UNIT 3

Energy Efficiency and Conservation

Q.1. What are clean energy technologies? Explain.

Ans. Clean energy refers to the energy produced from natural resources that are sustainable and so can be replenished over a period of time. This energy is also known as renewable or green energy. Essentially, the production of any clean energy does not result in the creation of environmental debt. Additionally, the technologies used in producing this energy pollute less or do not pollute at all while they also do not utilize resources that cannot easily be renewed.

Let's have a close look at the various forms of clean energy available today.

Forms of clean energy: The basic sources of clean energy include water, sun (solar) and wind. Others include biomass energy, geothermal energy, biogas energy, wave and tidal energy.

1. **Solar energy:** This energy form utilizes technologies that tap the nuclear fusion power emitted by the sun. The energy is then collected and converted for use in various ways such as solar water heating and solar electrical energy among others. Various technologies used for harnessing solar energy include solar collectors, photovoltaic cells and solar attic fans among others.
2. **Wind energy:** Wind is one of the most underutilized energy resource in the world today. However, it is gradually gaining popularity as an alternative and clean source of energy. Primarily, wind results from the sun's warming of the air that in turns creates disparities in the temperatures at the earth surfaces leading to atmospheric movements. Wind energy has been in use for centuries especially in powering windmills used to pump water and mill wheat. Today, a common technology used to harness wind energy is the wind turbine that helps to generate electricity in various parts of the world.
3. **Water energy:** There are several ways through which energy can be harnessed from water. The common ways include collecting energy from moving water (hydropower), waves, tides and ocean thermals among others.

Hydropower entails the energy derived from moving water and which makes the largest share of renewable electricity in the US. On the other hand, tidal and wave energy are two areas that are yet to be fully developed although they are considered to harbor very huge potential for the production of clean energy.

Others forms of clean energy include;

– **Geothermal energy**– this taps into the energy found in reservoirs of hot water and steam found beneath the earth surface.

– **Biogas energy**– this entails the conversion of animal waste into clean gas that can be used for heat and electricity generation.

Q.2. What energy forms are not considered as clean energy? Also explain why clean energy is preferred over non-clean energy sources.

Ans. Also referred to as non-renewable energy forms, these resources are only available in limited supply and thus are bound to vanish over time. Moreover, the use of these energy resources result in

unwanted effects to the environment such as pollution. Some of the common types of unrenewable energy include nuclear fuels, coal, natural gas and crude oil among others.

Clean energy: There you have it- the two categories of energy resources. The clean energy class is certainly preferred over the non-renewable energy forms since its sources are constantly being replaced while they also result in minimal impact on the environment. This is contrary to the impact that non-renewable energy resources have on the world.

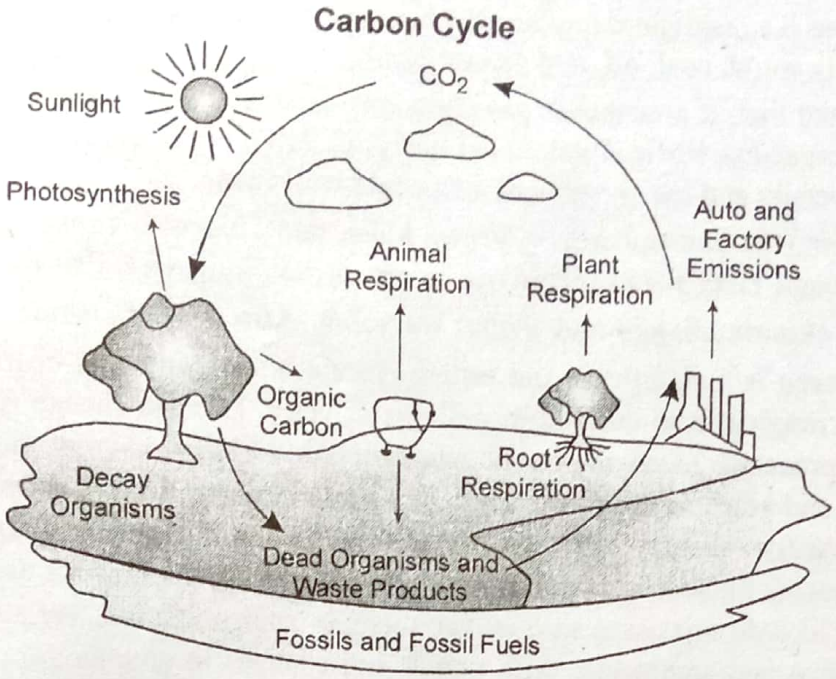
Q.3. Why is the role of clean energy important for sustainable development?

Ans. The indispensable partner in the fight against climate change: Renewables do not emit greenhouse gases in energy generation processes, making them the cleanest, most viable solution to prevent environmental degradation.

- **Inexhaustible:** Compared to conventional energy sources such as coal, gas, oil and nuclear - reserves of which are finite - clean energies are just as available as the sun from which they originate and adapt to natural cycles, hence their name "renewables". This makes them an essential element in a sustainable energy system that allows development today without risking that of future generations.
- **Reducing energy dependence:** the indigenous nature of clean sources gives local economies an advantage and brings meaning to the term "energy independence". Dependence on fossil fuel imports results in subordination to the economic and political short-term goals of the supplier country, which can compromise the security of energy supply. Everywhere in the world there is a renewable resource – whether that be the wind, sun, water or organic material – available for producing energy sustainably.
- **Increasingly competitive:** The main renewable technologies – such as wind and solar photovoltaic – are drastically reducing their costs, such that they are fully competitive with conventional sources in a growing number of locations. Economies of scale and innovation are already resulting in renewable energies becoming the most sustainable solution, not only environmentally but also economically, for powering the world.
- **Benefiting from a favorable political horizon:** Decisions adopted at COP21 have shone the spotlight firmly on renewable energies. The international community has understood its obligation to firm up the transition towards a low-carbon economy in order to guarantee a sustainable future for the planet. International consensus in favor of the "de-carbonization" of the economy constitutes a very favorable framework for the promotion of clean energy technologies.

Q.4. Explain Carbon cycle and its major components.

Ans. The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth. Carbon is the main component of biological compounds as well as a major component of many minerals such as limestone. Along with the nitrogen cycle and the water cycle, the carbon cycle comprises a sequence of events that are key to make Earth capable of sustaining life. It describes the movement of carbon as it is recycled and reused throughout the biosphere, as well as long-term processes of carbon sequestration to and release from carbon sinks



Components: The global carbon cycle is now usually divided into the following major reservoirs of carbon interconnected by pathways of exchange:

- The atmosphere
- The terrestrial biosphere
- The ocean, including dissolved inorganic carbon and living and non-living marine biota
- The sediments, including fossil fuels, freshwater systems, and non-living organic material.
- The Earth's interior (mantle and crust). These carbon stores interact with the other components through geological processes.

The carbon exchanges between reservoirs occur as the result of various chemical, physical, geological, and biological processes. The ocean contains the largest active pool of carbon near the surface of the Earth.

The natural flows of carbon between the atmosphere, ocean, terrestrial ecosystems, and sediments are fairly balanced so that carbon levels would be roughly stable without human influence.

Q.5. What are Greenhouse gases and how do they increase temperature?

Ans. A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Without greenhouse gases, the average temperature of Earth's surface would be about 33 °C colder, which is about 59 °F below the present average of 14 °C (57 °F).

Since the beginning of the Industrial Revolution (taken as the year 1750), the exhaust gas from burning of fossil fuels and extensive clearing of native forests has contributed to a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 392.6 ppm in 2012. It has now reached 400 ppm in the northern hemisphere. This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle. Anthropogenic carbon

dioxide (CO_2) emissions (i.e., emissions produced by human activities) come from combustion of carbon-based fuels, principally wood, coal, oil, and natural gas.

It has been estimated that, if greenhouse gas emissions continue at the present rate, Earth's surface temperature could exceed historical values as early as 2047, with potentially harmful effects on ecosystems, biodiversity and the livelihoods of people worldwide.

In the Solar System, the atmospheres of Venus, Mars, and Titan also contain gases that cause a greenhouse effect, though Titan's atmosphere has an anti-greenhouse effect that reduces the warming.

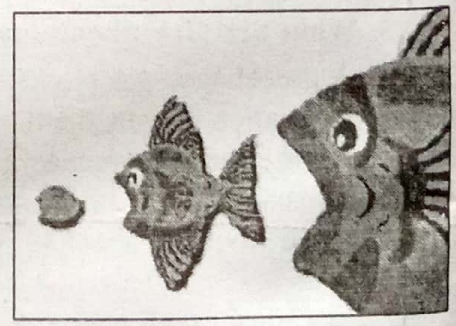
Q.6. Discuss the climate change and global warming. Also describe some control measures.

Ans. Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. Climate change is caused by factors that include oceanic processes (such as oceanic circulation), variations in solar radiation received by Earth, plate tectonics and volcanic eruptions, and human-induced alterations of the natural world; these latter effects are currently causing global warming, and "climate change" is often used to describe human-specific impacts. Factors that can shape climate are called climate forcing or "forcing mechanisms". These include processes such as variations in solar radiation, variations in the Earth's orbit, mountain-building and continental drift, clouds and changes in greenhouse gas concentrations. There are a variety of climate change feedbacks that can either amplify or diminish the initial forcing. Some parts of the climate system, such as the oceans and ice caps, respond slowly in reaction to climate forcing, while others respond more quickly.

Forcing mechanisms can be either "internal" or "external". Internal forcing mechanisms are natural processes within the climate system itself (e.g., the thermohaline circulation). External forcing mechanisms can be either natural (e.g., changes in solar output) or anthropogenic (e.g., increased emissions of greenhouse gases).

Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation. Since the early 20th century, Earth's mean surface temperature has increased by about 0.8 °C (1.4 °F), with about two-thirds of the increase occurring since 1980. Warming of the climate system is unequivocal, and scientists are more than 90% certain that it is primarily caused by increasing concentrations of greenhouse gases produced by human activities such as the burning of fossil fuels and deforestation. These findings are recognized by the national science academies of all major industrialized nations.

Global warming is affecting many parts of the world. Global warming makes the sea rise, and when the sea rises, the water covers many low land islands. This is a big problem for many of the plants, animals, and people on islands. The water covers the



plants and causes some of them to die. When they die, the animals lose a source of food, along with their habitat. Although animals have a better ability to adapt to what happens than plants do, they may

die also. When the plants and animals die, people lose two sources of food, plant food and animal food. They may also lose their homes. As a result, they would also have to leave the area or die. This would be called a break in the food chain, or a chain reaction, one thing happening that leads to another and so on.

Some counter measures are as follows:

1. Reducing usage by greater efficiency (choice of car, light etc) to provide exactly the same service with less greenhouse impact. This option is available now, typically at a lower net cost, but electricity is cheap enough that people don't bother.
2. More efficient lighting. CFL lighting is one solution[2] and can be cheaper in the long run,. Ordinary sized fluorescents with an electronic ballast are more efficient and can give a better light.

   Passive solar design and insulation in buildings.
3. Use of renewable energy in settings where it is known to actually provide an economic benefit: Solar hot water (at least in some climates), Low Head Water power
4. Reducing the CO_2 equivalent load of the output (energy or other product) by cleaner burning, less HC leaks, less cow farts, and finding alternatives to greenhouse gases such as methyl bromide (used for fumigation).
5. Strict fuel consumption standards for cars - taking into account the embedded energy of the car itself. Encourage small cars, with cheaper registration to reflect the lower cost to road maintenance, lower impact on traffic congestion and less parking area requirements.

Q.7. What is The greenhouse effect? Also discuss about causes and effects of Global warming.

Ans.

Cause of global warming: Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO_2), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect (see below). The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide.

The greenhouse effect: When sunlight reaches Earth's surface some is absorbed and warms the earth and most of the rest is radiated back to the atmosphere at a longer wavelength than the sun light. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. The absorption of this longwave radiant energy warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. The reflecting back of heat energy by the atmosphere is called the "greenhouse effect".

The major natural greenhouse gases are water vapor, which causes about 36-70% of the greenhouse effect on Earth (not including clouds); carbon dioxide CO_2, which causes 9-26%; methane, which causes 4-9%, and ozone, which causes 3-7%. It is not possible to state that a certain gas causes a certain percentage of the greenhouse effect, because the influences of the various gases are not additive. Other greenhouse gases include, but are not limited to, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorocarbons and chlorofluorocarbons.

Effects of global warming: There are two major effects of global warming:

- Increase of temperature on the earth by about 3° to 5° C (5.4° to 9° Fahrenheit) by the year 2100.

- Rise of sea levels by at least 25 meters (82 feet) by the year 2100.

More details about the effects of global warming: Increasing global temperatures are causing a broad range of changes. Sea levels are rising due to thermal expansion of the ocean, in addition to melting of land ice. Amounts and patterns of precipitation are changing. The total annual power of hurricanes has already increased markedly since 1975 because their average intensity and average duration have increased (in addition, there has been a high correlation of hurricane power with tropical sea-surface temperature).

Changes in temperature and precipitation patterns increase the frequency, duration, and intensity of other extreme weather events, such as floods, droughts, heat waves, and tornadoes. Other effects of global warming include higher or lower agricultural yields, further glacial retreat, reduced summer stream flows, species extinctions. As a further effect of global warming, diseases like malaria are returning into areas where they have been extinguished earlier.

Although global warming is affecting the number and magnitude of these events, it is difficult to connect specific events to global warming. Although most studies focus on the period up to 2100, warming is expected to continue past then because carbon dioxide (chemical symbol CO_2) has an estimated atmospheric lifetime of 50 to 200 years.

Q.8. What are the steps to control Global Warming?

Ans. Steps to control global warming:

1. Plant maximum number of trees as they releases oxygen and absorbs CO2 present in atmosphere. In this way a tree balance the temperature of air and reduces the amount of CO2 present in air.
2. Vehicles release many harmful gases in the air. Hence try to drive those cars which run on gas or electricity. If possible minimize the use of personal vehicle and travel by public transport. This way we can also control the problem of pollution.
3. Use fans more than air conditioners to use less energy. Hot air releases from air conditioner is one of the major factor behind global warming.
4. Avoid to use water heater or use that on temperature lesser than 120 F.
5. Instead of dryers take an advantage of sun light to dry wet cloths.
6. Unplug all the electrical appliances if they are not in use.
7. For less amount of carbon emission we can also use renewable energy like wind power which generate negligible amount of harmful gases.
8. Use recyclable materials instead of disposable materials. This is good to control on waste.

Q.9. What are the major causes of Deforestation? Discuss its consequences.

Ans. 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. Indigenous forests now cover 21% of the earth's land surface

Deforestation is brought about by the following:

- Conversion of forests and woodlands to agricultural land to feed growing numbers of people;

- Development of cash crops and cattle ranching, both of which earn money for tropical countries;
- Commercial logging (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forests for agriculture;
- Felling of trees for firewood and building material; the heavy lopping of foliage for fodder; and heavy browsing of saplings by domestic animals like goats.

To compound the problem, the poor soils of the humid tropics do not support agriculture for long. Thus people are often forced to move on and clear more forests in order to maintain production.

Consequences of Deforestation

(a) **The carbon cycle:** Forests act as a major carbon store because carbon dioxide (CO2) is taken up from the atmosphere and used to produce the carbohydrates, fats, and proteins that make up the tree. When forests are cleared, and the trees are either burnt or rot, this carbon is released as CO2. This leads to an increase in the atmospheric CO2 concentration. CO2 is the major contributor to the greenhouse effect. It is estimated that deforestation contributes one-third of all CO2 releases caused by people.

(b) **The water cycle:** Trees draw ground water up through their roots and release it into the atmosphere (transpiration). In Amazonia over half of all the water circulating through the region's ecosystem remains within the plants. With removal of part of the forest, the region cannot hold as much water. The effect of this could be a drier climate.

- *Soil erosion* With the loss of a protective cover of vegetation more soil is lost.
- *Silting of water courses, lakes and dams* This occurs as a result of soil erosion.
- *Extinction of species* which depend on the forest for survival. Forests contain more than half of all species on our planet - as the habitat of these species is destroyed, so the number of species declines.
- *Desertification* The causes of desertification are complex, but deforestation is one of the contributing factors.

Q.10. Define Carbon Footprint.

Ans. A carbon footprint is the amount of greenhouse gases—primarily carbon dioxide—released into the atmosphere by a particular human activity. A carbon footprint can be a broad measure or be applied to the actions of an individual, a family, an event, an organization, or even an entire nation. It is usually measured as tons of CO_2 emitted per year, a number that can be supplemented by tons of CO_2^- equivalent gases, including methane, nitrous oxide, and other greenhouse gases.

Q.11. How can we reduce our carbon footprint?

Ans. Methods of reducing our carbon footprint include driving more-efficient vehicles (or making sure that your current vehicles are properly maintained), taking public transportation, using energy-efficient appliances, insulating your home to reduce heating and air conditioning costs, consuming food that doesn't require as much transportation, and eating less meat, which has a higher carbon footprint than fruits and vegetables. Individuals and companies can also offset some of their CO_2 emissions by purchasing carbon credits, the money from which can go into projects such as planting trees or investing in renewable energy.

Q.12. How can the greenhouse gases be managed at the source and the sinks? Explain.

Ans. Greenhouse gases cycle through the oceans and the biosphere over time periods that can range from a few days to millions of years. Carbon, for example, may be stored deep within ocean sediments for many millions of years or it might be cycled back into the atmosphere in a matter of hours. Scientists are trying to understand the various sources and reservoirs – or sinks – of each of the greenhouse gases in order to create better models of how human actions may affect natural processes.

A *source* is any process or activity through which a greenhouse gas is released into the atmosphere. Both natural processes and human activities release greenhouse gases. A *sink* is a reservoir that takes up a chemical element or compound from another part of its natural cycle.

- ***Carbon Dioxide:*** With carbon dioxide, it is important to distinguish between natural and man-made (anthropogenic) sources. One of the largest sources of atmospheric carbon dioxide is through plant and animal decay as microorganisms break down the dead material, releasing carbon dioxide into the air as part of the process. Other naturally occuring sources include forest fire and volcanoes.

  Burning fossil fuels is a primary source of greenhouse gases caused by man; as the chemical energy in a hydrocarbon-rich fossil fuel is converted into heat, carbon dioxide is produced as a byproduct. Forest clearing – or deforestation – and the burning of solid waste, wood, and wood products are also sources of atmospheric carbon dioxide.

  The carbon cycle is one of the Earth's major biogeochemical cycles; vast amounts of carbon continuously cycle between the Earth's atmosphere, oceans, and land surfaces in both short and long-term cycles. The carbon exchange in the world's oceans take place on a very large scale, but it is often thought of to be a very rapid process; absorbing and releasing CO2 in short-term cycles with little long-term storage. However, scientists are now beginning to believe that much of the 'extra' carbon dioxide released into the atmosphere through human activities are being absorbed by the oceans, making it a possibility that we could increase the "ocean sink" through a method called ocean fertilization.

- ***Methane:*** Another important greenhouse gas is methane, which has both natural and human sources. Natural sources of methane include wetlands, gas hydrates, permafrost, termites, oceans, freshwater bodies, non-wetland soils, and other sources such as wildfires. Human activities that produce methane include fossil fuel production and transport, livestock and manure management, rice cultivation, and waste management (i.e., landfills and the burning of biomass).

- ***Nitrous Oxide:*** After carbon dioxide and methane, nitrous oxide is the third most important greenhouse gas. In nature, it is emitted from soils and the oceans; anthropogenic sources of nitrous oxide include the cultivation of soil, the production and use of fertilizers, and the burning of fossil fuels and other organic material. Nitrous oxide is not stored in significant amounts through natural processes or actively taken out of the atmosphere.

- ***Halocarbons:*** Man is completely responsible for emissions of greenhouse gas halocarbons, many of which are synthetic chemicals being used as alternatives to ozone-depleting substances, like CFCs. However, while halocarbons do not deplete the ozone, they are potent greenhouse gases.

Sources of these gases include electrical transmission and distribution systems, semiconductor manufacturing, and aluminum and magnesium production. Like nitrous oxide, halocarbons are not stored in significant amounts through natural processes or actively taken out of the atmosphere.

Q.13. What do you understand by Economics of Energy?

Ans. Energy economics is the field that studies human utilization of energy resources and energy commodities and the consequences of that utilization. In physical science terminology, "energy" is the capacity for doing work, e.g., lifting, accelerating, or heating material. In economic terminology, "energy" includes all energy commodities and energy resources, commodities or resources that embody significant amounts of physical energy and thus offer the ability to perform work. Energy commodities - e.g., gasoline, diesel fuel, natural gas, propane, coal, or electricity – can be used to provide energy services for human activities, such as lighting, space heating, water heating, cooking, motive power, electronic activity. Energy resources - e.g., crude oil, natural gas, coal, biomass, hydro, uranium, wind, sunlight, or geothermal deposits – can be harvested to produce energy commodities. Energy economics studies forces that lead economic agents – firms, individuals, governments – to supply energy resources, to convert those resources into other useful energy forms, to transport them to the users, to use them, and to dispose of the residuals. It studies roles of alternative market and regulatory structures on these activities, economic distributional impacts, and environmental consequences. It studies economically efficient provision and use of energy commodities and resources and factors that lead away from economic efficiency

Q.14. How the economic system determines the production and consumption of energy?

Ans. The mechanization of production and the emergence of mass (serial) production methods following the industrial revolution in the late eighteenth century resulted in an increased demand for energy. This, in turn, caused the production process and the capacity of a country to become increasingly dependent on energy and energy-based inputs. Although energy is not the only input that determines the level of production and the degree of economic development of a country, it is highly important for economic growth. It is only by means of consuming a certain amount of energy that countries can achieve a certain level of economic growth. In today's world, it does not seem possible to produce goods and services, sustain the production process or offer these goods and services to consumers in an appropriate way without energy (IAEA, 2009). Therefore, any interruption in the procurement of energy, which is a highly important input used in every phase of production, or any failure to meet the energy demand increase of increasing production under favorable conditions may cause a bottleneck in the economy (Smulders and De Nooij, 2003). Thus, countries should procure a sufficient amount of energy in a cost-effective, quality-conscious, safe manner – without any interruption – to achieve sustainable growth goals and improve their living standards.

It is well known that energy demands of countries are increasing with each passing day, but the resources used to generate energy are limited in both amount and range. Moreover, the distribution of energy resources around the world is not balanced, as some regions have more reserves compared to others in terms of both amount and range. Such an uneven distribution of energy resources is not only valid for the reserves but also for the consumption levels, and as such, there is a large imbalance between not only regions but also countries with respect to the use of energy resources around the world. This forces countries into a great struggle to access these resources under reasonable, reliable and sustainable conditions to meet their increasing energy demands. The scarcity of energy resources

around the world begets the emergence of a great competition for energy procurement among the countries.

The energy demands of countries are increasing every day, depending on their growing economies and their changing socio-economic structures. Their failure to increase energy generation despite their increasing energy consumption results in an important problem known as an energy deficit. If an economy experiences a lack of energy resources, it will either choose to accept "low economic growth through production with the existing energy resources" or attempt "to increase growth by meeting the uncovered part of energy demand through imports". The price and direct or indirect procurement of energy affect the production structures of countries as well as their budget balance and competitiveness in the national and international markets. They are also the major indicators of many economic problems, such as the current account deficit. For all of these reasons, energy has become one of the most important issues in the world. Moreover, as energy resources are under the control of a limited number of countries, the potential problems that these countries may have can jeopardize the security of energy procurement, which constitutes another problem together with the cost of consumption incurred by the energy resources used to meet the increasing demands. Such ambiguities in the procurement of energy cause welfare loss and failure to achieve sustainable growth. Thus, timely and sufficient procurement of highquality energy at an affordable price is of great importance, as it ensures the operation of the economy and leads to sustainable growth. However, the effective and efficient use of the procured energy is no less important.

The important role of energy as a production input had been disregarded until the oil crisis of the 1970s. Following this period, energy was considered, together with labor and capital, to be a factor of production, and the number of studies on energy and energy-related problems began to increase. These studies address the energy issue from different perspectives. Some of the studies in the economics literature regard energy as a technical problem, and thus, they assume that by improving existing production (consumption) technologies or by providing new technologies, it is possible to meet the higher energy demands of today, as compared to those of the past, with the same amount of energy used by economies in production or by humans in their daily lives. According to this assumption, the problem of increased demand will be eliminated as technology advances. Other studies regard energy as an economic problem and argue that the increased energy demand problem leads to exorbitant oil prices that increase the prices of other energy resources, making energy a difficult-toacquire commodity. This assumption implies that the energy problem will be solved if oil, whose cost does not exceed $10 per barrel, is used as an energy source that does not generate high profits. Other studies suggest that energy problems result from the gradual depletion of energy resources, especially primary resources, around the world. As the prices of depleted commodities increase, it becomes increasingly more difficult to find these resources. Therefore, the fact that known oil reserves now face the risk of depletion within approximately 50 years, production and consumption make this energy resource expensive and difficult to find. Due to the rapid depletion of oil reserves with each passing day, it is thought that this problem can be mitigated in the short term and completely solved in the long term, provided alternative energy sources are mobilized.

Q.15. Discuss the link between economic and environmental outcomes.

Ans. The links between the economy and the environment are manifold: the environment provides resources to the economy, and acts as a sink for emissions and waste. Natural resources are essential

inputs for production in many sectors, while production and consumption also lead to pollution and other pressures on the environment. Poor environmental quality in turn affects economic growth and wellbeing by lowering the quantity and quality of resources or due to health impacts, etc. In this context, environmental policies can curb the negative feedbacks from the economy on the environment (and vice-versa). But how effective they are and whether they generate a net benefit or a net cost to society is the subject of much debate and depends on the way they are designed and implemented.

While the main mechanisms that link the economy and the environment are qualitatively known, assessments of environmental policies are often hampered by a lack of consistent metrics to compare the costs and benefits of policy changes, or by a more general lack of empirical evidence. The economic costs of biophysical and environmental consequences of policy inaction, and the associated benefits of new policies, are often not quantified. Therefore, economic discussions are often dominated by the very visible costs of policy action.

There are environmental causes for economic problems and economic causes for environment problems. There are economic solution for environment problems and environment solution for economic problems. In the same way, environment theories are needed for economic theories and economic theories are essential for environment theories.

Industrial and domestic wastes are the prime cause of water pollution and air pollution. Polluted water gets absorbed in land and creates land pollution. Economics has a solution for this. According to economics, air, land, water, river, ocean etc. are public goods which spread out pollution. We should control these polluted public goods.

Q.16. How future energy use can be influenced by economic, environmental and research policies? Explain.

Ans. In light of the contribution of modern energy forms to higher incomes and greater economic well-being, the expansion of supplies should be welcomed from both economic and commercial viewpoints. Energy markets are potentially very large and are set to grow for most of the century. Recall that per capita consumption levels of commercial energy and electricity in developing countries are barely one-tenth of those in OECD countries, while their populations are over five times larger.

The energy scenarios point to an increase in the world's consumption of commercial energy over this century of roughly 2.5 to 5 times today's levels. Forecasts of long-term energy demands vary considerably with assumptions about the growth of per capita incomes and populations. They also vary with assumptions about future gains in energy efficiency. The assumptions about energy efficiency gains warrant further discussion because of their impact on assessments of the amount of energy required to support economic production and provide for people's energy needs. It has been widely observed that the energy intensity of an economy (the ratio of energy consumption to GDP) rises during the early and middle phases of economic development, when the industrialisation and 'motorisation' of economies are strong, and then peaks and declines as the less energy-intensive service sector begins to occupy a larger share of economic activity.

The later a country industrialises, the lower its peak energy intensity because of intervening improvements in the efficiency of energy conversion processes— especially for electricity generation— and energy use. This pattern has held for more than a century, as a comparison of the experiences of the United Kingdom, Germany, the United States, France, and Japan. Developing regions are exhibiting

the same pattern. (Exceptions are economies in transition, which have experienced abnormally high energy intensities historically, but which are now expected to decline with new investment and gains in energy efficiency.) A number of engineering and economic studies have shown that the possibilities for further gains in energy efficiency are far from exhausted, such that we can expect a continual lowering of the peak intensity as more countries become developed.

Such improvements in energy efficiency mean that developing countries are likely to need less energy to produce a unit of GNP and to meet consumer needs per unit of income than was the case for the industrialised countries. How much less is controversial, because of ambiguities in the evidence and oversimplifications in both the engineering and economic models of energy consumption. However, no empirically based study has shown that developing countries can achieve prosperity without very large increases in demand for energy, even with strong assumptions about improvements in energy efficiency

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