The Effect of Particulate Matter on Solar Energy

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Abstract

This GLOBE project investigates the effect of PM (particulate matter) on solar panel output. Based on the listed graphs, there is a weak correlation between PM 2.5 and solar output. PM 5.0 has a correlation of 0.3, which is weak, and in PM10, it is apparent that 0.23 is the correlation, which is also weak. Though there was little correlation seen between PM and kWh, this does not mean there isn't one. The purple air was stationed on a roof, so there is a chance it did not gather all the larger PM due to larger PM being heavier and residing closer to the ground.

Main Statement

There does not seem to be a significant correlation between particulate matter and solar output. The effect on solar panel output is hard to notice when looking at a graph or raw data numbers for analysis.

Introduction

How does particulate matter affect solar panel efficiency? The purpose of this research project is to find the relationship between air quality and solar panel outputs. One of the best sources showed that there is an effect of particulate matter deposition on solar panel efficiency (Kim, 2024). Air pollutants have become a serious environmental problem in recent years. Not only does it affect living creatures, but it also impacts the energy output of solar panels. Due to a rise in the amount of air pollutants, due to increased carbon emissions. The particulate matter in the air is acting as a barrier,

blocking sunlight from reaching the panels. This issue can cause a lot of energy to be wasted because of the increase in carbon emissions (Chandler, 2019).

Hypothesis

Air quality, specifically particulate matter, will have a negative effect on the output of solar panel arrays. This will occur because the particulate matter will deposit onto the panels and block light from reaching the lower levels of the panel (Roumpakias, Stamatelos, 2020).

Objective

To find the relationship between particulate matter and the output of solar panels in kWh.

Methods

- Bring the iPad and engineers notebooks to record data.
- Go onto the roof for a good connection with the sensors and to check on the sensors and solar panel array, done at 9-10 AM.
- Use the Davis app and Purple Air website to get PM1, PM2.5, PM5, and PM10.
- Use the APsystems website to get kWh data from the solar panel array output.
- Ensure the data is accurate and correct.
- Use a graphing website such as StatsBlue and graphs on Google Sheets to create a graph and analyze the data that was collected.

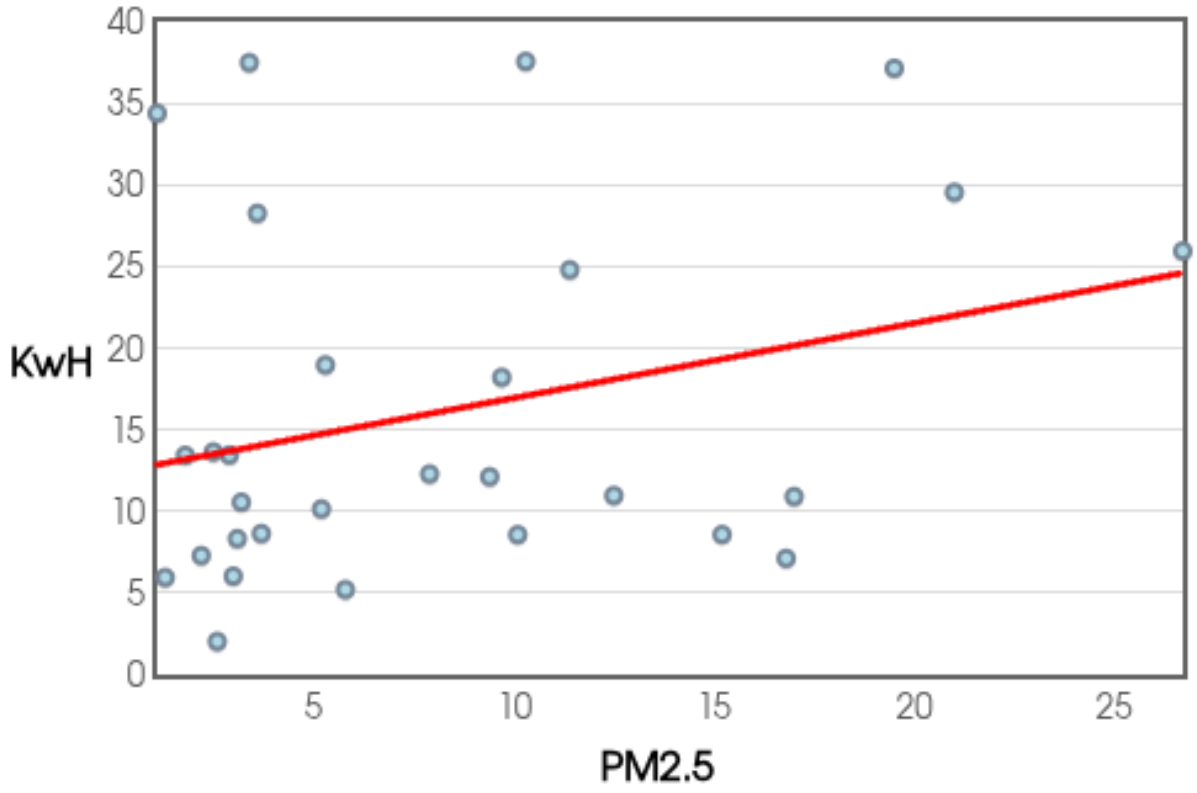
Results

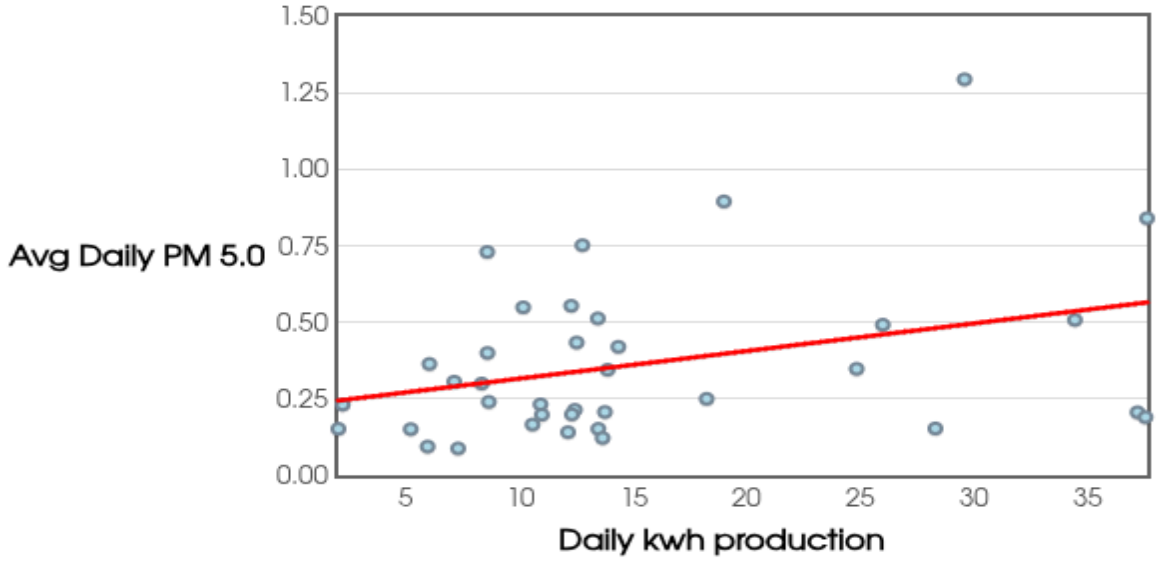
There appears to be a weak correlation between particulate matter and kWh of solar

energy. The PM2.5 likely does not affect the solar panels unless it is at a very high level. PM5 or PM10 appear to have a weak correlation of around 0.23 - 0.3, this is likely because they are larger particles. The particulate matter levels around the school appear to be low enough to not deposit a significant amount of particulate matter onto the panels or block the sunlight. Some parameters, such as temperature, humidity, and clouds, might have a larger and more noticeable effect on the solar output than particulate matter does (Shaik, et al, 2025).

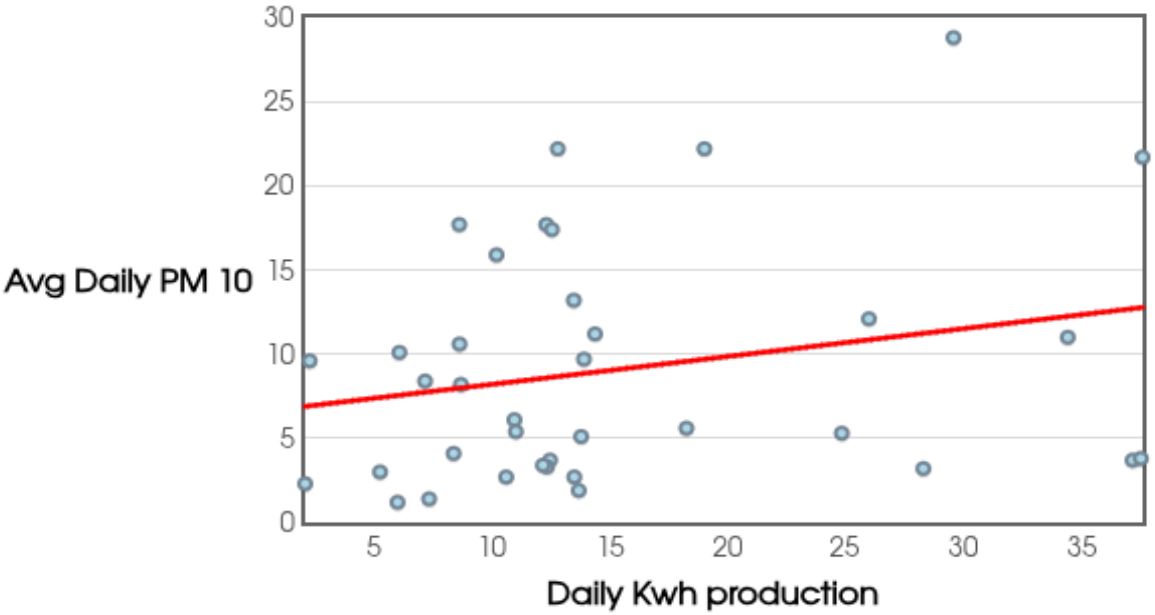
Graphs

Avg Correlation = 0.12 daily PM 2.5 vs Daily kWh





Avg Correlation = 0.3
Daily PM 5.0 vs Daily kWh



Avg Correlation = 0.23 daily PM 10 vs Daily kWh

Date	[kWh]											
2020-09-30	13.88	2020-09-30T00:00	6.8	2020-09-30T00:00	0.15	0.222	0.079	2020-09-30T00:00	6	6.2	6.8
2020-10-01	13.74	2020-09-30T00:00	16.7	2020-09-30T00:00	0.783	1.07	0.634	2020-09-30T00:00	17.9	18.3	17.5
2020-10-02	13.42	2020-09-30T00:00	8.7	2020-09-30T00:00	0.265	0.429	0.186	2020-09-30T00:00	8.9	9.1	8.7
2020-10-03	13.79	2020-09-27T00:00	11.9	2020-09-27T00:00	0.365	0.523	0.216	2020-09-27T00:00	12.3	12.6	12.2
2020-10-04	13.28	2020-09-30T00:00	19.5	2020-09-30T00:00	0.628	0.887	0.368	2020-09-30T00:00	20.1	20.3	19.9
2020-10-05	13.5	2020-09-29T00:00	16.7	2020-09-29T00:00	0.682	0.943	0.321	2020-09-29T00:00	16.3	16.6	16.9
2020-10-06	10.81	2020-09-30T00:00	9.1	2020-09-30T00:00	0.165	0.587	0.203	2020-09-30T00:00	8.7	9.6	8.7
2020-10-07	6.23	2020-10-01T00:00	4.9	2020-10-01T00:00	0.207	0.286	0.126	2020-10-01T00:00	5.1	5.1	5.2
2020-10-08	13.49	2020-10-01T00:00	3.5	2020-10-01T00:00	0.215	0.309	0.17	2020-10-01T00:00	3.7	3.7	3.7
2020-10-09	13.84	2020-10-01T00:00	20.9	2020-10-01T00:00	0.782	1.07	0.434	2020-10-01T00:00	22.2	22	22.5
2020-10-10	13.43	2020-10-01T00:00	17	2020-10-01T00:00	0.565	0.779	0.328	2020-10-01T00:00	17.7	17.6	17.9
2020-10-11	13.87	2020-10-09T00:00	17	2020-10-09T00:00	0.635	0.827	0.29	2020-10-09T00:00	17.6	17.1	17.7
2020-10-12	13.15	2020-10-09T00:00	5.8	2020-10-09T00:00	0.232	0.331	0.133	2020-10-09T00:00	6.1	6.1	6.1
2020-10-13	8.58	2020-10-07T00:00	2.9	2020-10-07T00:00	0.161	0.216	0.078	2020-10-07T00:00	3	3.1	3
2020-10-14	8.97	2020-10-09T00:00	2.5	2020-10-09T00:00	0.152	0.222	0.081	2020-10-09T00:00	2.7	2.8	2.5
2020-10-15	7.12	2020-10-09T00:00	1.8	2020-10-09T00:00	0.122	0.172	0.071	2020-10-09T00:00	1.9	2.1	1.8
2020-10-16	12.29	2020-10-10T00:00	12.5	2020-10-10T00:00	0.513	0.726	0.302	2020-10-10T00:00	13.2	13.5	12.8
2020-10-17	8.33	2020-10-11T00:00	5.2	2020-10-11T00:00	0.186	0.281	0.109	2020-10-11T00:00	5.6	5.5	5.2
2020-10-18	8.84	2020-10-12T00:00	15.2	2020-10-12T00:00	0.569	0.731	0.357	2020-10-12T00:00	15.9	16.1	15.7
2020-10-19	2.22	2020-10-13T00:00	13.1	2020-10-13T00:00	0.4	0.671	0.239	2020-10-13T00:00	13.6	13.7	13.5
2020-10-20	13.13	2020-10-13T00:00	16.8	2020-10-13T00:00	0.71	1.025	0.439	2020-10-13T00:00	17.7	17.8	17.5
2020-10-21	10.58	2020-10-13T00:00	7.8	2020-10-13T00:00	0.326	0.539	0.178	2020-10-13T00:00	8.4	8.5	8.3
2020-10-22	2.63	2020-10-13T00:00	3.1	2020-10-13T00:00	0.189	0.281	0.105	2020-10-13T00:00	3.3	3.4	3.2
2020-10-23	7.28	2020-10-17T00:00	3.7	2020-10-17T00:00	0.3	0.456	0.164	2020-10-17T00:00	4.1	4.3	3.9
2020-10-24	5.89	2020-10-13T00:00	6	2020-10-13T00:00	0.24	0.355	0.134	2020-10-13T00:00	6.2	6.4	6
2020-10-25	14.39	2020-10-13T00:00	8.6	2020-10-13T00:00	0.231	0.339	0.144	2020-10-13T00:00	9.6	9.7	9.5
2020-10-26	17.98	2020-10-20T00:00	3.2	2020-10-20T00:00	0.141	0.21	0.072	2020-10-20T00:00	3.4	3.5	3.3
2020-10-27	17.14	2020-10-21T00:00	2.6	2020-10-21T00:00	0.166	0.246	0.086	2020-10-21T00:00	2.7	2.8	2.7
2020-10-28	17.49	2020-10-22T00:00	2.2	2020-10-22T00:00	0.152	0.225	0.079	2020-10-22T00:00	2.3	2.5	2.2
2020-10-29	18.28	2020-10-23T00:00	1.3	2020-10-23T00:00	0.098	0.135	0.049	2020-10-23T00:00	1.4	1.5	1.4
2020-10-30	6.53	2020-10-23T00:00	1.1	2020-10-23T00:00	0.094	0.144	0.049	2020-10-23T00:00	1.2	1.3	1.1
2020-10-31	16.21	2020-10-26T00:00	10.3	2020-10-26T00:00	0.508	0.753	0.262	2020-10-26T00:00	11	11.4	10.6
2020-11-01	16.87	2020-10-26T00:00	19.5	2020-10-26T00:00	0.82	1.219	0.451	2020-10-26T00:00	21.7	22.1	21.4
2020-11-02	19.54	2020-10-27T00:00	3.4	2020-10-27T00:00	0.206	0.283	0.119	2020-10-27T00:00	3.7	3.8	3.6
2020-11-03	25.89	2020-10-28T00:00	3.6	2020-10-28T00:00	0.19	0.283	0.097	2020-10-28T00:00	3.8	3.8	3.6
2020-11-04	24.8	2020-10-28T00:00	3	2020-10-28T00:00	0.153	0.223	0.083	2020-10-28T00:00	3.2	3.2	3.2
2020-11-05	14.33	2020-10-30T00:00	9.7	2020-10-30T00:00	0.364	0.527	0.21	2020-10-30T00:00	10.1	10.3	10
		2020-10-31T00:00	5.1	2020-10-31T00:00	0.25	0.359	0.14	2020-10-31T00:00	5.6	5.8	5.4
		2020-11-01T00:00	21	2020-11-01T00:00	0.889	1.237	0.563	2020-11-01T00:00	22.2	23	21.3
		2020-11-02T00:00	26.7	2020-11-02T00:00	1.291	1.871	0.713	2020-11-02T00:00	28.8	28.1	27.4
		2020-11-03T00:00	11.4	2020-11-03T00:00	0.582	0.842	0.302	2020-11-03T00:00	12.1	12.8	11.3
		2020-11-04T00:00	5.9	2020-11-04T00:00	0.308	0.525	0.161	2020-11-04T00:00	6.1	5.8	5
		2020-11-05T00:00	13.7	2020-11-05T00:00	0.42	0.602	0.239	2020-11-05T00:00	11.2	11.5	13.9
		2020-11-06T00:00	5.1	2020-11-06T00:00	0.288	0.43	0.167	2020-11-06T00:00	5.6	5.7	5.2
		2020-11-07T00:00	22	2020-11-07T00:00	0.826	0.628	0.216	2020-11-07T00:00	23.5	23.8	22
		2020-11-08T00:00	8.8	2020-11-08T00:00	0.52	0.761	0.276	2020-11-08T00:00	10.5	11	10.1
		2020-11-09T00:00	8.5	2020-11-09T00:00	0.564	0.797	0.31	2020-11-09T00:00	10.2	10.8	8.5
		2020-11-10T00:00	1.1	2020-11-10T00:00	0.135	0.206	0.063	2020-11-10T00:00	1.3	1.5	1
		2020-11-11T00:00	7.8	2020-11-11T00:00	0.429	0.637	0.221	2020-11-11T00:00	8.5	8.6	7.6
		2020-11-12T00:00	6.3	2020-11-12T00:00	0.42	0.641	0.189	2020-11-12T00:00	6.8	7.4	6.2
		2020-11-13T00:00	3.4	2020-11-13T00:00	0.282	0.436	0.139	2020-11-13T00:00	3.7	4	3.4
		2020-11-14T00:00	16	2020-11-14T00:00	0.799	1.167	0.431	2020-11-14T00:00	17	17.7	16.4
		2020-11-15T00:00	32.1	2020-11-15T00:00	1.261	1.77	0.762	2020-11-15T00:00	35.2	35.6	35
		2020-11-16T00:00	4.4	2020-11-16T00:00	0.25	0.373	0.126	2020-11-16T00:00	4.6	4.8	4.5
				2020-11-17T00:00	0.355	0.561	0.147	2020-11-17T00:00	4	4.5	3.6
				2020-11-18T00:00	1.929	2.762	0.798	2020-11-18T00:00	25.1	25.8	23.6
				2020-11-19T00:00	0.81	1.288	0.53	2020-11-19T00:00	22.7	23.5	21.9
				2020-11-20T00:00	1.799	2.651	1.186	2020-11-20T00:00	33.5	33.9	33

Raw Data

Photos

Davis sensor and collaboration with Gabe and Isaiah

Collaboration with EPA and Dietrich's group at our air sensor

PurpleAir Sensor

Utilizing the Ipad and Davis weather app

Map

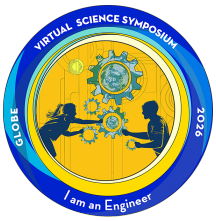
Data Collection Zone

Conclusion

Although there was no strong correlation between the parameters, that does not mean there is no correlation. The effect might have been too small to see because the particulate matter levels near the sensors were low enough to avoid having a visible effect. Based on the data, there is not a high enough concentration of small or large particles to deposit a significant amount of matter on panels or block sunlight. In the future, it would be helpful to make note of more parameters, such as clouds, humidity, or temperature.

Message of Hope: The particulate matter levels are up to acceptable standards around the school and do not have any major effect on the local environment despite the proximity to high traffic areas.

Badges



“I am an engineer.” My teammate and I utilized multiple sensors to make a participant-created data set that we analyzed to find a correlation with solar panel efficiency and to analyze the real-world issue of carbon emissions and airborne particulate matter.

“I work with a STEM professional,” We worked with STEM experts to help analyze our data and correct any potential issues with our research poster. These experts also helped to provide guidance for project types and how to gather and lay out our information for the poster. These experts helped to guide us and ensure our work was of the highest possible quality.

“I am a collaborator,” Seth Welly and Cameron Sherette worked with various collaborators such as Juthi Mitra and Dr. Kevin Czajkowski who helped to look over information on the project and analyze graphs. Dave Bydlowski who helped for drafting on projects and project types.

Gladwyn Richardson and Tucker Lux helped to look over spelling and citations as well as giving advice on changes to the poster. Laura Kubiak helped to go over posters and give suggestions on modifications as well as Christine Kania helped with graphing and laying out data.

Acknowledgements

Juthi Mitra and Dr. Kevin Czajkowski helped to look over this project and check the graphs and raw data. Dave Bydlowski helped with drafting for this project and ideas for project types. Gladwyn Richardson, Laura Kubiak, and Tucker Lux gave advice on citations, examined the poster, and gave advice on modifications, lastly. Christine Kania helped to graph our data and lay out the information.

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