

Internal Assessment Test 1 – May 2022
18EE653 - Renewable Energy Resources
(Civil & Mechanical)

Answer Key

- 1. Define Energy and Energy resources. Discuss different ways of their classification with examples in each category.**

Energy is the capacity to do work and is required for life processes. An energy resource is something that can produce heat, power life, move objects, or produce electricity. Matter that stores energy is called a fuel.

Energy sources are forms of potential energy that can be used to perform work. Energy sources are categorized as renewable if they constantly and rapidly renew themselves for steady, reliable use. Any other source of energy is considered nonrenewable.

Primary and Secondary Energy Resources

1. Primary energy resources are derived directly from natural reserve. Examples are chemical fuels, solar, wind, geothermal, nuclear hydropower, etc. They are used either in basic raw energy form or by converting them to usable form (secondary energy).

2. Secondary energy resources are usable forms of energy generated by means of suitable plants to convert the primary energy. Examples are electrical energy, steam power, hot water power, hydrogen energy, etc.

Usable form of energy is cost effective, highly efficient with improved performance, environmentally acceptable and system acceptability index approaching to unity is achievable during conversion, transportation, distribution, and end use. From the abovementioned viewpoints, electrical energy will continue to be dominant and will also be a usable form of energy till the turn of the century.

Primary energy resources may be further sub-classified as follows:

1. Conventional and non-conventional energy resources: (a) Conventional energy resources and their technical knowledge are known to mankind to a great extent. They are the energy store within the earth and the sea. They include both fossil fuels (coal, oil, and gas) and nuclear energy (uranium and thorium) and required human intervention to release the energy from them. These sources have formed over hundreds of millions of years ago and when they are used, there will be no more for future generations. They are also known as finite energy resources. (b) Non-

conventional energy resources are also known as infinite energy resources. Their technical knowledge is little known and they need full exploitation and improved technical understanding. However, it may be mentioned that owing to the cost factor and overall performance, one may think of utilizing all these energy resources only when all the conventional energy resources have been fully exploited and utilized. They are obtained from the energy flowing through the natural environment. It is necessary to note that the energy is passing through the environment as a current or as a flow and whether there is an artificial device there to intercept and harness the power or not. Further, it is important to know the rate at which useful energy can be obtained from these sources.

2. Renewable and non-renewable energy resources: (a) Renewable energy resources are continuously restored by nature. Examples are solar, water, wind, etc. (b) Non-renewable energy resources are the reserve that is once accumulated in nature has practically ceased to form under new geological conditions. They are also known as expendable energy. Examples are coal, oil, gas, nuclear, etc.

2. Discuss about causes of energy scarcity.

While the whole world is in the grip of energy scarcity, several countries, including India also, are facing various associated difficulties for its techno-socio-economic development because of energy shortages and many more things. However, they have been further complicated by the energy dependence on the other countries. Energy use scenario, as shown in Table 1.3, indicates that how equality (social and economical) can be achieved, when 30% population is utilizing 70% of energy and 70% population is forced to live with the 30% of the remaining energy. Following points may be considered as the principal causes of energy scarcity.

- **Increasing Population**

Undoubtedly, only 40–45% population constitutes child producing groups, worldwide population is increasing at an alarming rate. It is extrapolated that by the turn of 21st century, population will increase manifold (Malthusian population model). These populations are unevenly distributed worldwide. Africa shares the largest population growth rate, followed by South Asia and then by Europe.

- **Increasing Energy Usage or Consumption**

The movement of civilization from early man to the present technological man was totally based on energy usage. Energy is constantly used at home, at work, and for leisure period of enjoyment. Energy maintains techno-socio-economic development. Energy provides the society with heat and electricity daily and motive power to industry, transportation, and modern way of life.

1. In homes, for lighting and cooking, domestic appliances, televisions, computers, etc.
2. In industry to power the manufacture of the products.
3. In transport system to power cars, trucks, ships, and aero planes for transporting peoples and goods. An increase in the world population and consequent increase in energy consumption increases energy demands manifolds.

- **Uneven Distribution of Energy Resources**

It is well understood that very few wealthy countries have access to and actually use the largest part of the world's energy and material resources. The generation of environmental and social instability in several area of globe can be discussed in relation to the existence of disparity. Uneven

distribution of energy and resource trade among countries is of paramount importance to environmental and political stability. For example, Middle East countries are full of crude oil reserves, but they are forced to involve in conflicts and wars and their energy reserves are forcefully used by wealthy countries. Geographical distribution is the main consideration for an unevenly distribution of fossil fuels (coal, oil, gas, and nuclear). Renewable energy flows are also spread out unevenly. Cloudiness in equatorial regions reduces solar radiation. Whole stretches of the continent have insufficient wind. There are very few sites with the best potential for geothermal, tides, or ocean thermal. In fact, a few densely populated region or area have no significant locally available energy sources at all.

- **Lacks of Technical Knowhow**

Despite the fact that several countries or regions are having energy in abundance, they are not able to fully utilize them due to the lack of knowledge of conversion, transmission, distribution, and utilization. Because of the lack of technical knowledge, resources are mined and processed in resource enriched countries and then refined and used in developed countries. The price of exported resources is normally inadequate to compensate for the depletion of energy reserves and the environmental burden that is generated by resource extraction and primary processing in energy enriched countries. However, resources drive significant economic and environmental benefits in techno-economically developed countries.

3. Calculate zenith angle of the sun at Bengaluru (26.75°N) at 9.30am on March 15 2021.

- $\delta = 23.45 \sin [360 (284+n)/365]$

$$n = 31+16 = 47$$

$$\delta = -12.95^\circ = -13^\circ$$

- Hour angle ω

$$\omega = (1/4) t_m$$

$$t_m = 12.00 - 9.30 = (12*60) - (9*60) + 30 = 720 - 570 = 150 \text{ min}$$

$$\omega = \frac{150}{4} = -37.5$$

- $\phi = 26.75$

- $\cos(\theta_z) = \cos(\delta)\cos(\omega)\cos(\phi) + \sin(\delta)\sin(\phi)$

- $\theta_z = 53.914$

4. What are the prospects of renewable energy sources in India? Mention the advantages of renewable energy sources.

1. Clean, Safe & Efficient

One of the advantages of renewable energy is that it's clean, sustainable energy that is non-pollutant and for as long as the sun is shining, it will never run out. Australia has more sunny days than most countries, Perth in particular has been said to be the sunniest city in the world with 147 full sunny days and 121 partially sunny days.

2. Numerous methods for creating renewable power

There is now so many ways we can create renewable energy, technology is constantly developing and now we are seeing solar power roads, solar power phone chargers and many other options.

3. Gives your country energy independence

By using renewable energy you aren't relying on fossil fueled power that comes from overseas countries that control the pricing. If more people switched to renewable energy, there may be a day when we no longer need to import fossil fuels from other countries.

4. Provides jobs for your local community

The renewable energy industry is highly labour intensive, which means you will be helping in providing thousands of jobs nationwide and supporting your local community.

5. Doesn't rely on the main power grid

Every Australian has been in this situation. It's a 40+ degree day and you turn the air-con on high but then there is a blackout because the whole town is doing the same. With solar power you now don't have to worry about any blackouts, as you can rely on your own renewable energy instead.

6. Stable costs

Your local energy company controls the pricing of your electricity, so this means it can go up and down at any time, it can also sometimes be unpredictable as occasionally meter checkers do an estimate instead of coming out and actually checking your power meter. With renewable energy you don't have to worry about this.

7. Can enjoy the summer and winter whilst indoors

Now you can keep cool in the summer and warm in the winter with renewable energy. Normally the heating and cooling bill are the biggest bills you will receive throughout the year and we all tend to hold back on using up energy knowing how much it will cost, so renewable energy will help offset or even eliminate this problem.

8. Save & make money

By using renewable energy, you will be saving money and if there is excess power that you produce, you can sell that energy back into the grid. As a business that becomes eco-friendly and uses renewable energy, you might also find that advertising that you are a sustainable business will result in more customers and improved brand recognition.

9. Global warming

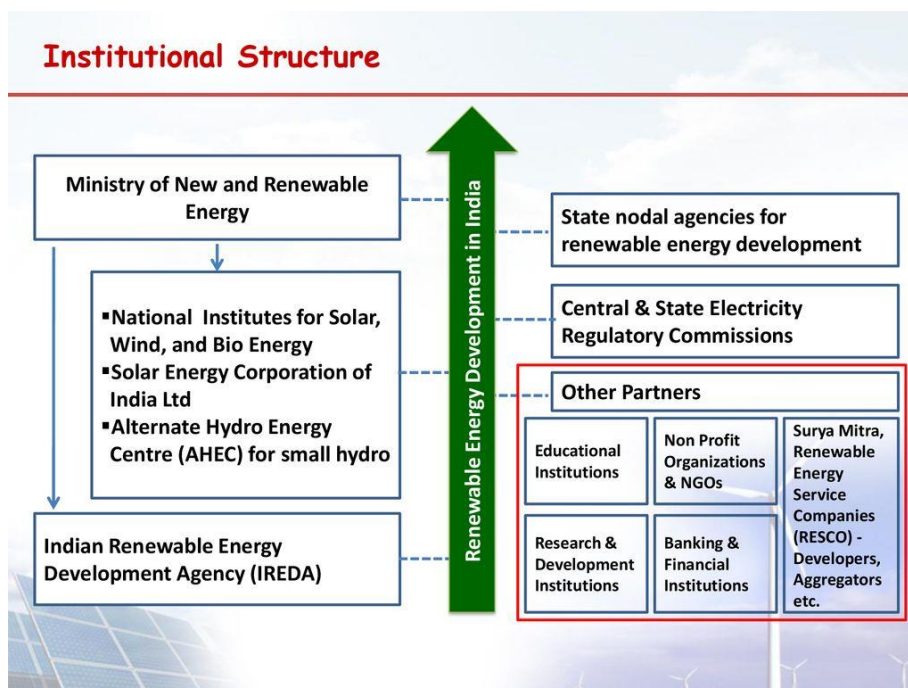
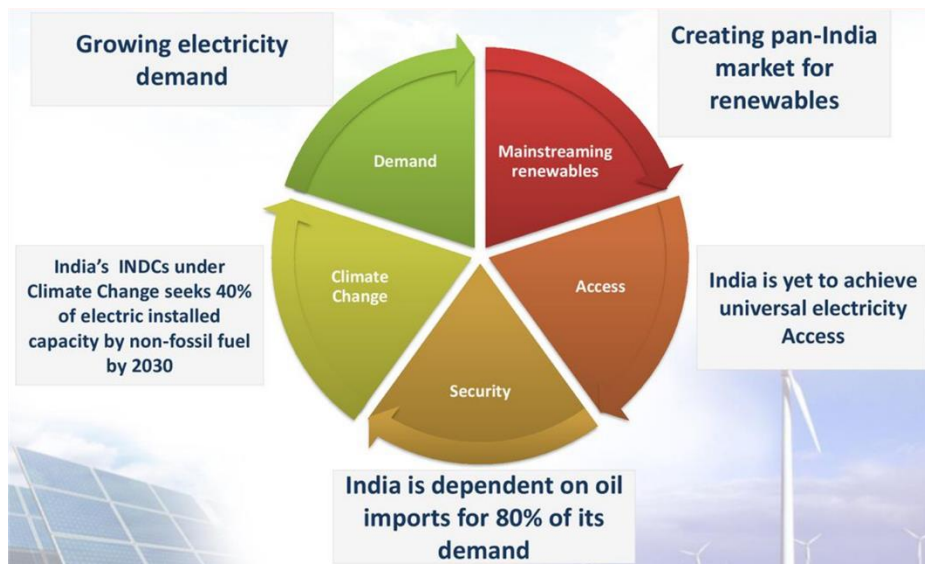
By using renewable energy, you will help in reducing the effects of climate change due to global warming by not using finite resources like fossil fuels that create greenhouse gases and harm the environment.

10. Pays itself off

After the initial cost of investing in the installation of renewable energy you will find that it will pay itself off within a few years, whether that's in savings from bills or selling excess energy back into the grid.

5. Explain briefly the Indian energy scenario.

- India is one of the countries with the largest production of energy from renewable sources.
- In the electricity sector, renewable energy account for 34.6% of the total installed power capacity.
- Large hydro installed capacity was 45.399 GW as of 30 June 2019, contributing to 13% of the total power capacity.
- The remaining renewable energy sources accounted for 22% of the total installed power capacity (80467 GW) as of 30 June 2019.
- Wind power capacity was 36,625 MW as of 31 March 2019, making India the fourth-largest wind power producer in the world. The country has a strong manufacturing base in wind power with 20 manufactures of 53 different wind turbine models of international quality up to 3 MW in size with exports to Europe, the United States and other countries.
- Wind or Solar PV paired with four-hour battery storage systems is already cost competitive, without subsidy, as a source of dispatchable generation compared with new coal and new gas plants in India.
- The government target of installing 20 GW of solar power by 2022 was achieved four years ahead of schedule in January 2018, through both solar parks as well as roof-top solar panels.
- India has set a new target of achieving 100 GW of solar power by 2022.
- Renewable energy in India comes under the purview of the Ministry of New and Renewable Energy (MNRE). India was the first country in the world to set up a ministry of non-conventional energy resources, in the early 1980s.
- Solar Energy Corporation of India is responsible for the development of solar energy industry in India.
- Hydroelectricity is administered separately by the Ministry of Power and not included in MNRE targets. In the 2027 forecasts, India aims to have a renewable energy installed capacity of 275 GW,
- In addition to 72 GW of hydro-energy, 15 GW of nuclear energy and nearly 100 GW from other zero emission" sources
- Four of the top seven largest solar parks worldwide are in India including the second largest solar park in the world at Kurnool, Andhra Pradesh, with a capacity of 1000 MW.
- The world's largest solar power plant, Bhadla Solar Park is being constructed in Rajasthan with a capacity of 2255 MW and is expected to be completed by the end of 2018.



6. Define the following with respect to solar radiation: i) Latitude angle ii) Altitude angle iii) Hour angle iv) Zenith angle

Latitude Angle: Angle between line drawn on a point from earth's surface to the center of earth and the earth's equatorial plane. Intersection of earth's equatorial plane with the surface of earth forms the equator and it is at 0 degree latitude.

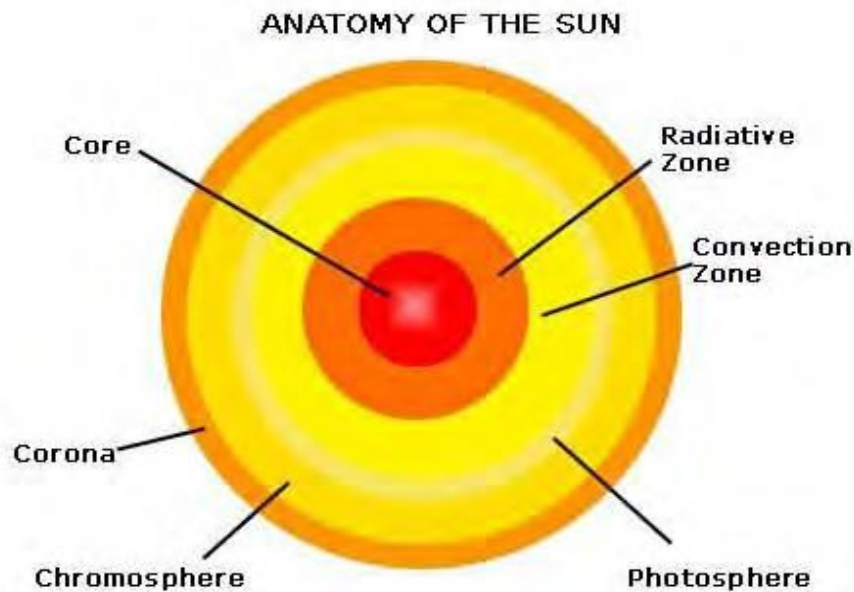
Altitude angle: Angle between the central ray of the sun and a horizontal plane containing the observer.

Hour Angle: Hour angle is the angular distance between the meridian of the observer and the meridian whose plane contains sun Hour angle is zero at solar noon Increases by 15 degrees every hour.

- $\omega = 15 (t_s - 12)$
- $t_s =$ solar time
- $\omega = (1/4) t_m$
- $t_m =$ time in minutes before or after solar noon

Zenith Angle: The Zenith angle (θ_z) Complement of solar altitude angle $\theta_z = 90 - \alpha$

7. Write a short note on layers of the sun.



Core

- Innermost layer
- Highly dense 160g/cm^3
- 40% suns mass in 10% volume
- Gaseous state
- 1,50,00000 degree celcius
- Fusion reactions produce gamma rays and neutrinos
- Each high energy gamma ray that leaves the solar envelope will become thousand low energy photons
- Neutrinos are non reactive

Solar envelope

- Radiative envelope surrounded by convective envelope
- Temp is 4 million Kelvin
- Less dense than core
- 60% mass in 90% volume

- Puts pressure on core and maintains core temperature
- Cooler and Opaquer than core
- Energy movement in huge cells in convection zone only

Photosphere

- Zone from which sunlight is seen and emitted
- Thin layer of low-pressure gases
- 6000-degree celcius

Chromosphere

- A red circle can sometimes be seen outside the sun during eclipse which is called chromosphere
- Hydrogen abundant so red in color
- 7000 K, hotter than photosphere

Corona or Crown

- The outermost layer of the sun
- Thin and faint so difficult to observe from the earth
- Visible during total solar eclipse
- Outer layer is very dim
- It is the hottest 10^6 K layer though Spreads over several million kilometers into space, lots of room for molecules to move
- Causes Solar winds