3.1 Power in the Wind:

Wind has kinetic energy due to its motion. This kinetic energy can be given by

$$KE = \frac{1}{2}\dot{m}u0^2$$

$$\dot{m} = \frac{dm}{dt}$$

Where,

$\dot{m}$ = mass of air passing through an area A per unit time

If $\mathbf{u_o}$ is the speed of free wind in unperturbed state,

the volume of air column passing through an area **A** per unit time is given by $\mathbf{Au_o}$.

If **ρ** is the density of air,

the air mass flow rate, through area A, is given as, $\boldsymbol{\rho A u_o}$

Power (Po) available in wind, is equal to kinetic energy rate associated with the mass of moving air,

i.e.:

$$P0 = \frac{1}{2}(\rho A u o)uo^2$$

(Or)

$$P0 = \frac{1}{2}(\rho A)uo^3$$

Power available in wind per unit area:

$$\frac{P_0}{A} = \frac{1}{2}(\rho A)uo^3$$

This indicates that power available in wind is proportional to the cube of wind speed.

The air density **ρ** varies in direct proportion with air pressure and inverse proportion with temperature as:

$$\rho = \frac{P}{RT}$$

Where,

P is air pressure in Pa,

T is air temperature in kelvin and

R is the gas constant, (= 287 J/kg K).

At the standard value of air pressure, 1.0132 × 105 Pa (i.e. 1 atmosphere), and at 15 °C, the value of air density

$$\rho = \frac{1.0132 * 10^{5}}{287 * 288} = 1.226 \frac{\mathrm{J}}{\mathrm{Kg}}\ \mathrm{K/m^3}$$

Assuming the above value of wind density, **ρ** at 15 °C and at sea level, the power available in moderate wind of 10 m/s is 613 W/m2.