

**SKILL ACTIVITY NO: 1**  
**( To be filled by the Instructor )**

Date : \_\_\_\_\_

Title : Selection of renewable source for particular application

Skills / competencies to be acquired :

1. Ability to analyse various renewable energy technology
2. Skills in assessing the availability & understand how renewable energy
3. Proficiency in conducting financial assessment resource can be integrated to existing
4. Projects feasibility & planning      8. Risk management

Duration of activity ( hours ) : \_\_\_\_\_

( To be filled by the Student )

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The purpose of this activity is to identify the most efficient sustainable and cost effective energy tailored to specific needs. This involves evaluating resources availability, environmental impact, financial feasibility & technical requirements. By doing so the goal is to minimize damage, reduce dependency on fossil fuels, promote energy efficiency. It is to ensure the renewable energy systems are integrated optimally into the existing infrastructure, providing sustainable future.

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1) Assess the energy needed for the application
- 2) Evaluate the availability & potential of renewable resource
- 3) Evaluate Suitable Technologies
- 4) Conduct feasibility studies
- 5) Analyze environmental impact
- 6) Regulatory & policy review
- 7) Choose the most efficient & environmental friendly
- 8) Identify negative risks
- 9) Employment & monitoring

3. What resources / materials / equipments / tools did you use for this activity ?

1. Internet
2. Notes
3. Stationery kit
4. Calculator
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

4. What skills did you acquire ?

1. Ability to analyze various renewable energy technologies assembly
2. Skill in accessing the availability
3. Project feasibility & planning
4. \_\_\_\_\_
5. Proficiency in industry financial
6. Risk management
7. \_\_\_\_\_
8. \_\_\_\_\_

5. Time taken to complete the activity ? 1 hrs (hours)

Please share your views on the activity performed at IIT Madras. Your feedback will help us to improve our program.

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1)	Ability to analyze various renewable energy technologies	/
2)	Skills to assess the availability	/
3)	Project feasibility & planning	/
4)	Risk management	/

Remarks

Total marks \_\_\_\_\_ out of 10.

**Sign of Instructor**  
**Date:**

Bio gas for electricity and cooking of a small dairy with 10 cows

Energy Demand - 5kwh/day (cooking)  
- 10kwh/day (electricity)

$$\text{Daily demand} = 5 + 10 = 15 \text{kwh/day}$$

$$\text{Monthly} = 15 \times 30 = 450 \text{kwh}$$

$$\text{Yearly} = 15 \times 365 = 54,750 \text{kwh}$$

1) Each cow produces 10.5kg of dung per day

1 kg cow dung produces 0.035 m<sup>3</sup> of biogas

Bio gas energy content = 612wh/m<sup>3</sup>

$$\text{Total daily dung} = 10 \text{ cows} \times 12.5 \text{ kg} = 125 \text{ kg/day}$$

$$\text{Bio gas produced} = 125 \times 0.035 = 4.375 \text{ m}^3$$

$$\text{Energy generated} = 4.375 \times 6 = 26.25 \text{ wh/day}$$

2) Cost

Small biogas (10m<sup>3</sup> capacity) ₹ 80,000

Gas storage burner = ₹ 20,000

Total Cost → ₹ 100,000

Annual maintenance ₹ 3000

## Energy Savings

4pg equivalent = 21pg Cylinders

$$\text{Cost} = 1000 \text{ /cylinder} = 2 \times 1000 = 2000$$

$$\therefore \text{Yearly} = 2000 \times 12 = \text{£}24,000/\text{year}$$

$$\text{Electricity saving} = 5475 \text{ kWh} \times 6 = \text{£}32,850 \text{ year}$$

$$\therefore \text{Total annual saving} = \text{£}56,850/\text{year}$$

## SKILL ACTIVITY NO: 2

Date : \_\_\_\_\_

( To be filled by the Instructor )

Title : Design of solar panel system for particular application

Skills / competencies to be acquired :

1. Understanding Solar energy tech 5. \_\_\_\_\_
2. PV System Comp & efficiency 6. \_\_\_\_\_
3. Skill in designing & optimizing layout \_\_\_\_\_
4. Regulatory & compliance knowledge \_\_\_\_\_

Duration of activity ( hours ) : \_\_\_\_\_

( To be filled by the Student )

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The purpose of designing a solar panel for a particular application is to optimize energy generation efficiently and case effectiveness ensuring that the solar system meet the specific energy needs of the application while considering factors like location size and environment impact.

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1] Identify the energy needs & application specifics
- 2] Evaluate the location for solar exposure & space
- 3] Choose type of solar panel
- 4] Estimate the total energy
- 5] Create a physical layout
- 6] Choose mounting fixtures
- 7] Perform cost analysis
- 8] Evaluate the performance

3. What resources / materials / equipments / tools did you use for this activity ?

1. Internet
2. Notes
3. Stationary kit
4. Calculator
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

4. What skills did you acquire ?

1. Understanding solar energy tech
2. Ability to access & calculate the
3. Skills in designing & optimizing the layout
4. Regulatory & compliance knowledge
5. Pv system component & efficiency
6. Energy demands of the app layout

5. Time taken to complete the activity ? 1 hr (hours)

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1	Understanding the Solar Energy Technology	✓
2	Skills in designing & optimising the layout	✓
3	Regulatory & compliance knowledge	✓
4	PV system Components & efficiency	✓

**Remarks**

Total marks \_\_\_\_\_ out of 10.

**Sign of Instructor**  
**Date:**



Solar pump water pump system for agricultural use

location - small farm with good sunlight (5 hrs peak sunlight)

load - 1.5kW

Solar PV system

1) Daily Demand =  $1.5 \text{ kW} \times 6 \text{ hrs} = 9 \text{ kWh/day}$

$$\text{monthly} = 9 \times 30 = 270 \text{ kWh}$$

$$\text{Year} = 270 \times 9 \times 365 = 3285 \text{ kWh}$$

Assuming 80% efficiency

$$P = \frac{\text{Demand}}{\text{Peak sun} \times \text{efficiency}}$$

$$P = \frac{9}{5 \times 0.8} = 2.25 \text{ kW}$$

2) No. of panels

Standard 300W per panel

$$N = \frac{2285}{300} = 7.52 \text{ panels}$$

3) Cost

1 panel = ₦ 25,000

$$\therefore 8 = ₦ 200,000$$

$$\text{Inverter} = ₦ 50,000$$

$$\text{Battery} = ₦ 1,00,000$$

Annual main = £5000

$$\text{electricity saving} = \text{demand yearly} \times \text{cost per kWh}$$
$$= 3285 \times 6$$

/ regular electricity  
 $3285 \times 8.80 = \text{£}29,000$

**SKILL ACTIVITY NO: 3**  
**( To be filled by the Instructor )**

Date : \_\_\_\_\_

Title : Determination of wind energy efficiency

Skills / competencies to be acquired :

1. To understand wind energy principles knowledge abt. sys & converter
2. To get familiarization wind turbine and components
3. To select a location with favorable wind conditions
4. Collection of comprehensive data on wind speed power etc

Duration of activity ( hours ) : \_\_\_\_\_

**( To be filled by the Student )**

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The main purpose of this experiment is to evaluate the efficiency of wind energy system for a specific application calculating its power density overall loss function also the efficiency of wind energy system ie. rotor size and finally the actualized power of turbine

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1) Selection of location
- 2) Measure baseline wind conditions
- 3) Collect data on wind speed
- 4) Calculate overall of loss function, power wind rating of turbine. Total Actual energy available, Rotor size power rotating actual rated power of turbine

3. What resources / materials / equipments / tools did you use for this activity ?

1. Stationery \_\_\_\_\_ 5. \_\_\_\_\_
2. Calculator \_\_\_\_\_ 6. \_\_\_\_\_
3. Notes \_\_\_\_\_ 7. \_\_\_\_\_
4. \_\_\_\_\_ 8. \_\_\_\_\_

4. What skills did you acquire ?

1. Understanding wind energy principle To get Knowledge of sys concern
2. To get familiar with wind turbine operation and components
3. To select a location wind toward local conditions
4. Collection of comprehensive data on wind speed power output

5. Time taken to complete the activity ?

1 hr

(hours)

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1	Understanding wind energy principles	✓
2	Get familiar with wind turbine operation and components	✓
3	Knowledge of site system & conversion	
4	Select a location with favorable wind conditions	✓
5	Collection of comprehensive data on wind speed power output	

Remarks

**Sign of Instructor**  
**Date:**

Total marks \_\_\_\_\_ out of 10.

Estimation of wind turbine power rating

Annual Energy Requirement = 20,000 kWh

Propeller type machine (coefficient of power  $C_p$ ) = 0.4

Find speed = 8.6 m/s

Density of air = 1 kg/m<sup>3</sup>

Capacity factor = 0.3

No of hr in a year =  $365 \times 24 = 8760$

Available power in the wind =  $P = \frac{1}{2} \rho A v^3$

$v$  = wind speed m/s  $\rho$  = air density kg/m<sup>3</sup>

$A$  = area of turbine ( $m^2$ )

A] Power density =  $\frac{1}{2} \times \text{air density} \times v^3 \times C_p \rightarrow 318.028$

B] Actual power density = power density  $\times$  overall loss factor

$$= 318.028 \times 0.072$$

$$= 22.89 \text{ W}$$

C] Overall loss factor =  $C_p \times \text{transmission loss} \times \text{generation loss}$

$$= 0.4 \times 0.6 \times 0.3$$

$$= 0.072$$

D] Annual useful energy density  $\rightarrow$  Actual power density  $\times$  no. of hr in a year

$$= 22.89 \times 8760$$

$$= 200.586 \text{ kWh}$$

I] Rotate size and turbine power rating estimation

$$\text{Rotate size} = \frac{\text{Total annual energy required}}{\text{usefull energy density (Annual useful energy)}}$$

$$= 0.124$$

II] Area of rotor =  $\pi r^2$  (where  $r = 8.23\text{m}$ )

$$= 212.787\text{m}^2$$

III] Power Rating of turbine  $\rightarrow$  Actual power density  $\times$  Area of rotor

$$= 22.89 \times 212.787$$

$$= 4870.74\text{W}$$

IV] Actual rated power turbine =  $\frac{\text{Power rating of turbine}}{\text{Capacity factor}}$

$$= 16235 ?$$

V] Cost of turbine per kW = 30k-50k

$$= 0009.2\text{kW} \times 332000$$

$$= 23054.4 \text{ for } 99.2\text{W turbine}$$

**SKILL ACTIVITY NO: 4**  
**( To be filled by the Instructor )**

Date : 7

Title : Design of biogas plant

Skills / competencies to be acquired :

1. Ability to analyse feedstock characteristics and biogas analysis
2. Understand anaerobic digestion process & biogas production
3. Understanding of financial analysis and cost estimation
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

Duration of activity ( hours ) : 1

( To be filled by the Student )

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The purpose of this activity is to assess the feasibility and efficiency of a biogas plant design using specific feedstocks. Determine the optimal size and configuration of the plant for maximizing biogas production, analyze the potential economic and environmental impacts of the biogas plant.

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1) Gather info on feedstock characteristics and biogas yield estimates
- 2) Determine the required digester size based on feedstock quantity & desired retention time
- 3) Evaluate the potential environmental benefits (e.g. waste reduction, energy generation and impact (e.g. emissions) of the biogas plant)

3. What resources / materials / equipments / tools did you use for this activity ?

1. Stationary
2. Calculator
3. Notes
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

4. What skills did you acquire ?

1. Ability to analyse feedstock char and biogas yield
2. Understanding the anaerobic digestion process & biogass production
3. Understanding of financial analysis and cost estimation
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

5. Time taken to complete the activity ? \_\_\_\_\_ (hours)

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1	Ability to analyse feedstock char and biogas yield	✓
2	Understanding anaerobic digestion process and Biogas production	✓
3	Understanding of financial analysis & cost estimation	✓

Remarks

Total marks \_\_\_\_\_ out of 10.

**Sign of Instructor**  
**Date:**

## Assumption

1) 350 - 450 l of digas/day

Average production of dung - Cow = 15 kg/day

Bull = 10 kg/day

Buffalo = 9 kg/day

1000 l of gas = 1 m<sup>3</sup> of gas

Average gas production dung = 40 l/day

Retention period of dung slurry = 50 days

Amount of gas required per day.

① 400 l/day (considering)

If no. of family = 8

Total requirement per day  $\Rightarrow 400 \times 8 = 3200 \text{ l/day} \Rightarrow 32 \text{ m}^3$

② Total amount of dung required  $= \frac{3200}{40} = 80 \text{ kg}$

③ No of cows required  $= \frac{\text{total amt of dung}}{\text{cows Avg Period}} \Rightarrow \frac{80}{15} = 6 \text{ cows}$

Design of digester & gas holder

① Total mass of slurry  $\rightarrow$  Dung + water  $\rightarrow 160$

② Volume of slurry per day =  $\frac{\text{Total mass of slurry}}{\text{specific gravity}} = \frac{160}{1090} = 0.1462$

③ Retention period for slurry = 50 days  $\rightarrow 0.1462 \times 50$

④ Diameter of digester =  $(\sqrt[3]{7.3} = 1.9398)$

⑤ Gas holder tank dimension = 60% of the per day gas vol

For civil construction of tank the different components of a tank & their cost

Dig stor tank = 50,000

Inlet pipe = 5000

Outlet pipe = 5000

Gas Collection dome = 20,000

gas outlet = 5000

Mixing System = 10,000

Heating system = 20,000

Insulation = 10,000

Piping & valves = 10,000

Total estimate (est = 500,000 to 15,00,000 (50+00m<sup>3</sup>)

**SKILL ACTIVITY NO: 5**  
**( To be filled by the Instructor )**

Date : \_\_\_\_\_

Title : Determine the efficiency of Solar cell

Skills / competencies to be acquired :

1. Understand of Solar cell operation and efficiency concepts
2. Ability to conduct experiments measured using appropriate tools
3. Skills the data analysis interpretation
4. \_\_\_\_\_

Duration of activity ( hours ) : \_\_\_\_\_

( To be filled by the Student )

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The purpose of the experiment is to measure the efficiency of a Solar cell by evaluation of output electrical power relative to the incident solar power.

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1) Go to the site given on google classroom
- 2) Change the settings of the ip parameters. Such as area, Circuit Voltage, short Circuit Current, fill factor FF, Input power pin (W), etc
- 3) Measure output power using the formula  $P_{out} = V \times I$
- 4) Calculate efficiency
- 5) Analyse results

3. What resources / materials / equipments / tools did you use for this activity ?

1. Preeducation requisite \_\_\_\_\_ 5. \_\_\_\_\_
2. Notes \_\_\_\_\_ 6. \_\_\_\_\_
3. \_\_\_\_\_ 7. \_\_\_\_\_
4. \_\_\_\_\_ 8. \_\_\_\_\_

4. What skills did you acquire ?

1. Understanding of solar cell operation & other skills in data analysis & interpretation \_\_\_\_\_
2. \_\_\_\_\_ 6. \_\_\_\_\_
3. Ability to conduct experimental measurement using appropriate tools \_\_\_\_\_
4. \_\_\_\_\_ 8. \_\_\_\_\_

5. Time taken to complete the activity ? 1 hr (hours)

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1	Understanding solar cell operation and efficiency concepts	✓
2	Ability to conduct experimental measuring appropriate tools	✓
3	Skills in data analysis and interpretation	✓

Remarks

Total marks \_\_\_\_\_ out of 10.

**Sign of Instructor**  
Date:

Efficiency is defined as the ratio of energy output from the solar cell to input energy from the sun in addition to reflecting the performance of the solar cell itself the efficiency depends on the spectrum of intensity of the incident sunlight to the temperature of the solar cell.

$$P_{max} = V_{oc} I_{sc} FF$$

$$\eta = \frac{V_{oc} I_{sc} FF}{P_{in}}$$

FF is a parameter which in conjunction with  $V_{oc}$  &  $I_{sc}$  determines the maximum power from a solar cell.

$V_{oc}$  is the open-circuit voltage

$I_{sc}$  is the short-circuit voltage

FF is the fill factor

$\eta$  is the efficiency

The input power for efficiency calculation is  $1\text{ kW/m}^2$  or  $100\text{ mW/cm}^2$ . Thus the input power for a  $100 \times 100\text{ mm}^2$  cell is  $1\text{ W}$  & for  $9156 \times 156\text{ mm}^2$  cell is  $24.3\text{ mW}$

$$\text{Open circuit voltage } V_{oc} = 9.61\text{ V}$$

$$\text{Short circuit current } I_{sc} = 3.5\text{ A}$$

$$\text{Fill factor (FF)} = 0.7$$

$$\text{Input power } P_{in} = 1\text{ W}$$

$$\text{Max power - } P_{max} =$$

$$\begin{aligned} & 9.61 \times 3.5 \times 0.7 \\ & = 23.549\text{ W} \end{aligned}$$

$$\text{Efficiency } \eta =$$

$$\frac{9.61 \times 3.5 \times 0.7}{1\text{ W}}$$

$$= 24.0632\%$$

**SKILL ACTIVITY NO: 6**  
**( To be filled by the Instructor )**

Date : \_\_\_\_\_

Title : Fuel Cell efficiency Calculation

Skills / competencies to be acquired :

1. Understand of fuel cell operation and efficiency concepts
2. Ability to conduct experiment measure using appropriate tools
3. Skills in data analysis, interpretation
4. \_\_\_\_\_
8. \_\_\_\_\_

Duration of activity ( hours ) : 1

**( To be filled by the Student )**

1. What is the purpose of this activity ? ( Explain in 3 - 4 lines )

The purpose of this activity is to measure the efficacy of a fuel cell by evaluation of a electric power relative

2. Steps performed in this activity ( Explain in 5 - 6 lines )

- 1) Solve the given question
- 2) Do the calculation corresponding to RQ given
- 3) Calculate the answer
- 4) Analysis results

3. What resources / materials / equipments / tools did you use for this activity ?

1. PDF
2. given question
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

4. What skills did you acquire ?

1. Understanding of fuel cell operation & efficiency concept
2. Ability to conduct experimental measurement using apparatus
3. Skill in data analysis & data interpretation
- 4.
- 5.

5. Time taken to complete the activity ? \_\_\_\_\_ (hours)

(Signature)  
Instructor

(Signature)  
Student

**( To be filled by Instructor )**

Sr. No.	Skills / Competencies	Achieved / Not Achieved ( YES / NO )
1)	Understand & fuel all operations efficiency concile	✓
2)	Ability to conduct experimental measurement using appropriate tools	✓
3)	Skills in data analysis & data interpretation.	✓

Remarks

Total marks \_\_\_\_ out of 10.

**Sign of Instructor**  
**Date:**

Given:-

$$\Delta H^{\circ} \text{ at } 298\text{K} = 285,838 \text{ J/mol or}$$

$$\Delta H^{\circ} \text{ at } 298\text{K} = -237191 \text{ J/mol}$$

Temperature  $T = 298\text{ K}$

1] Volume o/p

$$\Delta G^{\circ} = -nFE^{\circ}$$

$$n = 2 \text{ no. of electrons}$$

$$F = 96485 \text{ C/mol}$$

$E^{\circ}$  is the standard cell potential

rule  $E^{\circ}$

$$E^{\circ} = -\frac{\Delta G^{\circ}}{nF}$$

$$E^{\circ} = \frac{-237191 \times 10^3}{2 \times 96485} \text{ V}$$

✓

$$= 1.229 \text{ V}$$

2) Efficiency

$$n = \frac{\Delta G^{\circ}}{\Delta H^{\circ}}$$

$$n = \frac{-237191}{-285838}$$

$$= 82.981 \cdot$$

### 3] Electric Work O/P

Electrical work per mole of H<sub>2</sub>

$$W_{elec} = \Delta G_f$$

Per Mole of H<sub>2</sub>     $W_{elec} = -237,191 \text{ kJ/mol}$

Per Mole of H<sub>2</sub>O     $W_{elec} = -237,191 \text{ } 16 \text{ J/mol}$

### 4] Heat Transfer to the surrounding

$$q = \Delta H - \Delta G_f$$

$$q = (-285838) - (-237191)$$

$$\underline{\underline{q}} = \underline{\underline{-48,647 \text{ kJ/mol}}}$$