

RENEWABLE ENERGY TECHNOLOGY

EE / EEE

SEMESTER – FIFTH

These important questions have been prepared using your previous exam papers (PYQs), verified concepts, and additional reference from trusted online academic sources. For deeper understanding, please refer your class notes as well.

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1 HIGH & LONG IMPORTANT QUESTIONS (90–95% Expected)

1. Draw the block diagram of a basic **Photovoltaic (PV) system** for power generation and explain the function of each component (Solar Array, Battery, Inverter, Charge Controller).
2. Explain the construction and working principle of a **Flat Plate Collector (FPC)** with a neat diagram. Mention its applications.
3. Draw the block diagram of a **Wind Energy Conversion System (WECS)** and explain the working of its main components (Rotor, Gearbox, Generator, Controller).
4. Explain the working principle of a **Doubly-Fed Induction Generator (DFIG)** used in wind turbines.
5. With a neat schematic diagram, explain the construction and working of a **Fixed Dome type (Chinese Digester)** or **Floating Drum type (KVIC)** biogas plant.
6. Explain the working principle, construction, and chemical reactions of a **Hydrogen Fuel Cell**. Mention its advantages and disadvantages.
7. Explain the method of Hydrogen production using **Electrolysis of water** with a neat diagram.
8. Explain the various **Biomass Conversion Processes** (Anaerobic Digestion, Fermentation, Pyrolysis, and Gasification).
9. Explain the working principle of a **Geothermal Power Plant** (Dry Steam or Binary type) with a diagram.
10. Explain the working principle of **Ocean Thermal Energy Conversion (OTEC)** or **Tidal Power Plant** with a general arrangement diagram.

2 IMPORTANT & SHORT QUESTIONS (50–70% Probability)

1. Differentiate between a **Pyrheliometer** and a **Pyranometer**.
 2. Draw the **Equivalent Circuit** of a Solar Cell and explain its **I-V (Current-Voltage) characteristics curve**.
 3. Define the following Wind Energy terms: **Cut-in Speed, Cut-out Speed, Betz Limit, and Power Coefficient**.
 4. Differentiate between **Pitch Control** and **Yaw Control** in a wind turbine system.
 5. What are the major methods and challenges of **Hydrogen Storage**?
 6. Write a short note on **Polarization** (specifically Resistance Polarization) in fuel cells.
 7. Differentiate between **Focusing type** and **Non-focusing type** solar collectors.
 8. List the factors affecting **Biogas generation** (pH, Temperature, Retention time).
 9. List the important considerations for selecting a site for a **Wind Power Plant**.
 10. How are **Small Hydroelectric Power Plants (SHP)** classified into Micro, Mini, and Small?
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3 “AA BHI SAKTA HAI” QUESTIONS (20–30% Probability)

1. Define **Declination Angle, Hour Angle, and Zenith Angle** in solar geometry.
2. Write a short note on **Solar Air Heaters** and their advantages.
3. Briefly explain the concepts of **Lift and Drag forces** on wind turbine blades.
4. Explain the concept of **Variable speed and Constant frequency** schemes in wind power generation.
5. What are the hazards associated with handling Hydrogen and what are the preventive measures?
6. List the general components of a **Small Hydroelectric Power Plant** and their functions.

QUICK REVISE

UNIT I: SOLAR POWER TECHNOLOGY

• **Solar Radiation:**

- **Beam (Direct) Radiation:** Solar radiation received from the sun without change of direction.
- **Diffuse Radiation:** Radiation received after scattering by clouds/dust.

- **Insolation:** Total solar energy received on a surface area over a specific time.
 - **Measuring Instruments:**
 - **Pyranometer:** Measures **Global (Total)** radiation (Beam + Diffuse).
 - **Pyrheliometer:** Measures only **Beam (Direct)** radiation.
 - **Solar Cell (PV Cell):**
 - **Principle:** Photovoltaic Effect (Light energy -->Electrical energy).
 - **Material:** Semiconductor (Silicon).
 - **I-V Curve:** Shows relationship between Current and Voltage. Max power is at the "knee" of the curve.
 - **PV System Components:**
 - **Solar Array:** Multiple modules connected in series/parallel.
 - **Charge Controller:** Prevents overcharging/deep discharging of battery.
 - **Battery:** Stores energy (Lead-acid is common).
 - **Inverter:** Converts DC (from panel/battery) to AC (for home appliances).
 - **Solar Collectors (Thermal):**
 - **Flat Plate Collector (FPC):** Absorbs radiation to heat water/air. Used for domestic water heating. Non-focusing.
 - **Concentrating Collector:** Uses mirrors/lenses to focus sunlight on a point/line. Used for high-temperature applications (Power plants).
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UNIT II: WIND POWER TECHNOLOGY

- *Note:* Power is directly proportional to the **cube of wind speed** (V^3).
- **Betz Limit:** The theoretical maximum efficiency of a wind turbine is **59.3%**. No turbine can capture more than this.
- **Forces on Blades:**
 - **Lift Force:** Perpendicular to airflow (Causes rotation).
 - **Drag Force:** Parallel to airflow (Resists motion).
- **Main Components of WECS (Wind Energy Conversion System):**
 - **Rotor:** Blades + Hub.
 - **Gearbox:** Increases rotational speed from low-speed rotor to high-speed generator.
 - **Generator:** Converts mechanical energy to electrical (DFIG or SCIG).
 - **Nacelle:** Housing that covers the gearbox and generator.
- **Control Mechanisms:**
 - **Yaw Control:** Rotates the turbine to face the wind.
 - **Pitch Control:** Changes the angle of blades to control speed during high winds.

UNIT III: HYDROGEN ENERGY AND FUEL CELL

- **Hydrogen Production (Electrolysis):**
 - Passing DC current through water (H_2O).
 - **Anode (+):** Oxygen collected.
 - **Cathode (-):** Hydrogen collected.
- **Hydrogen Storage:**
 - High-pressure gas cylinders.
 - Liquid Hydrogen (Cryogenic storage).
 - Metal Hydrides (Solid-state storage).
- **Fuel Cell:**
 - **Definition:** Electrochemical device converting chemical energy ($H_2 + O_2$) directly into electricity.
 - **By-product:** Water (H_2O) + Heat.
 - **Types:** PEMFC (Proton Exchange Membrane), SOFC (Solid Oxide).
- **Polarization (Losses):** Voltage drop in a fuel cell.
 - **Activation Polarization:** Loss at start of reaction.
 - **Ohmic/Resistance Polarization:** Loss due to resistance of electrolyte/electrodes.
 - **Concentration Polarization:** Loss at high current densities due to mass transport.

UNIT IV: BIOMASS ENERGY

- **Biomass Conversion Processes:**
 - **Anaerobic Digestion:** Bacterial breakdown in *absence* of oxygen --> Produces Biogas.
 - **Fermentation:** Yeast converts sugar to Alcohol (Ethanol).
 - **Pyrolysis:** Heating biomass in absence of air --> Charcoal/Bio-oil.
 - **Gasification:** Partial combustion --> Syngas ($CO + H_2$).
- **Biogas Composition:**
 - Mainly **Methane (CH_4)** ~55-70% (Combustible).
 - Carbon Dioxide (CO_2) ~30-45%.
- **Types of Biogas Plants:**

- **Fixed Dome (Chinese):** Brick masonry, underground. Gas collects in dome, pressure varies. *Low maintenance.*
 - **Floating Drum (KVIC):** Steel drum floats on slurry. Drum rises as gas fills. Pressure is constant. *Corrosion is a problem.*
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UNIT V: OTHER RENEWABLE SOURCES

- **Geothermal Energy:**

- Heat from inside the Earth.
- **Dry Steam Plant:** Uses direct steam from ground to turn turbine.
- **Binary Cycle:** Uses hot water to boil a secondary fluid (like Ammonia) which turns the turbine.

- **Ocean Energy:**

- **OTEC (Ocean Thermal Energy Conversion):** Uses temperature difference between warm surface water and cold deep water to run a heat engine.
- **Tidal Energy:** Uses the rise and fall of sea levels (tides) due to Moon's gravity.

- **Small Hydro Power (SHP):**

- **Run-of-River:** No large dam/storage required.
- **Components:** Weir (diverts water), Penstock (pipe), Turbine (Pelton/Francis), Generator.
- **Classification:**
 - Micro: Up to 100 kW
 - Mini: 101 kW to 2 MW
 - Small: 2 MW to 25 MW