ESA21
Environmental Science Activities for the 21st Century

Renewable Energy: Capstone

Introduction

Renewable energy is the key to a sustainable future. All other forms of energy will eventually run out, whether it is oil within the next century or coal within the next several hundred. At some point in the future, we will need to be totally reliant on renewable forms or else we will have nothing left to "burn".

Renewable energy is also a key to a sustainable future in that it has a much smaller environmental impact. The largest impact for many renewable forms is the damage done in getting the materials to make the machinery to harvest the energy. For some, the only other impact is aesthetic (ugly solar panels and noisy windmills); for others, the impact can be fairly large (river ecosystem converted to lake by hydroelectric). However, the overall impact is much smaller than fossil fuels or nuclear energy, which has large extraction and waste problems.

The drawbacks to using renewable energy are availability and economics. Some forms of renewable energy are not readily available in certain locations, such as solar panels in a cloud forest. In other locations, they might be available, but at a cost that makes them very uneconomical. Some forms of renewable energy are uneconomical no matter where they are placed.

Activity

In this capstone activity, we are going to look at the availability and economics of solar and wind power where you live. To do this, we are going to need maps of available sunshine provided by the U.S. government. We are also going to need to know the price of solar panels and wind turbines that are commercially available. Foremost, though, we are going to need to know how much electrical energy you use before we proceed to estimate the cost of using renewable energy.

Finding out how much electrical energy we use is actually quite easy. All that one needs to do is to either monitor their electric meter for some period of time, or review their electrical bills. Either of these two methods will give you an exact amount for how much electricity you use. However, this value will tell you nothing about the sources of your usage. It will also only tell you what your usage was for the past, which depended greatly upon conditions in the past such as the indoor and outdoor temperatures. What we really want is a way of estimating your usage in the future, and finding ways of controlling it. In order to do this, we are going to estimate how much usage you have by looking at the individual appliances in your home.

To help us in the venture, we are going to use the Home Energy Saver online calculator from the U.S. Department of Energy. This calculator allows one to make as detailed an estimate as one would like, or as general as possible. In order to have an estimate that is as accurate as possible, you will need to know some information about the appliances in your home, such as their wattage and the amount of time that they are turned on during an average week. If you cannot find that information, the calculator will allow you to choose national average values for wattages and time usage.

Using the calculator is quite simple. At the front page, put in your zip code. You will be sent to a page to enter some basic information about your home, such as the date that it was built, the amount of livable square footage, and the types of energy used. After filling out the appropriate slots on that page, click Save Answers. This will take you to another page that has links to various aspects about a home, such as water heater, lighting, etc. The calculator will also assign you a Session ID number, which you should write down on the activity sheet (the number is found next to the Calculate button). Clicking on each on

of these factor links will allow you to personalize the information about your home, such as what type of air conditioner you have and what are your temperature settings. After you have visited a link, the page will place a blue dot by that link to tell you that you have already filled in that information.

When you are all done with the factors, click the Calculate button. The server will then take some time (usually 20 seconds) to calculate the usage in your home and to present the information back to you in the form of a bar graph with dollar amounts for using the different components in your home. Information about the amount of electrical energy used can be received by clicking on the "See Greenhouse Gas Emissions and Energy Consumption" button. This will open a new window that contains the information. Use this information to fill in the activity sheet below.

Now that we have the approximate electrical energy usage per year, we are prepared to investigate the economics of using solar or wind energy in your present location. Let us start with solar energy. Use the annual solar radiation map from the National Renewable Energy Labs to find out the average amount of solar energy that strikes a 1-m^2 solar panel at your current location. Enter this value on the activity sheet and then multiply it by 365 days in order to calculate the amount of energy that is striking the surface in a year. Since most standard solar panels are only about 12% efficient, this number needs to be divided by 8 in order to calculate the approximate amount of energy produced by a 1-m^2 solar panel per year in your area. If this number is then divided into the total amount of electrical energy needed for you home, you will have estimated the area of solar panels that you need to meet your electrical needs for the year. Using current price estimates (either find this data yourself or ask your instructor) for solar panels then allows you to calculate the price of putting in solar panels.

After finishing filling in this data, answer the questions on the activity sheet. On the last question, you will be asked to re-visit the calculator to make changes in your home.

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Activity Sheet
Renewable Capstone

Name:

Session ID number: _____

Area	Kwhr	Therms	CO_2	Elect. Cost	Gas Cost
Heating					
Cooling					
Hot Water					
Major Appliances					
Lighting					
Miscellaneous					
Total					

Average Solar Energy (ASE) at your location = _____ kwhr/m^2
Average Solar Panel Output (ASPO) at your location = ASE/8 = _____ kwhr/m^2
Size of solar panel needed for your location = Total Kwhr (from table)/ASPO = _____ m^2
Average cost of 1-m^2 commercial solar panel = $_____

Estimated cost of home solar system = Size of solar panel x average cost = $_____

1) The average solar panel system should last about 25-30 years before it needs to be replaced. If you were to keep paying the same cost for electricity that you do now, how does the total cost of a solar system compare to what you will pay over that time span?

2) As oil prices continue to increase, it is expected that all energy costs will go up. If this happens, you can expect to pay more for electricity in the future. If the cost were to double over the next decade, how would this affect your answer to question 1?

3) If you used less electricity, you could put in a smaller solar system, thereby reducing your total cost. Go back to the calculator (remember your Session ID number) and make the following changes a) increase summer thermostat settings by 2 degrees, b) decrease winter thermostat settings by 2 degrees, c) reduce dryer loads to 0 (use a clothesline), and d) reduce dishwasher loads to 0 (wash dishes by hand). All of these changes will cost you no money. By how much did this decrease the amount of electricity you used? By how much did the size of your solar system decrease? Is your system more reasonable now?