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Name: _____
Date: ____ / ____ / ____ Class Hour: ____

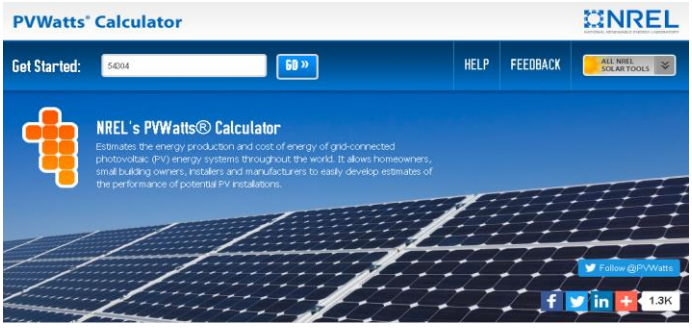
SOLAR LOCATION ANALYSIS:
THE PV WATTS® CALCULATOR

Student Activity Guide

INTRODUCTION:

Until recently, it was difficult to make a good estimate of how much energy a solar PV system might be able to produce at a given location unless you had specialized training in solar PV technologies. However, an interactive web application developed by the National Renewable Energy Laboratory (NREL) called the PVWatts® Calculator has solved this problem. The PVWatts Calculator enables anyone with internet access and a little education to come up with location-specific preliminary performance estimates for potential solar PV installations.* With PVWatts, solar installers, solar manufacturers, investors, homeowners, people who are curious, and students like you can now estimate the electricity production of a grid-connected solar PV system for many places across the globe with a few simple input prompts.

In this lesson you'll be introduced to, and then learn how to use the PVWatts Calculator. Along the way you'll become acquainted with important solar system terminology, information, economics and production data. Using PVWatts you'll record solar PV production data from several locations and graph that data. Finally, you'll close the activity by using the graphs you made to draw important conclusions and summarize what you've learned about the science of locating a solar PV array.



*** Important Note i**ncluded here from NREL's PVWatts Calculator website:

"PVWatts® is suitable for very preliminary studies of a potential location for a photovoltaic system that uses crystalline silicon or thin film photovoltaic modules. The production estimates that PVWatts® calculates do not account for many factors that are important in the design of a photovoltaic system. If you are using PVWatts® to help design a system, you should work with a qualified professional to make final design decisions based on an assessment of the system location and using more detailed engineering design and financial analysis tools."

Activity, Part 1

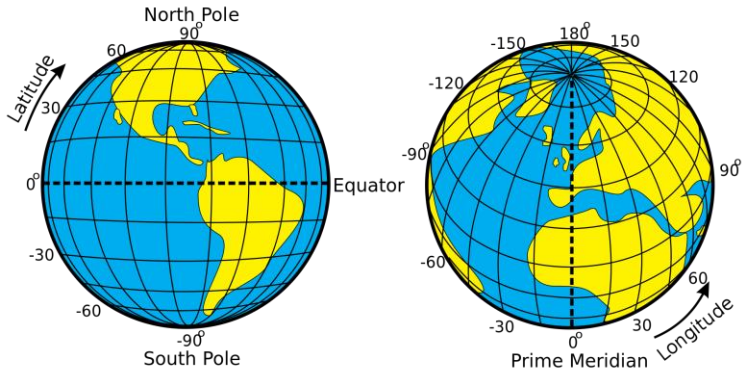
Develop definitions for the following terms according to your teacher's directions. Word-process your definitions into the **Student Response Guide** for this lesson.

Definitions for:

Latitude

Longitude

Figure 1.

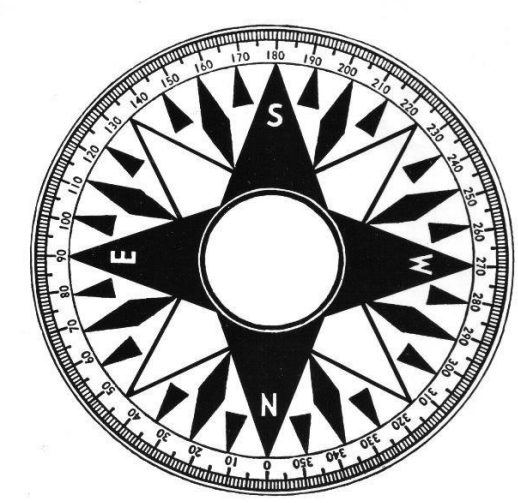


Definitions for:

Solar azimuth

Solar altitude or solar elevation

Figure 2.



Definition for:

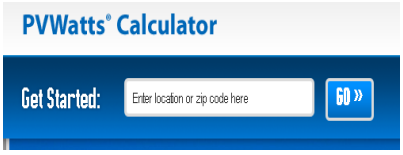
Solar tilt angle

Figure 3.

Activity, Part 2

1. Navigate to NREL's PVWatts Calculator: http://pvwatts.nrel.gov/

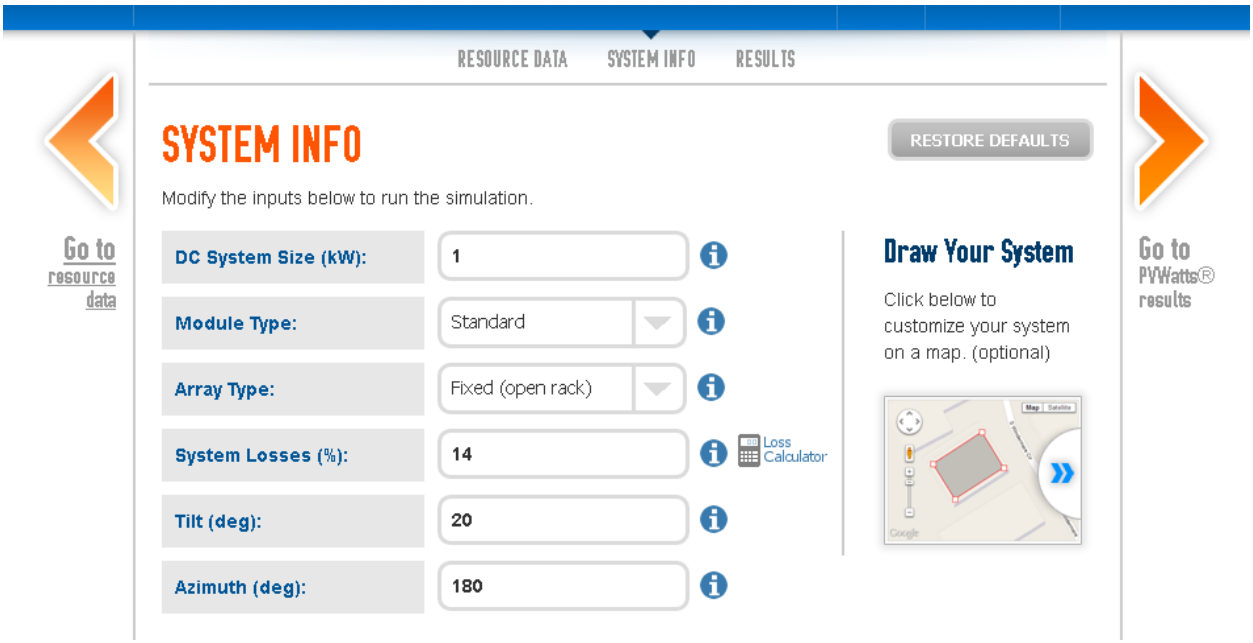
2. Enter your home address or zip code in the menu bar labeled **Get Started.** Then click on **Go**.



3. Clicking on **Go** will access the solar database and weather station(s) nearest to your location. This customizes the inquiry you're making for your location. Click on the Orange Arrow at the right of the screen to **Go to system info**.

4. Input solar PV system information for your location using this data:

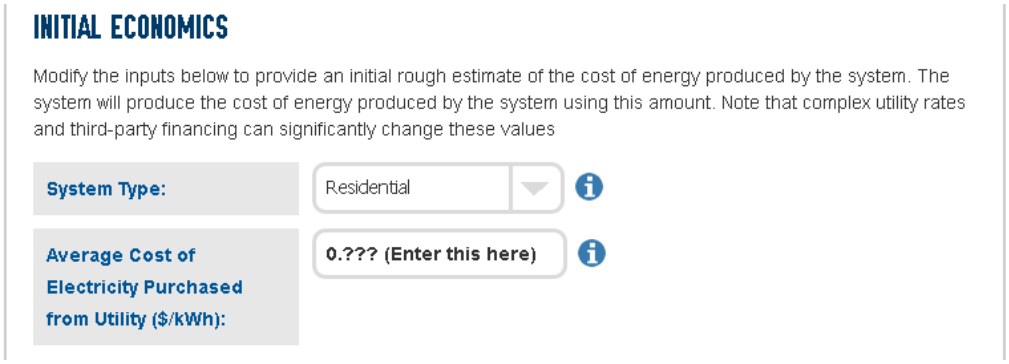
- System size = 1 kW
- Module Type = Standard
- Array Type = Fixed (Open Rack)
- System Losses = 14%
- Tilt = 20 degrees (the default value for a 4:12 pitch roof)
- Array Azimuth = 180 degrees (this is due south, the default value for a solar array in the northern hemisphere)



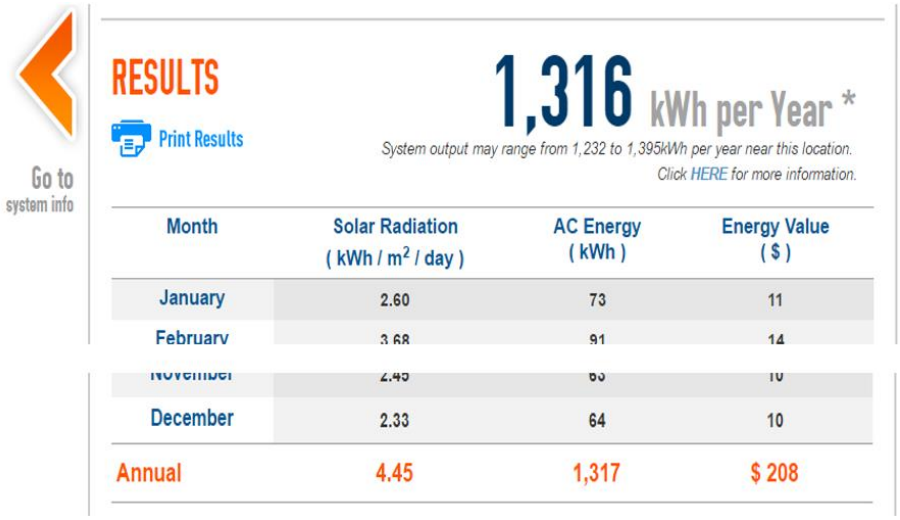
5. Scroll to **Initial Economics** at the bottom of the webpage. Here you'll enter the **Average Cost of Electricity Purchased from Utility ($/kWh)**.

- If you or your teacher know the current, utility-charged $/kWh number, input it here.
- Otherwise, navigate to the United States Energy Information Administration **State Electricity Profiles** webpage. Find your state's Average retail price for electricity and input it here. Here is the link to this EIA webpage: http://www.eia.gov/electricity/state/

6. Click the orange arrow to the upper right of your screen to **Go to PVWatts results**.



7. Examine your **Results** and how this page is organized. Soon you'll record information from the **Results** page into data tables provided by your teacher for this lesson. Open the **Student Spreadsheet** for this lesson now to make the data tables available to you. You'll produce several meaningful graphs from the data you collect.



8. Use the Orange Arrow on left of screen to return to the **System Info** input page for the PV Watts Calculator. In the **System Info** section, you'll vary the solar array Tilt Angle for the solar PV system at your location. Determine Annual energy data for tilt angles of 0, 5, 15, 25, 35, 45, 55, 65, 75, 85, and 90 degrees at a constant Azimuth of 180°. Record the **Annual AC Energy (kWh)** produced and the **Annual Energy Value ($)** for each tilt angle in the data table provided by your teacher for your location, **Location 1**. Use the orange arrows on the **System Info** and **Results** pages to systematically change the tilt and view the results you need to post each time to your data table. At the top of your first table (**Location 1**), enter your location, its latitude and longitude, and the cost /kWh of electricity at this location. Enter 180° as your Constant Azimuth for the part of the table where you are varying the tilt angle.

9. After entering all of the data into your table from step 8, return to the **System Info** input page for the PV Watts Calculator. Set the solar array Tilt Angle back to 20° for your location. You will now explore the effect of the solar array Azimuth on system performance. Determine the annual energy data for azimuth angles of 0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, and 330 degrees. Record each of these points and enter them into the same data table as before. Enter 20° as your Constant Tilt Angle for the part of the table where you are varying the azimuth.

Activity, Part 3

10. Now you'll compare a similarly sized system in Quito, Ecuador with your location. Change the location in PVWatts to Quito, Ecuador. Use the same **System Info** as before. However, you'll have to do some internet research to find your entry for the **Average Cost of Electricity Purchased from Utility ($/kWh)**. This may require you to use an international exchange rate currency converter.

11. Collect data for Quito the same way you collected data for **Location 1** (your location), but post it in the data table for **Location2**. Enter the necessary identifying information in the top of the table. Vary the Tilt Angle as before at a Constant Azimuth of 180°. Then vary the Azimuth as before at a Constant Tilt Angle of 20°.

12. Finally, choose another location in an area that interests you. Explore other continents, regions, climates, and countries. In the end however, choose a latitude that is quite different from your location and Quito. Enter this location into PVWatts and collect solar energy data for it just as you did for your location and Quito. Record your data into the table for **Location 3**.

Show What You Know

Return to the Student Response Guide now. Follow the instructions in the guide for producing graphs and answering questions to conclude **Solar Site Analysis: The PVWatts Calculator**.