**Laboratory 9: Simple Solar System Model**

**BSEN 5250/6250**

The purpose of this laboratory is to develop a simple solar system model following the procedures given in class. An initial spreadsheet containing initial system parameters and one year of weather data can be found on the Canvas site under \files\Labs\Lab 9-Simple Solar System.xlsm. This is a simple model that can be developed in Excel (rather than VBA).

**Sequence of Calculations**

1. Convert daily energy from the sun (MJ/m2/day) to Watt-Hours (WH/m2).
2. Convert WH/m2 received by the solar panel into Amp-Hours (AH/m2) into the battery bank.
3. Reduce AH/m2 into battery bank due to solar panel efficiency.
4. Compute total AH into the battery bank from the solar panel by multiplying by solar panel area.
5. Compute battery AH output due to daily load.
6. Compute battery bank AH balance state variable.
7. If AH balance in the battery bank exceeds battery storage capacity, set battery storage to the storage capacity and (Step 8) compute AH to be sold to the Grid today. The amount of power to sell to the grid is the difference between the computed battery bank storage today and the maximum battery bank storage capacity.

**Hint:** When computing the battery balance state variable in Step 6, The Bt term should come from the adjusted battery storage from the previous day in column L rather than the previous day’s battery balance in column K. The previous day’s battery storage in column K can exceed the maximum storage capacity of the battery bank, while the adjusted value for battery storage in column L never exceeds the battery bank storage capacity. Column L contains the final adjusted Bt value for the previous day.

**Question 1.** Assume the cost of a battery is $120 and the cost of a panel is $150. Study the “Solver Constraint Function” section of the spreadsheet. This section computes the minimum battery storage over the year, as well as 50% of the storage capacity of the battery bank. Look at the “Solver Objective Function” box in the spreadsheet. This box computes the total cost of panels and batteries. Use ***Solver*** to determine the best number of panels and batteries for the system by minimizing total cost and meeting the battery storage constraint. The Battery Bank storage should never drop below 50% of the total battery storage during the year (constraint). Develop a graph of battery and panel number vs daily load for loads ranging from 10 to 100 AH in increments of 10 AH. Add the graph as a separate tab in the spreadsheet. In order to set the daily loads, you can simply type in the desired daily load in cell F21 or find a combination of loads that gives the desired total daily demand. Note that Solver will give fractional panel and battery solutions. Round the number of panels and batteries up to the next integer value for the table below.

|  |  |  |
| --- | --- | --- |
| Daily Load, AH @ 120 V | Number of Panels | Number of Batteries |
| 10 |  |  |
| 20 |  |  |
| 30 |  |  |
| 40 |  |  |
| 50 |  |  |
| 60 |  |  |
| 70 |  |  |
| 80 |  |  |
| 90 |  |  |
| 100 |  |  |

**What to turn in:** Fill in the table for Question 1, add your graph as a separate tab in your spreadsheet, then upload this form and your spreadsheet to Canvas.