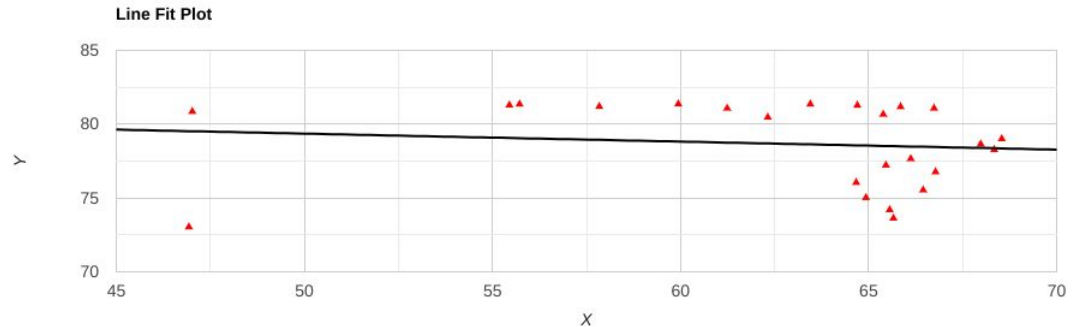
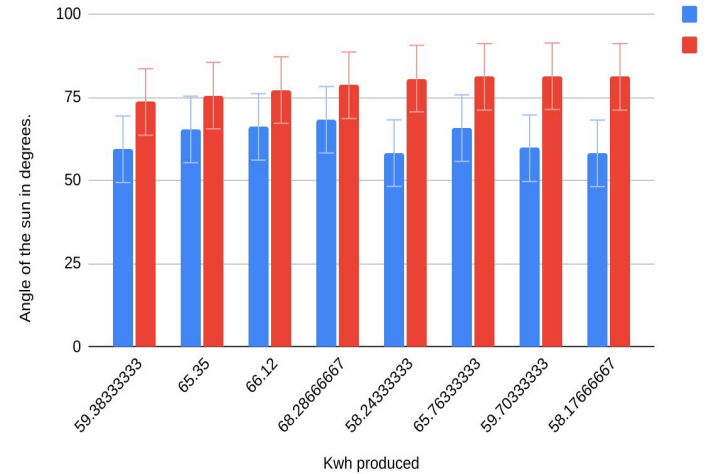


Chasing Sunshine: Finding the Perfect tilt for Solar power.

This project was done to see if the angle of the sun would affect the energy output of solar panels, according to my data the two variables have no correlation

This project is for areas using solar power to be able to get all the energy possible out of solar panels to minimize the need for fossil fuels.



Introduction

Energy is important for modern day life, an example of this is the U.S. Consumes around 81,642 kWh/capita per hour (Jager 20). Solar energy has proven to be one of the most popular and widespread sources of renewable energy. Many experiments have been done to test solar panels or compare two types of solar panels, or to see if solar panels are a viable option in certain areas or places. Solar panels are quite complicated in how they work, first photons release valence electrons on impact. This makes the electron create a small electric current, which makes electricity. This is a very simplified description of how solar panels work and different solar panels might work in different ways. Although there are no experiments that I can find on the specific question I am asking, there are experiments trying to find the optimal tilt angle for solar panels to get the maximum amount of solar radiation. For example, an experiment done by Sethi, Sumathy, Yuvrajan, and Pal finds the maximum energy output at multiple latitudes influenced by the swing angle of the sun. They found out that less energy was gathered by a solar panel during months that did not have as much direct sunlight compared to months that did. Another experiment done by Roshan R. Rao, H. R. Swetha, J. Srinivasan, and Sheela K. Ramasesha compares two different solar panels, one on a fixed axis at 13 degree north latitude and the other on a dual axis tracker, which is technology that is used to track the sun. d the results were the panels on a dual axis tracker generated 21% more electricity compared to the

Questions and problems.

Researchable question:

How does the angle of the sun affect the energy output of solar panels?

Hypothesis:

As the angle of the sun increased, energy output of the solar panels would increase, and as angle of the sun decreased, energy output of the solar panels would decrease

Procedures

Procedures

1. Log into the My Solar Edge app
2. Look in the top right where it says “production today”, this will give energy made that day.
3. Check for weather, if the sun is blocked for more than 5 hours do not take any data that day
4. Record the total energy and put the data into one column in google sheets every Monday, Wednesday, and Sunday.
5. On Monday, Wednesday, and Sunday, measure the angle of the sun using shadows, this is done with a ruler and then take the vertical measurement and divide it by the shadow measurement, ('b' divided by 'a') at the exact same time everyday, at 4:30 PM
6. Put the angle of the sun in google sheets in a separate column
7. Every Sunday, average the amount of energy made by the solar panels using the data collected, this is done using the google sheets function “average” and selecting the 4 values, this will average the values.
8. I Averaged the angle of the sun the same way I averaged the energy output.
9. Compare how much the angle of the sun either increased or decreased to the percent change overtime for energy output.

Materials

Materials:

Solar panels

phone / electronic device

My solar edge app

Laptop

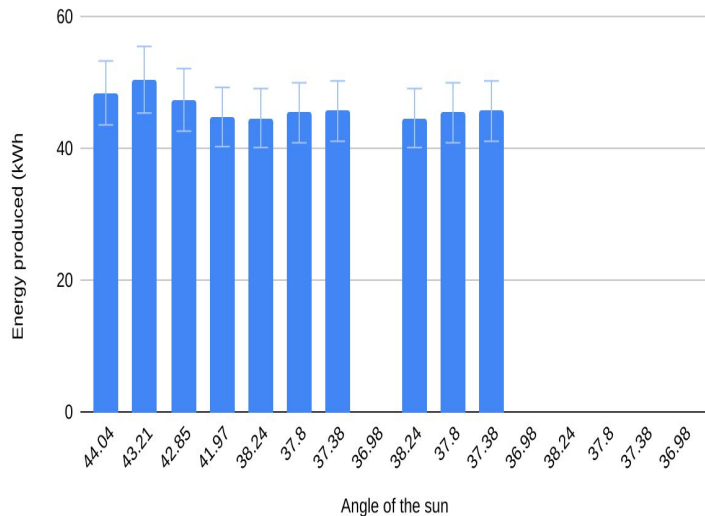
Google sheets

Round 1 data table and chart

1. On the graph both Kwh produced and angle of the sun went down showing a correlation
2. Kwh has less data on table because of the app used to collect data not working.
3. Kwh averages and angle of the sun averages both went down.

	Angle of the sun averages	Energy produced kWh on average
Summary table	43.0175	44.86
	40.82	39.99
	38.3	
	37.6	
Standard deviations:	2.477261908	3.443610024

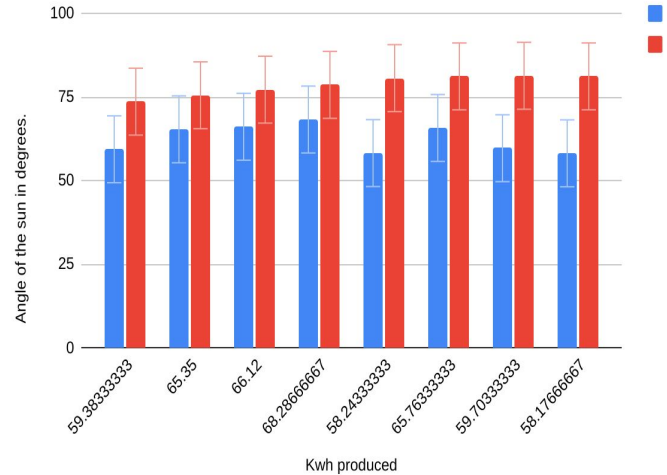
How angle of the sun affects energy produced



Round 2 data tables

1. Both the summary table and the graph show no correlation between the Kwh and angle of the sun values, which did not support my hypothesis.
2. There were many outliers in the data which is most likely the reason for the two variables having no correlation.

Summary table	Angle of sun averages:	Kwh's produced
	73.62333333	59.38333333
	75.53666667	65.35
	77.21666667	66.12
	78.64333333	68.28666667
	80.66666667	58.24333333
	81.18	65.76333333
	81.36333333	59.70333333
	81.19	58.17666667
	2.959012464	4.133061435



Results of the experiment

As a result of both rounds, trial 1 supported my hypothesis and trial 2 did not. In round 1, despite having half the data needed for Kwh produced, it still had a downward slope similar to angle of the sun. In round two, there was no correlation between angle of the sun and Kwh produced. The website used to measure angle of the sun was very reliable but the website used for kwh produced was extremely unreliable at times and could be the reason there was no correlation between the two variables on round 2.

Ideas for further research

This project could have helped people maximize the energy gained from solar panels meaning less fossil fuels that have to be used. For further research you could just change the angle of the solar panels themselves meaning you can see what angle is best for what season, time, etc. Overall this project was done to find a way to make solar panels more effective.

Resources

- [1] Benganem, M. “Optimization of tilt angle for solar panel: Case study for Madinah, Saudi Arabia”, *science direct*. version 4, vol. 88, issue 2, Department of Physics/Elsevier, April 2011, Madinah, Saudi Arabia.
- [2] Holland P. G. “On calculating the position of the sun”, *google scholar*, vol. 9, issue 11, Taylor and Francis online, March 2011.
- [3] Jager, Klaus. *solar energy, infobooks*, Olindo Isabella, Arno smets, Rene Van Swaaji, Miro Zeman Delft University of technology, 2014
- [4] Rao, R. R. “Comparison of performance of solar photovoltaics on dual axis tracker with fixed axis at 13°N latitude”, *Ebscohost*, vol. 108, no. 11, June 2015, current Science.
- [5] Rizk “J. Solar Tracking System: More Efficient Use of Solar Panels” *google scholar*, Chaiko Y. World academy science, 2018.
- [6] Sethi, V.P. “Maximum power output of a solar PV module at various latitudes as influenced by the swing angle of the sun”, *Ebscohost* v. 33, n. 3 *International Journal of Sustainable Energy*,
- [7] Wardhana A S J. “The Effect of Inclination Angle of The Solar Panel on The Resulting Output Voltage”, no . 211, January 2023 *Phys: Conf. Ser*.
- [8] West Micheal. “Solar Energy Basics ... and More”, *Florida cooperative extension service*, June 1993, Florida