

# **POSTAL** **Book Package**

# **2023**

## **Mechanical Engineering**

### **Conventional Practice Sets**

#### **Renewable Sources of Energy**

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# 1

## CHAPTER

## Renewable Sources of Energy

# Introduction

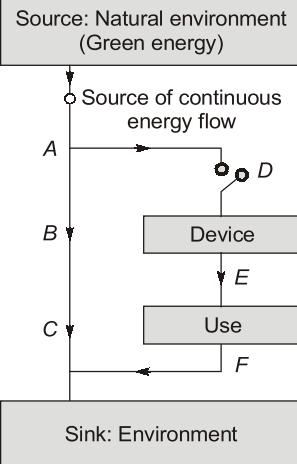
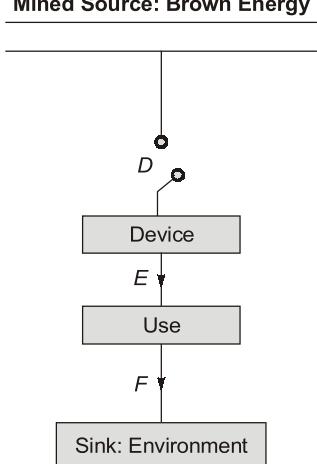
## Practice Questions

**Q1** What do you understand by renewable energy? How it differs from Non-renewable energy?

**Solution:**

**Renewable Energy:** Renewable energy is the term used for energy flows occurring naturally and repeatedly at a rate such that it is replenished at the same rate as they are used. The ultimate sources of renewable energy are : Sun, gravity and rotation of earth. Energy from these resource is derived in various forms such as solar, wind, tidal, biomass etc.

### Difference between Renewable and Non-renewable Source of Energy

Renewable	Non-Renewable
<ol style="list-style-type: none"><li>Energy obtained from natural and persistent flows of energy occurring in the immediate environment is renewable energy.</li><li>Examples: Solar, Wind, Hydro power, Biomass Tidal, Ocean thermal.</li><li>This type of energy is already passing through the environment as flow or current, irrespective of the fact that there is any device present to harness this energy or not.</li><li>Other names : Green Energy, Sustainable energy.</li><li>Energy Flow Diagram<p>ABC → Environmental energy flow. DEF → Harnessed energy flow.</p></li></ol>	<ol style="list-style-type: none"><li>Energy obtained from static stores of energy that remained underground unless released by human interaction is known as non-renewable energy.</li><li>Example: Nuclear fuels, fossil fuels of coal, oil, natural gas.</li><li>This type of energy is initially in the form of isolated source potential. An external (human) action is required to start the supply of energy for practical purpose.</li><li>Other names: Finite supplies, Brown energy.</li><li>Energy Flow Diagram<p>DEF → Extracted energy from brown energy source.</p></li></ol>

**Q.2** What is Green Power?**Solution:**

The term “green power” is used to describe sources of energy which are considered environment friendly, non-polluting; and therefore may provide a remedy to the systemic effects of certain forms of pollution, and global warming. This is in fact the renewable energy sourced from the sun, the wind, water, biomass and waste, etc. Green energy is commonly thought of in the context of electricity, heating, and cogeneration, and is becoming increasingly available. Consumers, businesses, and organizations may purchase green energy in order to support further development, help reduce the environmental impacts associated with conventional electricity generation, and increase their nation’s energy independence. Renewable energy certificates (green certificates, or green tags) have been one of the ways for consumers and businesses to support green energy.

**Q.3** How much energy is required to meet the demand of world's energy? Can it be fulfilled with renewable energy?**Solution:****Energy Demand of World and Contribution of Renewable Energy:**

**World energy consumption** is the total energy used by human civilization. It involves all energy harnessed from every energy source applied towards humanity's endeavors across every single industrial and technological sector, across every country. It is usually measured per year. World energy consumption has a deep implication for humanity's social-economic-political sphere. Majority of the world energy consumption is harnessed from fossil fuel i.e. oil, coal & natural gas

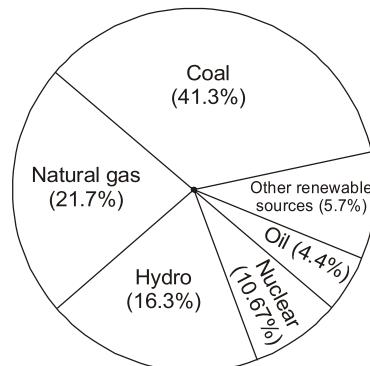
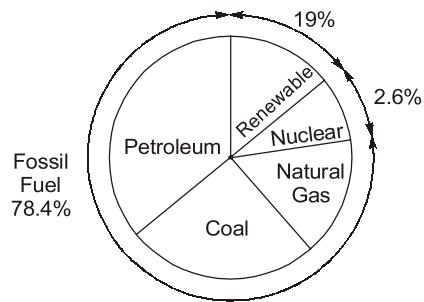
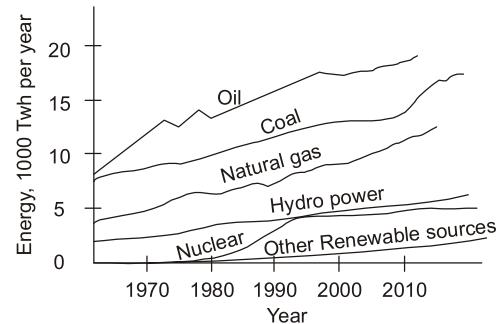
International Energy Agency (IEA) estimated an average power consumption of 12.3 terawatts for the year 2013. World's energy consumption and the source from which it was obtained, are shown in above figure.

Hydropower is one form of renewable energy, which contributes slightly more than nuclear energy. It can also be observed that renewable energy resources are contributing least but their share is increasing now a days.

The electricity production by various energy sources worldwide is depicted by given pi-diagram.

**Renewable energy sources included :**

- |                                   |                  |
|-----------------------------------|------------------|
| 1. Traditional Biomass            | 9.0%             |
| 2. Hydropower                     | 3.8%             |
| 3. Bio-heat                       | 2.6%             |
| 4. Wind                           | 0.39%            |
| 5. Ethanol                        | 0.34%            |
| 6. Bio-power generation           | 0.25%            |
| 7. Solar heating/cooling          | 0.16%            |
| 8. Biodiesel                      | 0.15%            |
| 9. Solar-PV                       | 0.077%           |
| 10. Geothermal Heat + Electricity | (0.061 + 0.049)% |

**World Energy Consumption : Share of Energy Resources**

From these charts it is clear that fossil fuels are major sources of energy. But fossil fuels are depleting at a faster rate and cannot meet the energy requirement in future. Environmental pollution is another major concern when fossil fuels are used.

The contribution of renewable energy is 19% in world power consumption and 22% in the world electricity generation. Since, renewable energy is replenished at the same rate at which it is consumed hence it is grabbing attention worldwide. Moreover, it is the clean or green energy which is not causing pollution like fossil fuel.

Some of the countries are getting most of power from renewable energy sources.

The leading countries are listed below :

Sl. No.	Country	% of power generation from renewable source
1.	Iceland	100
2.	Norway	98
3.	Brazil	86
4.	Austria	62
5.	New Zealand	65
6.	Sweden	54

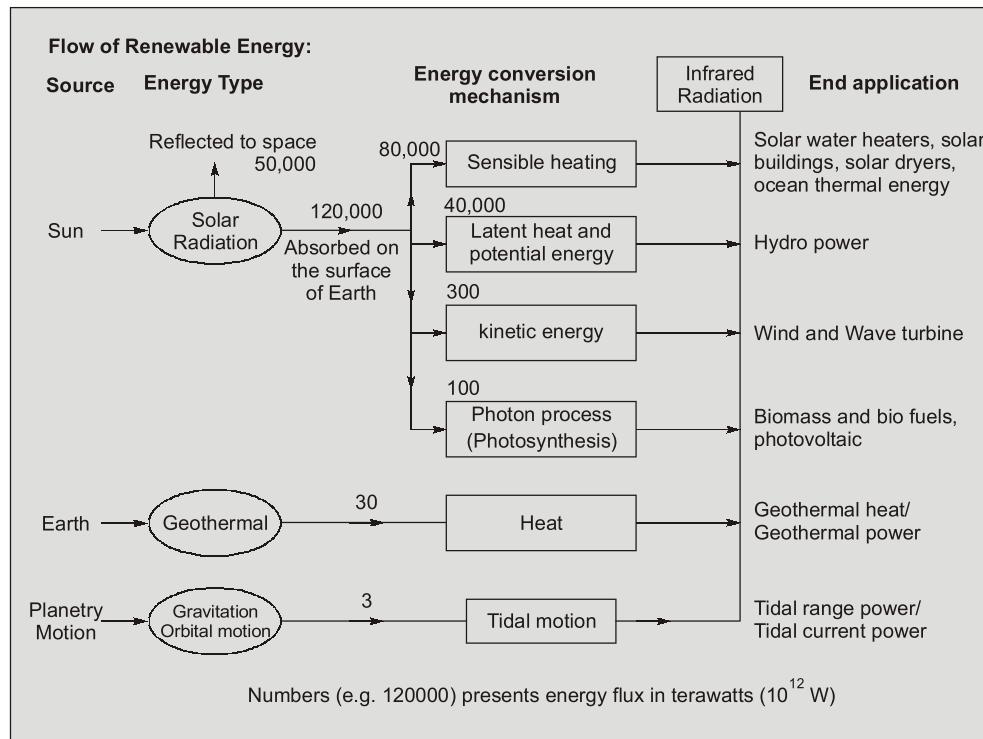
### Availability of Renewable Energy on Earth

The Energy flux received per square meter on the surface of the earth is 500 W (approximately) from all the sources of renewable energy. The demand of energy per person is 2 kW, considering the requirements of modern society. If renewable energy flux is harnessed at just 4% efficiency, 2 kW of the power required can be drawn from an area of  $10 \times 10 \text{ m}^2$  with suitable method of power harnessing. The total energy demand can be fulfilled by using just 5% of the local land area.

The major contribution in the renewable energy comes from solar energy. The total solar flux absorbed at the sea level is about  $1.2 \times 10^7 \text{ W}$ . Thus, the availability of solar flux per person on Earth's surface is 20 MW which is 10,000 times compared to the requirement of energy per person.

Thus, it can be said that renewable energy source has the potential to cater the demand of energy globally, but only if the technical methods and institutional frameworks exist to extract, use and store the energy in an appropriate form at realistic costs.

### Flow of Renewable Energy:

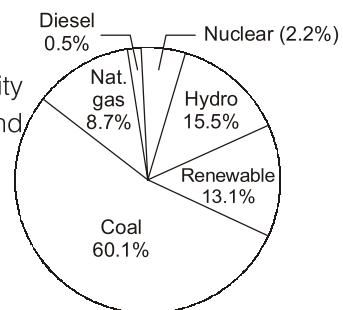


The dominance of solar energy is clearly visible from the renewable energy flow diagram. Although, flow energy diagram gives a glimpse of available energy yet the information has little practical engineering applications. It is because of rapid change in geographical conditions. Suitability of renewable energy source is decided based on availability and economy of energy production, e.g flat regions or shore areas are suitable for wind energy but not for hydro energy. Similarly hilly areas with rivers are suitable for hydropower and not for wind power. Tropical rain forest regions are good for harnessing biomass energy but not good for wind and solar.

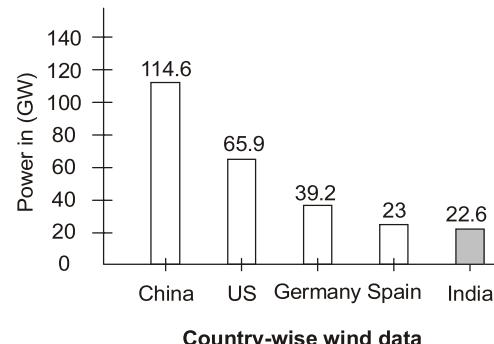
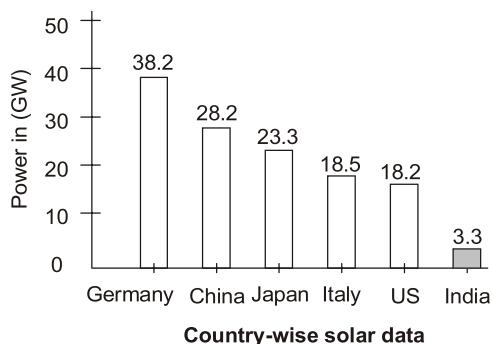
**Q4** What are the main renewable energy sources in India? In which form renewable energy is used in India?**Solution:****Present Power Scenario of India**

In India, total power production installed capacity is 263.66 GW (Gigawatt) and renewable energy capacity is 34.35 GW i.e. 13% of the installed capacity and 7% of the electricity produced, as on march 2015 by Ministry of New and Renewable Energy (MNRE) report.

Total installed capacity is shown by given Pi-chart.

**Renewable energy constitutes :**

1. Wind 8.6%
  2. Solar Heating/Cooling 1.5%
  3. Solar PV 1.3%
  4. Biomass 0.5%
  5. Biogas 1.1%
- India is 5<sup>th</sup> largest country producing wind energy (22.6 GW out of 370 GW) (By report : Global Wind Energy Council as on 2014)
  - India is 11<sup>th</sup> largest country in solar power production (3.3 GW out 177 GW) (As on Jan 2014, IEA report)

**Country-wise Solar & Wind data are given in graphs below :**

**Utilities of Renewable Energy:** There are numerous applications where renewable energy can be utilized. Broadly these segments can be categorized as :

1. Electricity Generation
2. Air and water heating/ cooling
3. Transport (Biodiesel, Biogas, Ethanol, Solar vehicles)
4. Rural (off grid) applications

