

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
MECHANICAL ENGINEERING DEPARTMENT
HARMATTAN SEMESTER POSTGRADUATE EXAMINATION

Course Title: Solar Energy

Course Code: MEE 855

Instruction: Answer ALL Questions

Date: November 15, 2017.

1. A friend has approached you on his desire to replace his diesel generator with PV panels. A check on his apartment shows that the electrical appliances in his house consume a total of 5 kW. At present, he uses a diesel generator which consumes 8 litres of diesel daily. In order to ensure that there is continuous power supply, the generator is serviced once every three months; a process which cost N5,000.00 for materials/parts and N4,000.00 for labour. The cost of diesel is N165.00 per litre. Apart from the quarterly servicing, some parts are replaced once a year and it cost N10,000.00. The cost of purchase of the generator is N1,200,000.00 while its installation cost is N5,000.00. It should be replaced every 4 years. To replace the generator with a solar system and still enjoy the same level of power supply as with the generator, PV panel of cost N110,000.00, eight 200 AH battery of N140,000.00 per battery, a solar charge controller of cost N22,000.00 and a 7.5 kW off-grid inverter of cost N550,000.00 are required. Installation cost of the PV system is N25,000.00. The batteries have to be replaced every 7 years while the PV panels are replaced every 16 years. Once installed, no maintenance is required.

Considering the above, advice your friend. Base your decision on the economics of the systems over a 15 year period. *ASSUME AN INFLATION RATE OF 15% AND INTEREST RATE OF 19%.*

2. Find the total radiation on a receiver surface between 11:00 am and 12:00 noon local time in Owerri, Nigeria on the 15th day of February. The receiver surface is inclined at an angle of 5.49° to the horizontal. The measured monthly average daily total radiation on a horizontal surface for Owerri is 20.06, 20.37, 19.55, 18.20, 16.85, 15.06, 13.55, 13.27, 13.87, 15.36, 17.52, 19.07 MJ/m²/day for January – December, respectively. If during test between 11:00 and 12:00 noon of the said day, a solar air heater was able to heat air initially at ambient temperature of 30°C to 45°C at a mass flow rate of 0.002 kg/s, calculate the efficiency of the solar air heater for the hour. Make any necessary and reasonable assumption.