Solar Panel Energy Analysis

MENG 4349 - Introduction to Renewable Energy Systems

Group 1

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I certify that the narrative, diagrams, figures, tables, calculations, and analysis in this report are my own work.

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PROBLEM GIVEN

Problem Motivation: The availability of energy has become an important part of our society. In this and related problems, we will discuss issues of energy consumption, energy reserves, and energy related emissions. Furthermore, we will analyze conventional and alternative energy systems. A particular emphasis will be placed on the generation of hydrogen for use in fuel cells for transportation and/or stationary applications.

GIVEN DATA

Electrolysis unit efficiency = 60%

Area for solar panel = 70x40 in^2

Time	**Power (W)**	**Time**	**Power (W)**	**Time**	**Power (W)**	**Time**	**Power (W)**	**Time**	**Power (W)**
6:00	0	9:15	22	12:30	17	15:45	155	19:00	29
6:15	0	9:30	29	12:45	6	16:00	149	19:15	12
6:30	0	9:45	108	13:00	3	16:15	146	19:30	19
6:45	0	10:00	117	13:15	20	16:30	138	19:45	16
7:00	1	10:15	121	13:30	121	16:45	128	20:00	16
7:15	1	10:30	142	13:45	170	17:00	119	20:15	12
7:30	1	10:45	100	14:00	182	17:15	109	20:30	9
7:45	2	11:00	64	14:15	170	17:30	99	20:45	7
8:00	3	11:15	84	14:30	102	17:45	86	21:00	0
8:15	5	11:30	92	14:45	24	18:00	75		
8:30	13	11:45	59	15:00	56	18:15	63		
8:45	31	12:00	78	15:15	177	18:30	51		
9:00	12	12:15	27	15:30	164	18:45	39		

Table 1. Instantaneous measurements amount of electrical power generated for a cloudy day.

ANSWERS

A) Determine the cumulative electrical energy produced in kW-hr

$$E = \int_{sunrise}^{sunset} P(t)dt \sim \sum_{i=2}^{N-1} \frac{1}{2}(P_i + P_{i+1})\Delta t \quad (1)$$

$$E = \int_{sunrise}^{sunset} P(t)dt \sim \left(\frac{1}{2}P_1 + \frac{1}{2}P_N + \sum_{i=2}^{N-1} P_i\right)\Delta t \quad (2)$$

Using the equation with the data given we calculate and find that

$$950W \cdot hr = \mathbf{.950\ kW \cdot hr}$$

B) Determine the fraction of energy produced compared with the sunny day from the example problem.

$$\frac{950W \cdot hr}{} \cdot \frac{3600s}{hr} \cdot \frac{\frac{J}{s}}{W} = \mathbf{3.42 \cdot 10^6 J} \quad (3)$$

Converting the energy produced in kW-hr into J we can compare the energy produced in Joules on a sunny day ($\mathbf{5.28 \cdot 10^6 J}$) and a cloudy day ($\mathbf{3.42 \cdot 10^6 J}$). Finding the difference in the energy produced to be $\mathbf{1.86 \cdot 10^6 J}$ more on a sunny day.

C) An electrolysis unit operates at 60% efficiency. If the theoretical amount of energy needed to convert 1 mol of liquid water into 1 mol of hydrogen and ½ mol of oxygen is 285 kJ, determine the mass of hydrogen produced in g for one day.

$$\frac{3.42 \cdot 10^6 J}{} \cdot \frac{kJ}{1000J} \cdot \frac{mol}{285kJ} \cdot \frac{2g}{mol} = \mathbf{14.4\ g} \quad (4)$$

D) If each solar panel has 70x40 in^2 (see Table below), determine the number of panels and solar surface area in ft^2 required to supply 1 kg of hydrogen on cloudy days.

$$\frac{.950kW \cdot hr}{14.4g} = \frac{x}{1000g} \quad (5)$$

$$\mathbf{x = 65.97\ kW \cdot hr}$$

$$\frac{65.97kW \cdot hr}{.950kW \cdot hr} = 69.44 \approx \mathbf{70\ panels} \quad (6)$$

According to the given data, each panel has an area of 70x40 inches^2 which calculates to 19.44 ft^2. The area required for 70 panels will then be found as

$$70 \cdot 19.44\ ft^2 = \mathbf{1360.8\ ft^2} \quad (7)$$