1. **Solar Constant(Isc)**
    - Is the rate at which energy is received from the sun on a unit area perpendicular to the rays of the sun , at the mean distance of the earth from the sun.
    - Based on 1970 measurements :1353 W/m2
    - Subsequent measurements : 1367 W/m2
2. **Beam Radiation(Ib):** Solar radiation received on earth's surface without change in direction.
3. **Diffuse radiation(Id):** The radiation received at the earth's surface from all parts of the sky's hemisphere (after being subjected to scattering in the atmosphere) is called diffuse radiation.
   Total radiation: Ib+Id

4. **What are Solar Radiation Measurements?**

Light from the sky dome
- Direct from the sun
- Everywhere but not from the sun
- Entire sky

We call it
- Direct (beam)
- Diffuse (sky)
- Global (total)

5. **Why Do We Need Solar Radiation Data?**
    - Agriculture Photosynthesis
    - Astronomy Solar Output Variation
    - Atmospheric Science Numerical Weather Prediction
    - Climate Change Energy Balance
    - Health UV effects on skin
    - Hydrology Evaporation
    - Materials Degradation
    - Oceanography Energy Balance
    - Renewable Energy Sustainability

6. Instruments for Measuring Solar Radiation and Sunshine

Pyranometer

- Used to measure either global or diffuse radiation
- It consists of a black surface which heats up when exposed to solar radiation.
- Its temperature increases until the rate of heat gain equal to heat loss by conduction, convection and reradiation
- The hot junctions of a thermopile are attached to the black surface, while the cold junctions are located in such a way that they do not receive radiation.
- As result emf is generated
- This is measure of global radiation.

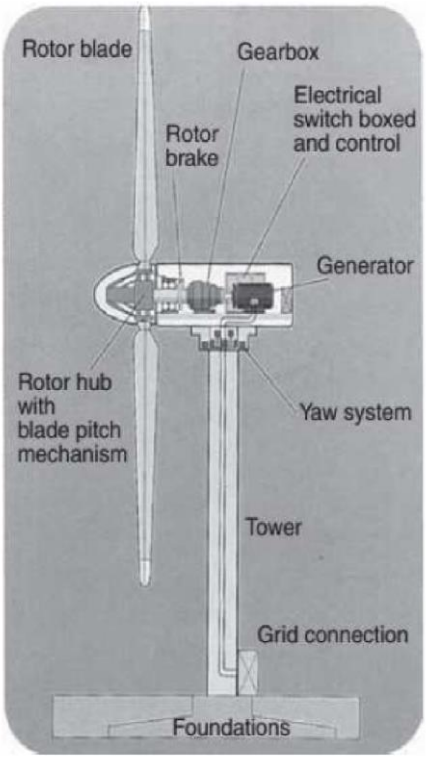
7. Types of Solar Collectors

- Flat Plate Collectors
- Evacuated Tube Collectors
- Line Focus Collectors
- Point Focus Collectors

8. What is wind energy? Significance of wind as non conventional energy source

- Wind power or wind energy describes the process by which the wind is used to generate mechanical power or electricity.
- Wind energy is a large renewable energy source. Global wind power potential is of the order of 11,000 GW. It is about 5 times the global installed power generation capacity. This excludes offshore potential as it is yet to be properly estimated.

9. Components of wind mill



- The wind power system comprises one or more wind turbine units operating electrically in parallel.
- Each turbine is made of the following basic components:

i. Tower structure
ii. Rotor with two or three blades attached to
iii. the hub
iv. Shaft with mechanical gear
v. Electrical generator
vi. Yaw mechanism, such as the tail vane
vii. Sensors and control

- **Rotor** : The portion of the wind turbine that collects energy from the wind is called the rotor.
- **Generator** : The generator is what converts the turning motion of a wind turbine's blades into electricity.
- **Transmission (Gear Box) :** Most wind turbines require a gear-box transmission to increase the rotation of the generator to the speeds necessary for efficient electricity production.
- **Tower :** The tower on which a wind turbine is mounted is not just a support structure. It also raises the wind turbine so that its blades safely clear the ground and so it can reach the stronger winds at higher elevations.
- **Yaw drive:** It keeps the upwind turbine facing into the wind as the wind direction changes. A yaw motor powers the yaw drive.
- **Nacelle :** A nacelle is a cover housing that houses all of the generating components in a wind turbine, including the generator, gearbox, drive train, and brake assembly.

10. POWER OUTPUT FROM AN IDEAL TURBINE

- The kinetic energy in a parcel of air of mass m, flowing at speed u in the x direction is

$$U = \frac{1}{2}mu^2 = \frac{1}{2}(\rho Ax)u^2 \qquad \text{Joules}$$

where A is the cross-sectional area in m2 , is the air density in kg/m3 , and x is the thickness of the parcel in m.

- Power in the wind is derivative of kinetic energy:

$$P_w = \frac{dU}{dt} = \frac{1}{2}\rho Au^2\frac{dx}{dt} = \frac{1}{2}\rho Au^3 \qquad \text{W}$$

- Air density

$$\rho = 3.485\frac{p}{T} \qquad \text{kg/m}^3$$

p is the pressure in kPa and T is the temperature in kelvin.

11. Factors for selecting site

- Adequate wind speed;
- sufficient area;
- appropriate ground conditions;
- access to the electricity grid;
- feasibility of access for abnormal loads;
- suitable terrain and topography;
- agreements with site landowners.

12. Angle of Attack, Lift and Drag

- Angle of attack, which is the angle between the chord line of the blade and the relative wind or the effective direction of air flow.
- Drag Force : The component of the force acting in the direction of the free stream is called Drag force (D=F cos θ)
- Lift Force : The component of the force in a direction at right angles to the direction of the free stream is called lift force. (L=Fsin θ)