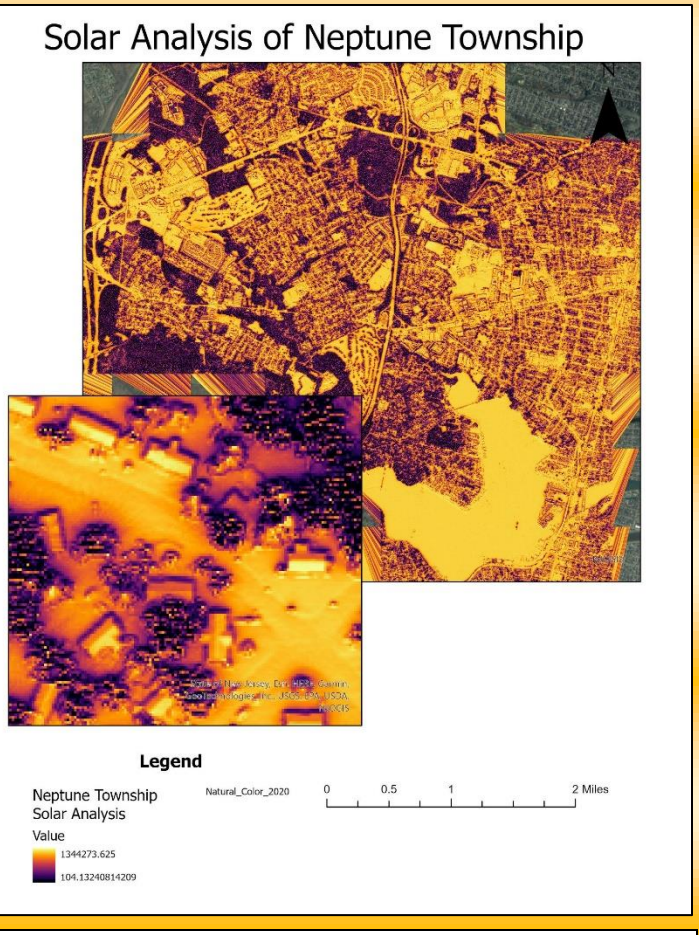
Solar Analysis of Neptune Township NJ
By: Patrick Lombardi of Stockton University



Introduction:

When looking into LiDAR data and how it is utilized, Solar came up as a top search result, and this piqued my interest. I knew that solar companies came door to door all the time and never thought much about it, but now I wonder where they get their solar data and how it is collected. First, we need to know what Solar Radiation is, and it is a simplified term for electromagnetic radiation emitted by the sun (Energy.gov). It is divided into three types: Direct, Diffused, and Reflected. Direct is when the sunlight is unblocked by anything and has clear contact with the earth's surfaces. Diffused is when the sunlight passes through clouds or glass before making contact. Lastly, reflected is when the sunlight bounces off a surface, such as the atmosphere, the surface, glass, or ice depending on the albedo.

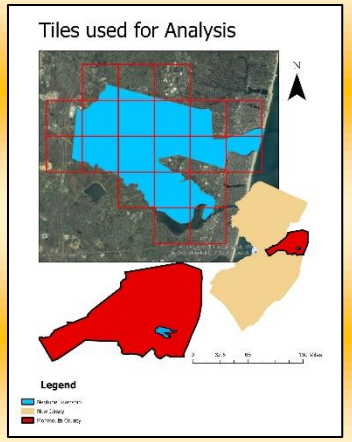
Without Solar Radiation organisms would not have the energy to produce for themselves and keep cycles of the earth in place. On top of that, Solar is a renewable energy source commonly used throughout the world. We use Solar panels to harness this radiation and power many everyday uses. For example, vehicles, homes, heating of water and ventilation, and even calculators, are powered through Solar panels. Solar has been used for thousands of years and the collection methods have advanced with the growth of technology. With its growth and practicality, it is sought after by many businesses, schools, and residential areas to supply the local grids with clean renewable energy. When it comes to gathering data for solar radiation, such as surface data, building elevations, and access to numerous open data sources, ArcGIS has LiDAR data that gives us the ability to gather this useful information. Bringing me to my question: how much solar radiation does my hometown, Neptune Township, New Jersey, put out in a year or day?

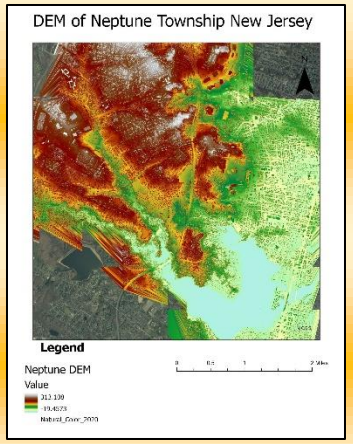
Methodology:

First, we must start by isolating Neptune Township on a map. We do this by adding a municipality layer and using the Clip tool to create a new layer with just Neptune. Next is to generate a DEM (Digital Elevation Model) of Neptune which we downloaded using the Statewide DEM & Hillshade 2021 Edition raster file available from NJGINs open data. The DEM is crucial for Solar Analysis and the Clip Rater tool is used to bring this just to Neptune because we do not need the entire state. Following this, we are to run the Run Solar Analysis tool. Using the NJGIN Northeast NJ Post-Sandy 2014 Tile Grid, the point data and associated tif files were easily accessible and free to download. Steps were taken to make sure every tile within the border of Neptune was used. Then, the tiles were converted from LAZ to LAS files using the Convert LAS tool, which were colorized using the Colorize LAS tool, and combined by the Mosaic To New Raster tool. The Area Solar Radiation Tool was used and took the amount of Solar Radiation and derived it by taking in data every 30 minutes from 2020-2021. This tool takes many factors into account, like solar declination and solar position to give the most accurate data from that year.

Now, we must single out the buildings in Neptune, which was done by (1 using a building footprint layer that was Clipped to Neptune and 2) using the Select Layer by Location tool to single out the solar raster layer. After this, it is necessary to get the buildings to be a cohesive Vector shapefile, rather than the individual cells that were generated. This was done by using the Extract by Mask tool, followed by the Raster to Polygon tool with the same building footprints as before to get the solid shapes. This housed all of the individual cells data for each building independently.

Finally, the total amount of Kilowatt hours per square meter (kWH/m^2) on every building was the desired unit of measurement; however, the Area Solar Radiation tool gives the measurements in Watt hours per meters squared (WH/m^2). To convert to the desired unit of measurement, we simply take the Average Solar radiation in WH/m^2 and divide it by 1000, and this gives us the kWH/m^2 on average in a year.

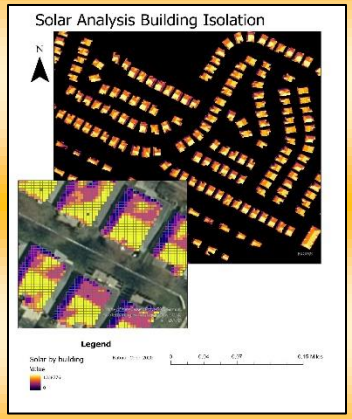


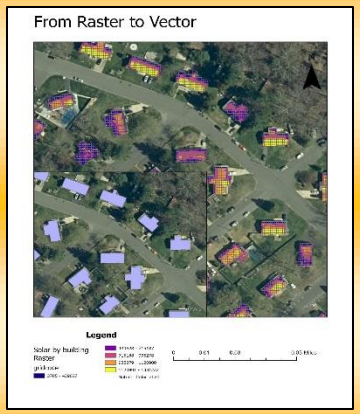


Results:

Now with this data the total amount of WH/m^2 per building in Neptune Township from 2020-2021 is available to us. But we need the kWH/m^2 since according to Solar.com the average amount produced from a single solar panel home in New Jersey is about 1.8 kWH/m^2

Taking the yearly average of a home in Neptune that gets a fair amount of solar based on the visuals which is 984197.95 WH/m^2 and dividing that by 1000 gives us 984.20 kWH/m^2 and that is the amount of kWH/m^2 that home averages in a year. To get a day we take that yearly average and divide that by 365 which gives us an average daily of 2.696 kWH/m^2. Now for the big question: how much raw solar data are all of the buildings in Neptune Township taking in on average in a day and year. We take the total average solar radiation from the vector building layer which is 1,762,725,091,311 WH/m^2 and divided by 1000 gives us 1,762,725,091.311 kWH/m^2 on average in a year and this divided by 365 gives us 4,829,383.811 kWH/m^2 in a day on average. These numbers are still too big for a reasonable analysis so we are taking them to Terawatt Hours (TWh) in a year this is 1.762 TWh/m^2 in a day this is 0.004 829 TWh/m^2.





Discussion/Conclusion:

The Solar analysis was a success as far as the process and creation of the dataset. The total amount of raw solar radiation the buildings take in on average in a day or year was achieved. The data generated could be valuable for homeowners looking to get solar or even companies looking where to canvas for new solar clients. The data is also something the town could investigate as far as expanding their renewable energy footprint. The data used however was from 8 years ago and therefore was lacking in some respects. For instance, my house used to have a tree in the front yard which would block a lot of direct solar radiation to my home but has since been removed in the past eight years which takes away the total solar my home takes in. Also, a new addition to the hospital in my town was built which was a large-scale project that also would allow more solar to be recorded. These instances while isolated to what I know could be at hundreds of homes in my town so having a new dataset to run the Solar analysis on would make this a more efficient project. Also, the slope of the rooftops of the buildings were not involved in the process which would also give different values to every building in the town. While the Total Area Solar Radiation tools take in the angle of instance from the sun it does not consider the pitches of rooftops. This data is also raw solar data meaning it does not have the potential the buildings could take in but the solar that hits the surfaces. Considering things like chimneys, antenna or overall, nowhere to place panels the amount a building could collect from this raw data would also be varied.

This project could easily be replicated and improved by following the same steps and adding a few more elements to narrow down the results and once new data is put out should be done to the benefit of homeowners, businesses, and solar companies.

https://www.energy.gov/eere/solar/solar-radiation-basics
https://www.solar.com/learn/how-much-energy-does-a-solar-panel-produce/
https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/area-solar-radiation.htm