Clean Energy Technologies
- Solar
- Wind Energy

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25/03/26 Unit-4

★ **Green Bonds**

- Green bonds are investment made by an investor for financing renewable energy installation, green building development, eco-friendly transportation, water harvesting etc.
- A bond is a loan given by an investor to a company or the government when the company or the government borrow money from the investor, they give the investor a bond.
- The face value of a bond is generally rupees 1000₹ but it can go higher upto rupees 10,000 also.
- The investor is paid interest on the money they have loan as of early 2026.
- Government bonds yield a percentage interest of around 6.7% while high yield corporate bond can offer over 11%.

★ **Carbon Credits**

- A Permit from the government which allows a company to produce a certain amount of carbon emission. (1 carbon credit = 1 tonn of CO_2 emissions) and which can be traded if the full allowance is not used.
- It is a form of formal penalization mechanism for producing excess CO_2 emissions.

- As of early 2025 the cost of 1 Carbon Credit in India voluntary market ranges from ₹ 200-300.
- The money that the government receives from the company in the form of Carbon Credits must be used for the development of Green Projects.

Example

- If a company buys 100 carbon credits from the government then they can produce an excess of 100 tonnes of CO_2.
- In Practice if the company produces only 90 tonnes of CO_2 then 10 excess credit can be traded by selling them to some other company.

(A) 100
90 —10→ (B) 210 (limit 200)
10+200

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Solar Panel Numerical

Numerical A high efficiency Monocrystalline solar Panel is installed on a rooftop of a house located in dharwad karnataka You are given the following information.

(i) Rated power output of Solar Panel. ($P_{max} = 400\ W$)

(ii) band gap energy (E_g) = 1.12 eV

(iii) Average peak sun hours (T) = 5.5 hr/day.

(iv) Planks constant (h) = 6.62×10^{-34} J/sec.

(v) Charge of an electron (e) = 1.6×10^{-19} C

$E = h\nu$

(vi) Calculate the following:

a) Maximum wavelength (λ_{max}) of the incident light that can contribute to electricity generation.

b) The total electrical energy generated in a single day in kWh

Sol:

(a) $E = h\nu$

$E = \frac{hc}{\lambda}$ ⇒ $\lambda = \frac{hc}{E}$

1.12 eV = 1.792×10^{-19} J

eV → Convert → V

$P = VI \Rightarrow \frac{q}{t}$

$\lambda_{max} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{1.12} = \frac{17.73 \times 10^{-26}\ m}{\times 1.6 \times 10^{-19}}$

$= 11.07 \times 10^{-7}\ m$, $1107 \times 10^{-9}\ m$

$\lambda_g \leq 1107 \times 10^{-9}\ m$

↳ should be lesser than the λ_g.

(b) $P = VI \Rightarrow \frac{1.12 \times q}{5.5 \times 60 \times 60}$

$q = \frac{400 \times 5.5 \times 60 \times 60}{1.12}\ C$

$q = 7,071,428.571\ C$

q

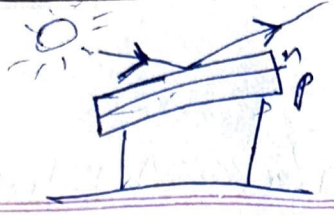
no. of electrons = 4.41×10^{23}.

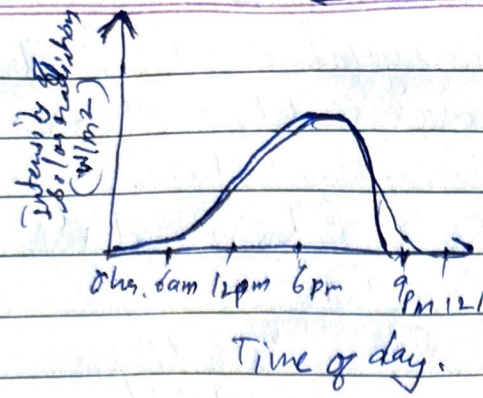
Energy produced by panel

$= 400 \times 5.5$ wh/day

$= 2200$ wh/day.

Entry





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Tough ???

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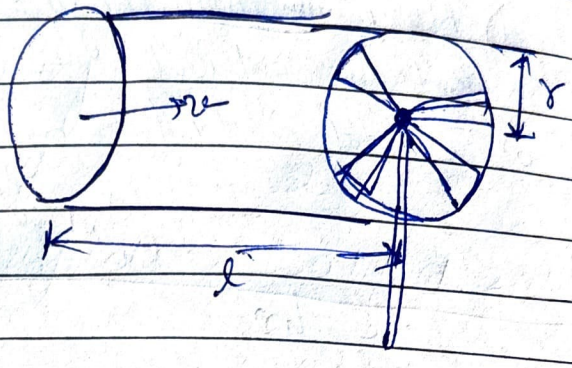
Wind Energy (EN322)

using kinetic energy Equation.

$$E_k = \frac{1}{2} m v^2 \quad \text{—(1)}$$

m → mass of air (kg), v → Wind velocity (m/s)



V (volume) $= A \times l$

$= \pi r^2 \times l$

$\Rightarrow \pi r^2 \times (v \times t)$

$V = A \times v t$

$\rho = \frac{m}{V} \Rightarrow m = \rho V \quad \text{—(2)}$

$E_k = \frac{1}{2} \rho V \times v^2$ (Joules)

$= \frac{1}{2} \rho (A \times v t) \times v^2 \Rightarrow \frac{1}{2} \rho A v^3 \times t$

Kinetic Energy of the wind turbine

$$\text{Power} = \frac{\text{Energy}}{\text{Time}} = \frac{E_k}{t} = \frac{1}{2} \rho A v^3$$

Watt (W)

density of water → 1000 kg/m³

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Numerical

Calculate the Power in the wind that is being transferred to the blades of a given wind turbine if the wind speed is 15 m/s and blade length 60m. density of wind = 1.302 kg/m³

Sol: $v = 15 m/s$, $r = 60m$

$$P = \frac{1}{2} \times \pi (60)^2 \times 1.302 \times (15)^3 \quad , A = 3600 \times \pi = 11,309.73 m^2$$

$P = 24,848,898.332$ Watt or Joules/sec.

$P = 2.5 \times 10^7$ watt.

Ques

Ques Find the Kinetic Energy and Power of the wind if you are given wind speed = 5 m/s. Diameter of the wind turbine = 90m. (r = 45m). if the actual Power output recorded from the turbine is 250 kwatts then find the efficiency of energy conversion by the wind turbine.

(follow standard pattern calculate each term.)

Sol: $v = 5 m/s$, $r = 45 m$.

$A = \pi r^2 \Rightarrow 6361.725 m^2$

Mass = 38000 kg/s

$KE = 489.024$ Joules $\times 10^3$

$$P = \frac{1}{2} \rho A v^3 \Rightarrow \frac{1}{2} \times 1.23 \times 6,361.725 \times (5)^3$$

$= 489,057.61$ watts $\Rightarrow 489.057$ kwatts

$V = A \times l$

$= \pi r^2 \times v \times t \Rightarrow 6361.72 \times 5 \times 1$

$\Rightarrow 31,808.625 m^3/s$

$$\text{efficiency} = \frac{\text{Actual}}{\text{Theoretical}} \cdot \frac{\text{Theoretical}}{\text{Actual}} \times 100$$

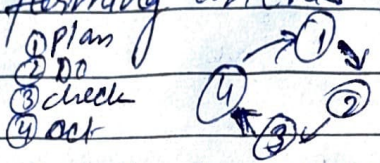
$= 51.11\%$

19/04/26

Unit-4 (ISO 14001)

- ISO 14001 is the international standard for Environmental management System (EMS). Which is a Plan that provides a structured framework for organisation to manage Environmental impacts ensure legal compliance & improves sustainability performance. It facilitates the reporting of Environmental related data. Providing evidence of environmental aspects ... goals and Performance.

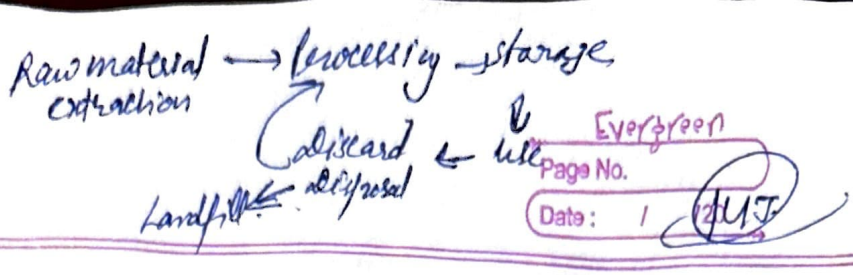
The principle of forming an EMS is Plan-Do-Check-act (PDCA).



~~4 Plan~~

Some of the important aspects of ISO 14001:2015 are:

1. It defines the Environmental Policy of an organisations management to commit to pollution Prevention & continuous improvement.
2. It helps in Planning & identification of Environmental aspects/impacts of activities and legal compliance obligations set by the government.
3. It involves performance evaluation in monitoring measuring and auditing the EMS to ensure that the targets are met.
4. It includes improvement activities for correction of current issues regarding environmental impacts and enhancing the performance of mitigation measures.
5. The EMS considers a life cycle perspective involving evaluation Environmental impacts from raw material Acquisition to final disposal.



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- Benefits of ISO14001

1. It helps in reducing Environmental impacts & resource consumption.
2. It helps in preventing accruance of legal fines.
3. It influences Public perception of the company.
4. It helps in continuous improvement in Environmental performance.
5. It acts as a data collection mechanism for Environmental Reporting under metrics such as global Reporting initiatives. (GRI) & Carbon disclosure project (CDP).

ISO 14064 (impr). [least is after mid-terms]