Running on Renewables

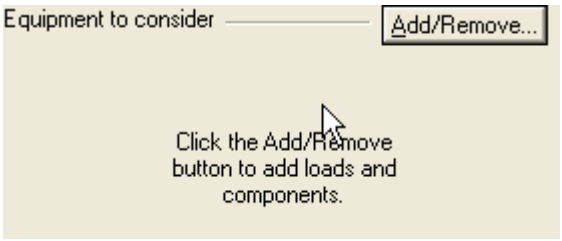
Student Handout (Track 2): A Step-by-Step Guide to Using HOMER

Getting Started:

1. Open the HOMER program on your computer.
2. Select the New File Icon to create a new file. HOMER will create a blank schematic window as on the left of your screen.

■ PART 1: Building your Schematic

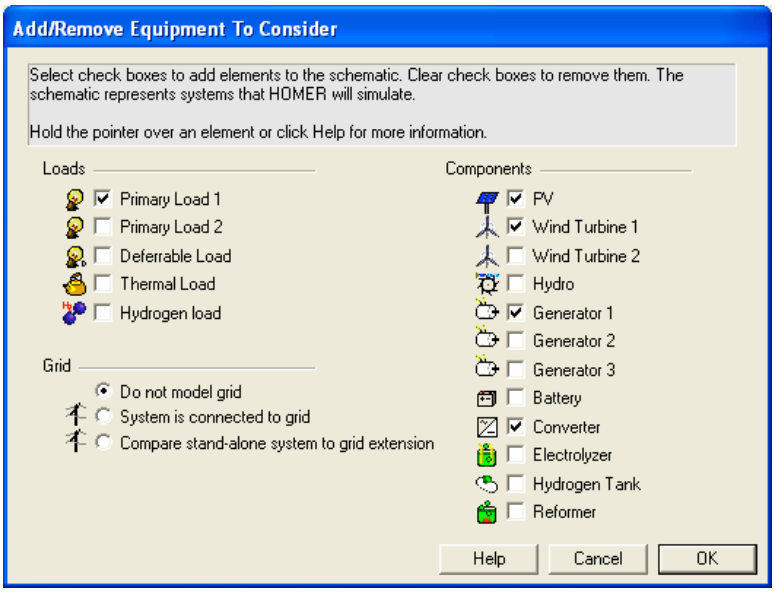
1. Click on the Add/Remove Button to build your schematic. Note: Your schematic will allow you to select your components to best answer your question: "How does the addition of a Photovoltaic (PV panels) and a wind turbine assist our schools energy usage?" Keep in mind that HOMER will consider all options and pick the best optimal design.



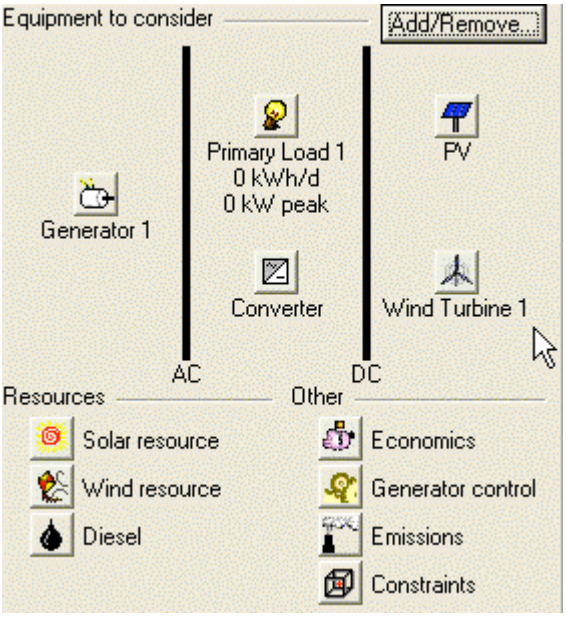
2. Check the box next to **Primary Load 1** under the heading "Loads".
   Note: Every system must be assigned to one of the following, a Primary Load (a description of the energy demand), a Deferrable Load, or be connected to the grid.

3. Check the boxes for **PV** (Solar Cell), **Wind Turbine 1**, **Generator 1** and **Converter**.

4. Click "OK" when finished to return to the Main window.



From the **Main Window** you will notice that HOMER displays buttons with your components and your load requirements. Also notice in the Resource section display buttons for your solar, wind and diesel resource appear.



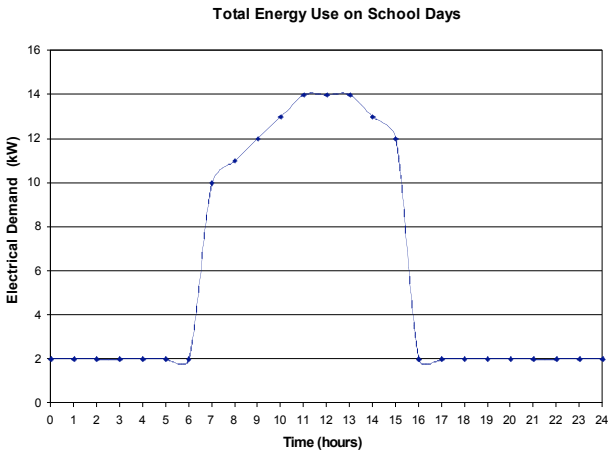
■ PART 2: Assigning your System's Load

A key piece of information for the model is your school's electricity load—the electricity demand of the system at any one time.

1. Next you will assign Load inputs for your system. Click on the Primary Load 1 Icon. 

2. Select **AC** as your load type.

3. Next you will enter information explaining the average kW of energy used for each hour of the day in your school. Keep in mind that the normal hours for a school are approximately 7:00 a.m. to 4:00 p.m. as shown on the chart to the right, your school uses the most energy during these times. (Note: Military time is used; i.e. 1:00 p.m. = 13:00) Type in the following data into the baseline data chart.



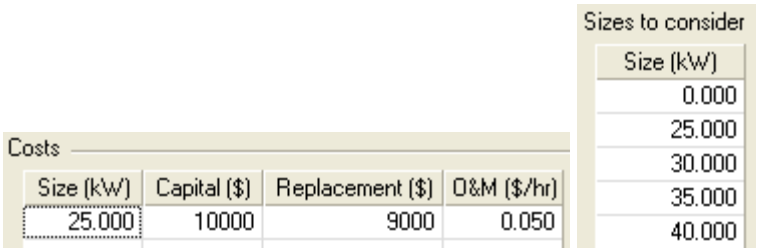
Hour	Load (kW)	Hour	Load (kW)
00:00 - 01:00	2.000	12:00 - 13:00	14.000
01:00 - 02:00	2.000	13:00 - 14:00	14.000
02:00 - 03:00	2.000	14:00 - 15:00	13.000
03:00 - 04:00	2.000	15:00 - 16:00	12.000
04:00 - 05:00	2.000	16:00 - 17:00	11.000
05:00 - 06:00	2.000	17:00 - 18:00	2.000
06:00 - 07:00	2.000	18:00 - 19:00	2.000
07:00 - 08:00	10.000	19:00 - 20:00	2.000
08:00 - 09:00	11.000	20:00 - 21:00	2.000
09:00 - 10:00	12.000	21:00 - 22:00	2.000
10:00 - 11:00	13.000	22:00 - 23:00	2.000
11:00 - 12:00	14.000	23:00 - 00:00	2.000

4. After entering the data click "OK", this will close the primary Load Window.

■ PART 3: Details for Components

Generator 1 

1. Click on the Generator 1 icon  to open up the "Generator Inputs" window. Input the following information into your table:



Costs

Size (kW)	Capital ($)	Replacement ($)	O&M ($/hr)
25.000	10000	9000	0.050

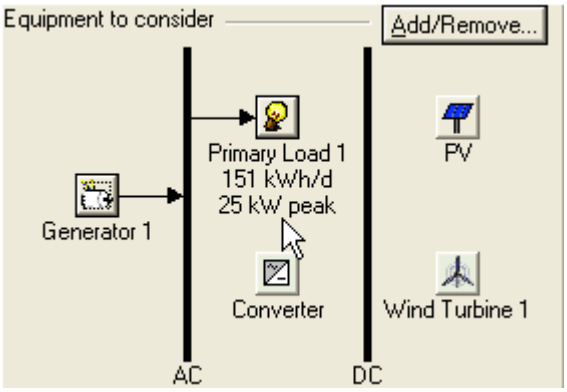
Sizes to consider

Size (kW)
0.000
25.000
30.000
35.000
40.000

- These numbers tell HOMER that for the generator's size it will produce 25 kW of energy. The generator costs $10,000 and to replace it would cost $9,000. It also costs 5 cents an hour to operate and maintain your generator.
- In the "Size to consider" table HOMER will consider generators that produce 0, 25,30,35 and 40 kW of electricity, thus a 50.000 kW generator will cost twice as much as your 25.000 kW generator.

2. Click "OK" to return to the Main Window.

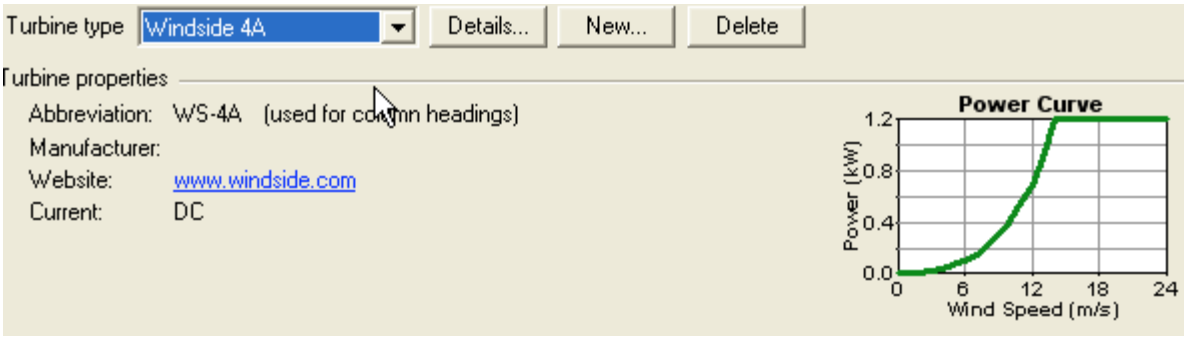
   You will now notice that the arrow connects the generator 1 to the AC load and shows the direction of energy flow to the Primary Load 1. Also your system produces 151 kilowatt hours per day, and 25 kilowatts at it peak.



Wind Turbine

1. Click on the Wind Turbine icon to open the "Wind Turbine Inputs" window.
2. From the drop down list click through the wind turbines and look at the power curve that is shown on the right side of the screen. Try to find a Wind Turbine that would best maximize your Average Wind Speed (m/s) from your PA city found on your Student Worksheet Track 2, Question 3 and choose that Turbine.

    b. From the example below we can see that the Windside 4A turbine produces 1.2 kW of energy when the Wind speed is at 14m/s. Would this Turbine we a good choice for PA? Probably not since it maximizes its performance at 14m/s.



9. After choosing your Wind Turbine input the following values in for the Costs:

Costs

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1	30000	25000	500

Sizes to consider

Quantity
0
1
2
3

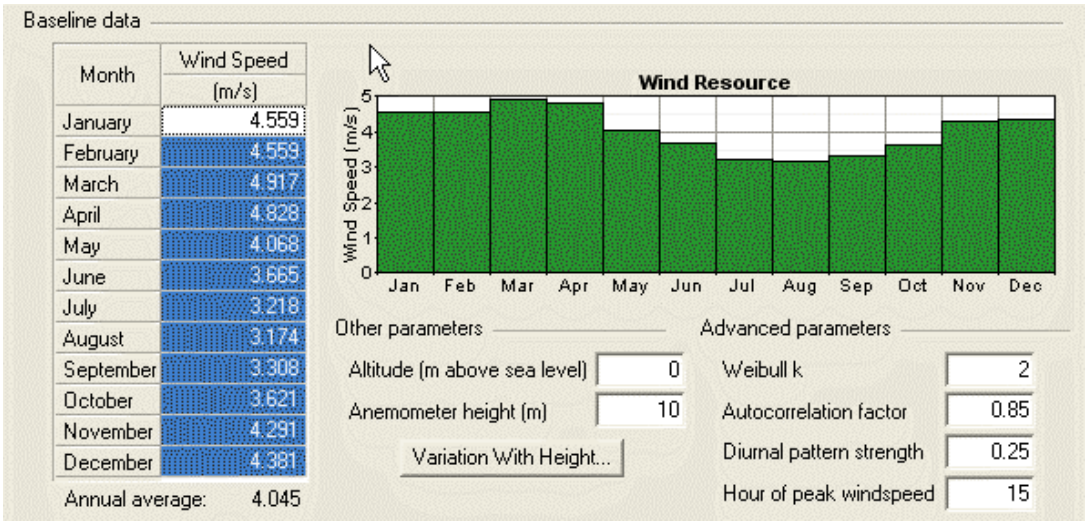
7. Click "OK" to return to the Main Window.

Wind Resource Data

1. Click on the Wind Resource icon to open the Wind Resource inputs window.

2. For Data Source select "Enter monthly averages"

3. Next, type in your monthly data from your Student Worksheet Track 2, Question 2 for Wind Speed (m/s). (Please refer to your chart for your cities Wind Speed (m/s)).You will also notice that HOMER creates a Wind Resource graph on the right.



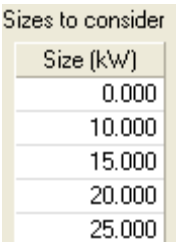
4. Click "OK" to return to the Main window.

Photovoltaic

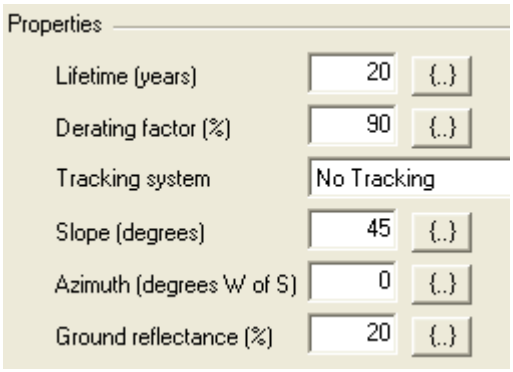
1. Click on the Photovoltaic icon to open up the "Photovoltaic Inputs" window.

2. Input the following information into your Costs table:

3. Input the following values for the Size in kW of your Photovoltaic:



4. Under the Properties for Slope (degrees) type in 45, this will simulate the pitch of the roof of your school.



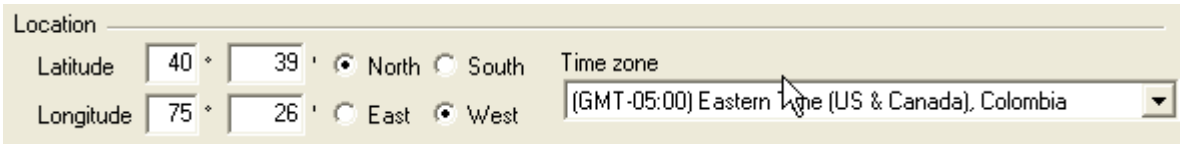
5. Click "OK" to return to the Main Window.

Photovoltaic Resource Data

1. Click on the Solar Resource icon to open the Solar Resource inputs window.

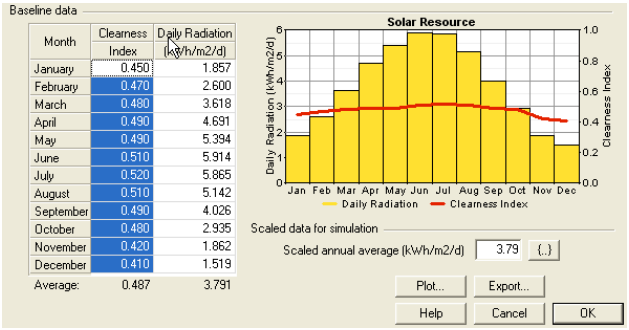
2. Type in your latitude and longitude data from your Student Worksheet Track 2 Questions 4-5 into HOMER, and choose the Eastern Time Zone, US & Canada from the drop box:

   For example: Allentown has a latitude of 40°, 39 North, and a longitude of 75°, 26 West as shown below.



3. For Data Source choose to enter monthly averages.

4. Next type in the your data from your Student Worksheet #1, question 6 for Clearness Index (Kt) and the Daily Radiation will be automatically calculated by HOMER, you will also notice that HOMER creates a Solar Resource graph on the right.



5. Click "OK" to return to the Main window.

Converter

A converter is used to convert DC current to AC current which can be utilized by your school.

1. Click on the Converter icon to open up the "Converter Inputs" window.
2. Input the following information into your Converter Cost table:

Costs

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
5.000	4000	4000	0

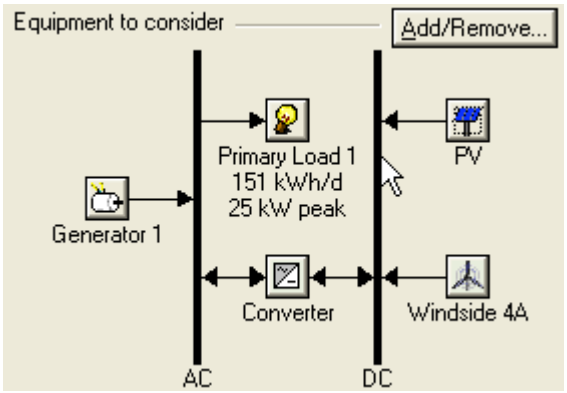
3. Input the following values for the Size in kW of your Converter:

Sizes to consider

Size (kW)
0.000
5.000
10.000
15.000

4. Click "OK" to return to the Main Window.

5. You are now finished entering your components. The schematic should like as follows:



In looking at the schematic above, please write a brief explanation of the way the energy is flowing in the system in the box below:

■ PART 4: Assigning Resource Details

The resource data that you will now input will tell HOMER the availability of solar radiation and wind for each hour of the year.

Diesel Resource 

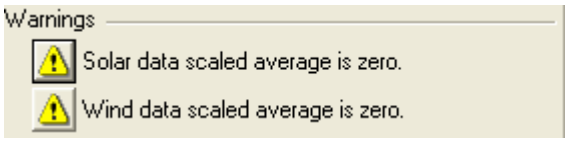
1. Click on the Diesel icon. 
2. Look at the chart from your Student Worksheet Track 2 Question 7 and change the fuel price to _____ per liter based on the current cost of Diesel per gallon in your town.

3. Click "OK" to return to the Main window.

■ PART 5: Checking for Errors

Homer may give you a warning if any of the data that has been inputted is not correct.

If you see a box like the following within HOMER:

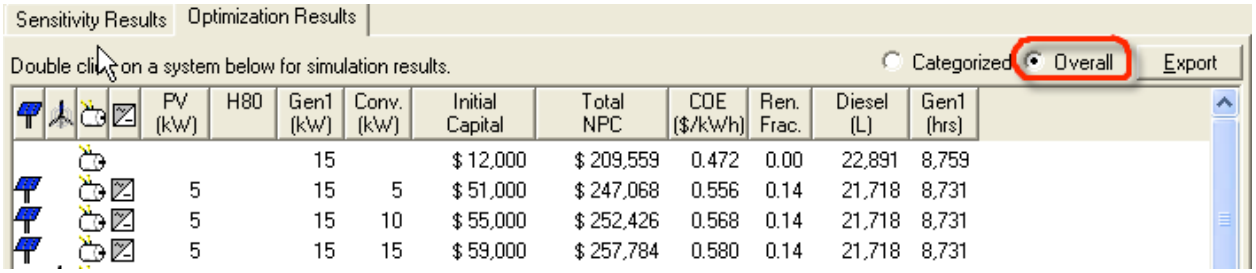


1. Click the Warning Icon to view a more detailed message.  Follow the hint to correct the error.
2. Continue until all warning icons have disappeared.

■ PART 6: Analyze the System and Examine the Results

You have just completed setting up HOMER, the software is now ready to calculate and analyze your data to see what is "the best" energy system for your school from least to most expensive. Whether it recommends that your school would benefit from a single solar panel or the installation of a wind turbine….let's sit back and see.

1. Click Calculate  to start the calculation.
2. After the simulation runs click on the "Overall button" to view all possible combinations for each component in the "Optimization Results" window.



PV (kW)	H80	Gen1 (kW)	Conv. (kW)	Initial Capital	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Gen1 (hrs)
		15		$ 12,000	$ 209,559	0.472	0.00	22,891	8,759
5		15	5	$ 51,000	$ 247,068	0.556	0.14	21,718	8,731
5		15	10	$ 55,000	$ 252,426	0.568	0.14	21,718	8,731
5		15	15	$ 59,000	$ 257,784	0.580	0.14	21,718	8,731

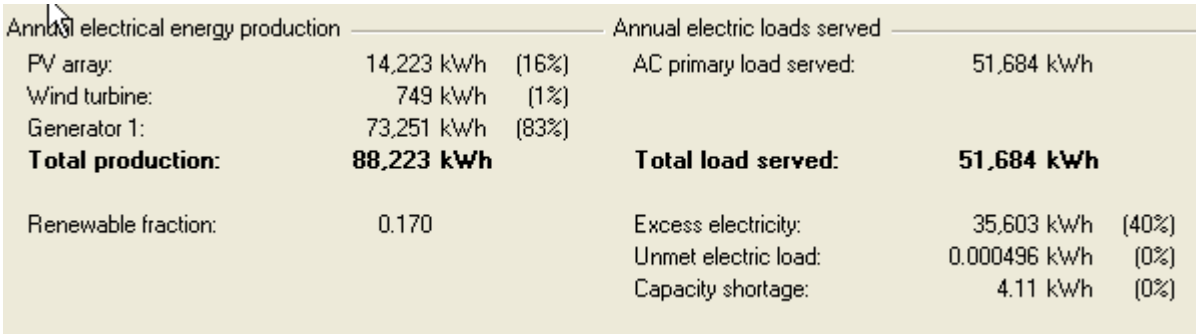
3. Next click on the "Overall" button in the "Optimization Results" window. This will show you the least expensive option for each different component configuration (e.g., diesel with PV cells, or PV cells with wind turbines).

4. Next choose a system of interest by double-clicking on one of the configurations to open up the "Simulation Results" window, where you can see the complete results of HOMER's analysis.

5. You can explore the results for each of the configurations in the "Categorized" view to determine Cost, Electrical energy production, the efficiency of the generator, and the pollutants created under emissions buy clicking on the different tabs.

6. Double click on a simulation that has all 4 components of the system, a PV cell, a wind turbine, a battery, and a converter.

7. Next Click on the Electrical Tab. You should see a window like the one shown below:



8. Notice that this system relies mostly on the generator for electricity at 83%, next the PV array is 16% and the wind turbine at 1%

Please complete the rest of your Student Worksheet Track 2 from the information calculated by HOMER.