as heat, pressure, organic activity, weathering and other processes).

Fossil fuels

Natural resources such as coal, petroleum (crude oil) and natural gas take thousands of years to form naturally and cannot be replaced as fast as they are being consumed. Eventually it is considered that fossil-based resources will become too costly to harvest and humanity will need to shift its reliance to other sources of energy such as solar or wind power, see renewable energy. At present, the main energy source used by humans is non-renewable fossil fuels. The continual use of fossil fuels at the current rate is believed to increase global warming and cause more severe climate change.

Nuclear Power

Nuclear power is the use of nuclear reactions that release nuclear energy to generate heat, which most frequently is then used in steam turbines to produce electricity in a nuclear power station. The term includes nuclear fission, nuclear decay and nuclear fusion. Nuclear power is generated using Uranium, which is a metal mined in various parts of the world. Nuclear power is the fourth largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. The famous nuclear plants in India are French backed 9900MW Jaitapur Nuclear power project in Maharashtra and Russian backed 2000 MW Kudankulam Nuclear power plant in Tamilnadu.

ADVANTAGES:

- Less fuel offers more energy. It represents a significant save on raw materials but also in transport, handling and extraction of nuclear fuel. The cost of nuclear fuel (overall uranium) is 20% of the cost of energy generated.
- The production of electric energy is continuous. A nuclear power plant is generating electricity for almost 90% of annual time. It reduces the price volatility of other fuels such as petrol.
- It's an alternative to fossil fuels, so the consumption of fuels such as coal or oil is reduced. This reduction of coal and oil consumption benefits the situation of global warming and global climate change.
- Geographical limitations - nuclear power plants don't require a lot of space; they do not need a large plot like a wind farm. But they have to be built near a large body of water for cooling purposes - using the water as a heat sink. They are usually found on the coast so there is no risk to drinking water sources.
- Nuclear power stations do not contribute to carbon emissions - no CO₂ is given out - it therefore does not contribute to global warming.
- Nuclear power stations do not produce smoke particles to pollute the atmosphere or emit gases that contribute to acid rain.
- Nuclear energy is by far the most concentrated form of energy - a lot of energy is produced from a small mass of fuel. This reduces transport costs - (although the fuel is radioactive and therefore each transport that does occur is expensive because of security implications).
- Nuclear power is reliable because most nuclear reactors have a life cycle of 40 years which can be easily extended for twenty more years.
- Nuclear power produces a small volume of waste.

DISADVANTAGES:

- Nuclear power plants generate external dependence. Not many countries have uranium mines and not all the countries have nuclear technology, so they have to hire both things overseas.
- Disposal of nuclear waste is very expensive. As it is radioactive it has to be disposed of in such a way as it will not pollute the environment.
- Nuclear accidents can spread 'radiation producing particles' over a wide area, This radiation harms the cells of the body which can make humans sick or even cause death. Illness can appear or strike people years after they were exposed to nuclear radiation

and genetic problems can occur too. A possible type of reactor disaster is known as a meltdown. In a meltdown, the fission reaction of an atom goes out of control, which leads to a nuclear explosion releasing great amounts of radioactive particles into the environment. Three major accidents have occurred in commercial power plants: Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011). Three Mile Island is a nuclear power plant located in Pennsylvania in USA. It was a partial-core meltdown, where coolant levels dropped below the fuel and allowed some of it to melt. No one was hurt and very little radiation was released, but the plant had to close, causing the operating company and its investors to lose a lot of money. Chernobyl Nuclear power station is in Ukraine. It was an uncontrolled steam explosion which released a large amount of radiation into the environment, killing over 50 people, requiring a mass evacuation of hundreds of thousands of people, and causing up to 4000 cancer cases. Fukushima Dai ichi is a nuclear plant in Japan. It was a station black-out caused by a huge Tsunami. Four neighboring plants lost cooling and the decay heat melted the cores. Radiation was released and the public was evacuated. These three accidents are very scary and keep many people from being comfortable with nuclear power.

- Cost: Nuclear power plants are larger and more complicated than other power plants. Many redundant safety systems are built to keep the plant operating safely. This complexity causes the up-front cost of a nuclear power plant to be much higher than for a comparable coal plant. Once the plant is built, the fuel costs are much less than fossil fuel costs. In general, the older a nuclear plant gets, the more money its operators make. The large capital cost keeps many investors from agreeing to finance nuclear power plants.
- Nuclear terrorism: a concern that nuclear facilities could be targeted by terrorists or criminals.

Conclusion: Many Anti-nuclear power groups have emerged in every country that has had a nuclear power programme. Protest movements against nuclear power first emerged in the USA, at the local level, and spread quickly to Europe and the rest of the world. National nuclear campaigns emerged in the late 1970s. Fuelled by the Three Mile Island accident, Chernobyl disaster and the Fukushima nuclear accident the anti-nuclear power movement mobilized political and economic forces which for some years "made nuclear energy untenable in many countries". Some of the major anti-nuclear groups include Campaign for Nuclear Disarmament, Friends of the Earth, Greenpeace, International Physicians for the Prevention of Nuclear War and the Nuclear Information and Resource Service. Besides there are a number of groups operating at the local, national and international level.

How Pertinent is the Nuclear Option?

1) Identify the conflict between the government's aim and people's fears.

A) There is conflict between government's aim and people's fears as the aim of the government was to produce clean nuclear energy but people were afraid of nuclear plant catastrophes, the accidents like Three Mile Island, Chernobyl and Fukushima.

2) What were the beliefs of the protagonists of nuclear power in the initial stages?

A) The beliefs of the protagonists of nuclear power were that the power was so cheap and clean that even meters were not really needed and also electricity from nuclear reactors was to be given away free to the world.

3) How were those beliefs belied?

A) The beliefs of the protagonists about nuclear energy that it was very cheap and clean and can be given for free were belied because nuclear energy production actually costs more due to the safety measures taken to avoid catastrophic events.

4) What's India's nuclear power capability now?

A) India's twenty nuclear power plants generate only 3% of the country's electricity output.

5) Why aren't tourists allowed to visit the Chernobyl plant even 25 years after the disaster?

A) [Chernobyl](#) Nuclear power station is in Ukraine. It was an uncontrolled steam explosion which released a large amount of radiation into the environment, killing over 50 people, requiring a mass evacuation of hundreds of thousands of people, and causing up to 4000 cancer cases. Due to this tourists were not allowed to visit the Chernobyl plant even 25 years after the disaster.

7) List out the prevalent fears regarding the nuclear power plants. Do you think they are genuine or are we being led to believe them?

A) There are so many fears regarding the nuclear power plants. They are genuine as many accidents occurred in nuclear power plants like Three Mile Island, Chernobyl and Fukushima disasters. Due to these there were many deaths and also due to radioactive emission many people were affected by cancer.

8) What suggestion do experts offer to meet the demand of the state? Do you agree with the suggestion?

A) The suggestion by experts was to expand capacity at nuclear power to meet the demand of the state. I agree with the suggestion.

9) What are your suggestions for 'bridging the widening gap' between the demand and supply for power?

A) Many Nuclear plants should be set up with more safety measures so that clean energy will be produced without any catastrophies. This can 'bridge the widening gap' between the demand and supply for power.

In Search of our Energy Solutions

Question and Answers:

1) What are the primary reasons for the energy crisis in our country?

A) The primary reasons for the energy crisis in our country are:

i) Politicians encouraging fuel subsidies has become a "gold standard" in Vote-getting Campaign promise.

ii) Over population is another major reason for energy crisis.

iii) Lack of resources mainly caused by deforestation and pollution soil erosion which can in turn affect loss of mineral resources.

iv) No sufficient alternative sources.

v) The tradition of freebies like promising for free power to farmers etc.

2) How do you think the 'scramble for energy' is likely to hurt the image of India being a 'bridge nation'?

A) Scramble for energy mainly refers to the struggle India facing today for energy policies that are interlinked with foreign countries. These energy concerns deeply influence our position towards Burma and Iran. This may often decline India's fame and name. It may essentially condone human violation, such as atrocities against Burmese monks. This may often hurt our efforts to become a 'bridge nation' between countries in the west and east.

3) Why do you think reform in unlike the reforms in energy sector is held back telecom sector?

A) Though the energy sector in our country has long- term policy plans such as Integrated Energy Policy, it could not tackle the fundamental issues as our domestic energy industry is dominated by inefficient, entrenched Govt-owned monopolies. The energy sector also has another weakness such as intractable policy knot-our massive subsidy economy. There were good visionaries, Sam Pitroda and A.B.Vajpayee to transform telecom, but our energy sector has yet to see its reformers.

4) Why does the writer state, "Energy subsidies are a big obstacle to efficiency gains as well as to changing energy behavior and popularizing clean energy behavior and popularizing clean energy solutions? Do you agree with this?"

A) Yes, I agree with this aspect because India has a tradition of freebies surrounding energy which is a gold standard of vote-getting Campaign promise. The politicians promise free power

to farmers into their election promises. Central government gives subsidies on oil and kerosene prices .These subsidies often lead to the very bad situation of country's economic growth.

5) For India to become 'developed economy' energy supply and sustainability are critical. Do you agree? Give reasons for your answer.

A) Yes, I agree. In spite of having large number of resources in India; still it is not well developed economically. Day-to-day life energy consumption is increasing a lot as there is a large growth in population, energy resources are less. To overcome these problems there should be development in energy resources which may be capable of long lasting. By these aspects it is very clear that energy supply and sustainability plays a crucial role in making India a developed economy.

6)The writer points out that, 'our ability to achieve social goals and to effectively create jobs and provide food, health services, housing, education, transportation, communication services and security depends on the availability of energy,' thereby suggesting that energy is fundamental to a nation's growth. Do you agree or disagree with this viewpoint? Give reasons.

A) According to the writer energy is fundamental for a nation's growth. Energy plays key role in the development of a nation. In order to create energy we can use power stations which in turn provide lot of jobs. For example if we take electric energy, to create electric energy we make use of water by building dams across the river which is useful for irrigation purpose also by this we can provide food .In present days without electrical energy nothing can be done even in household appliances. For transportation purpose also we have electrical trains which run by using coal(thermal energy).For security purpose nuclear energy for guns, atomic bombs in military. Finally I can conclude energy is a fundamental for everything in our country.

Wind Energy

1) Describe how wind energy is produced.

A) The wind energy is considered as a green power technology because of its minor impact on environment. Wind, which is essentially air in motion, carries with it kinetic energy. The available kinetic energy of wind is captured by the wind turbine consisting of two or more blades mechanically coupled to an electrical generator. The turbine is mounted on a tall tower to enhance the energy capture. The kinetic energy is converted into either mechanical or electrical energy. In this way the wind energy is produced.

2) Why did wind energy utilization decline even though it was in use for thousands of years?

A) Thousands of years ago, wind energy was used to propel ships and to produce mechanical energy for pulling up water from wells and grinding agricultural produce. There is also evidence that the ancient Egyptians used windmills as early as 3600 BC to pump water for irrigating lands and to grind grains. Though wind energy was in use for thousands of years its use declined everywhere to a negligible level due to the cheap availability and exploitation of coal, oil and gas resources.

3) What are the reasons for its revival in the last three decades?

A) The reason for the revival of wind energy is the energy crisis in 1973. The development of wind turbines to generate electricity was resumed in the mid 1970s. As a result, wind turbine technology improved considerably and the cost of electricity produced by wind turbines decreased dramatically.

4) Mention the three different modes through which wind generated electricity is put to use.

A) Three different modes of wind energy utilization

- Small wind electric generators below 4KW capacity have been used as battery chargers.
- Wind electric generators in the range of 50 to 300 KW used in grid connected wind farms.
- Wind electric generators in the middle range of 20 to 100 KW used in standalone models supplemented from diesel-generator sets.

5) List the advantages and disadvantages of wind energy. Do the advantages outweigh the disadvantages?

A) Advantages Of Wind Energy

- 1) Wind Energy is an inexhaustible source of energy and is virtually a limitless resource.
- 2) It is a clean fuel source. Wind energy doesn't pollute the air like power plants that rely on combustion of fossil fuels, Such as coal or natural gas. Energy is generated without polluting environment.
- 3) This source of energy has tremendous potential to generate energy on large scale.
- 4) Like solar energy and hydropower, wind power taps a natural physical resource.
- 5) Windmill generators don't emit any emissions that can lead to acid rain or greenhouse effect.
- 6) Wind Energy can be used directly as mechanical energy.
- 7) In remote areas, wind turbines can be used as great resource to generate energy.
- 8) In combination with Solar Energy they can be used to provide reliable as well as steady supply of electricity.
- 9) Land around wind turbines can be used for other uses, e.g. Farming.

Disadvantages of Wind Energy

- 1) It is unreliable energy source as winds are uncertain and unpredictable.
 - 2) Requires large open areas for setting up wind farms..
 - 3) Wind energy can be harnessed only in those areas where wind is strong enough and weather is windy for most parts of the year.
 - 4) Usually places, where wind power set-up is situated, are away from the places where demand of electricity is there. Transmission from such places increases cost of electricity.
 - 5) The average efficiency of wind turbine is very less as compared to fossil fuel power plants. We might require many wind turbines to produce similar impact.
 - 6) It can be a threat to wildlife. Birds do get killed or injured when they fly into turbines.
 - 7) Maintenance cost of wind turbines is high as they have mechanical parts which undergo wear and tear over the time.
 - 8) The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. There will be times when they produce no electricity at all.
 - 9) Wind turbines are noisy. It is produced by rotor blades.
 - 10) Initial cost for wind turbine is greater than that of conventional fossil fuel generators.
 - 11) Wind energy cannot be stored. (Unless batteries are used)
- Yes, the advantages outweigh the disadvantages.

6) In the light of current research and development, do you foresee a time when wind energy would emerge as the most significant form of energy?

A) The wind energy emerges as the most significant form of energy by the current research and development as it is continuing for development of more pitch regulated, yaw controlled and structurally strong & healthy wind energy generators. The old wind turbines were no longer economically competitive with conventional sources of energy. Therefore, research was done to develop new and efficient wind turbines.

7) How can generation and distribution of wind energy become more localized, to cater to the needs of the people living in a particular area?

A) Though the wind energy is ecofriendly, there are few limitations such as energy from wind is not constant and also diffuse i.e. only a relatively small amount of energy can be obtained from a given local area. Wind potential is even more of a localized concept than the solar energy.