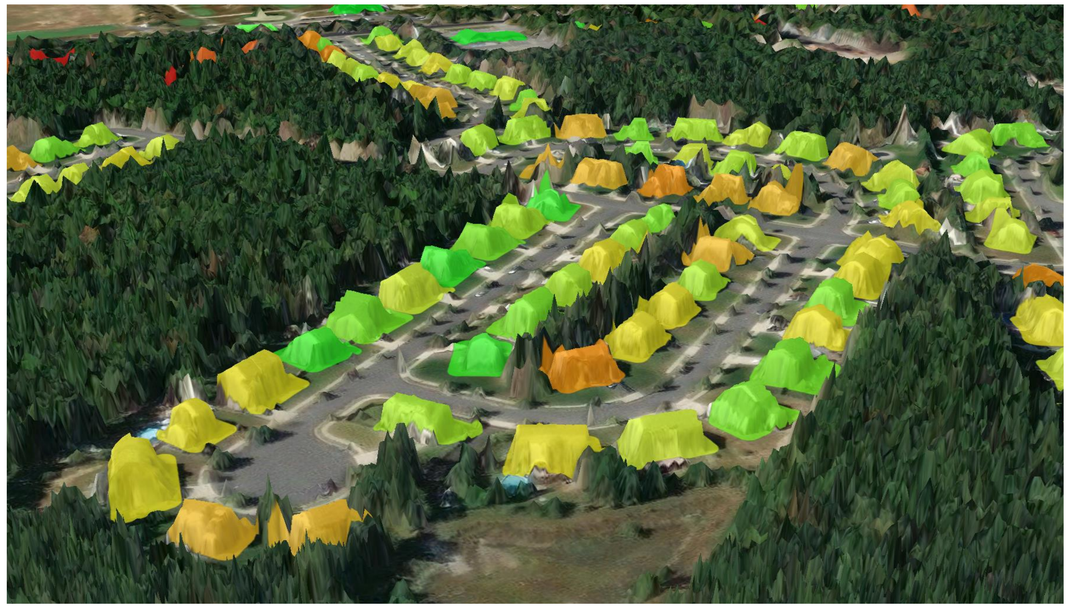
Technical Feasibility Analysis of LiDAR Derived Solar Analyses on the County Level

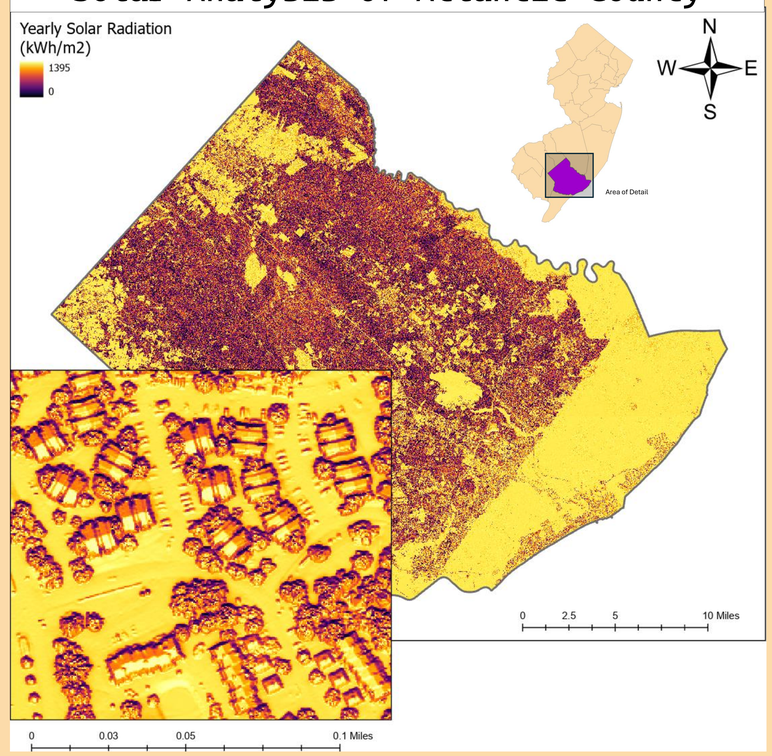
STOCKTON UNIVERSITY

3D Local Scene of Yearly Solar Radiation per Building

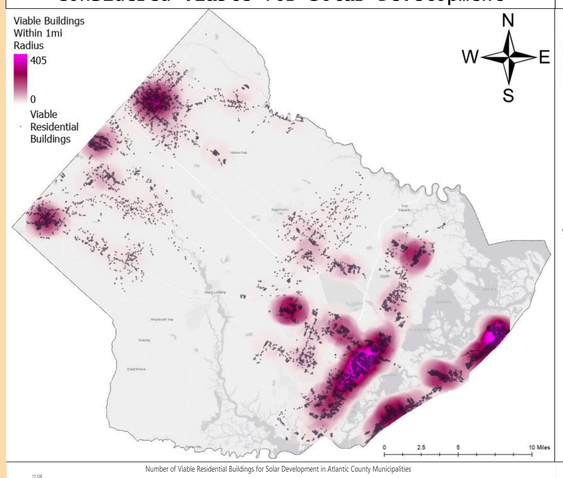


Aerial View of Yearly Solar Radiation per Building

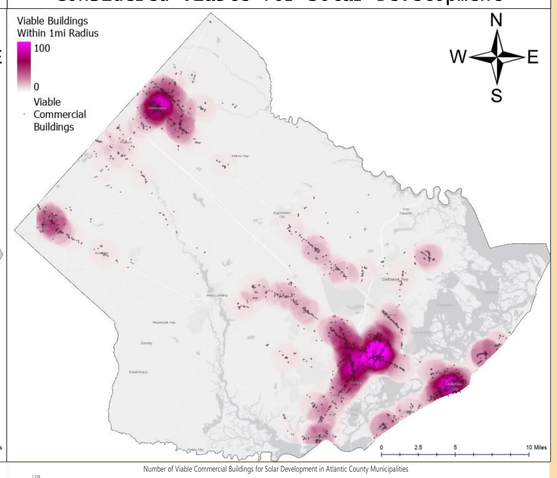
Solar Analysis of Atlantic County

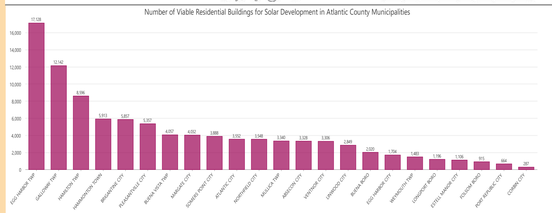


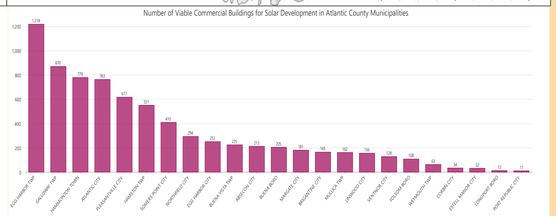
Cluster Analysis of Residential Buildings Considered Viable for Solar Development

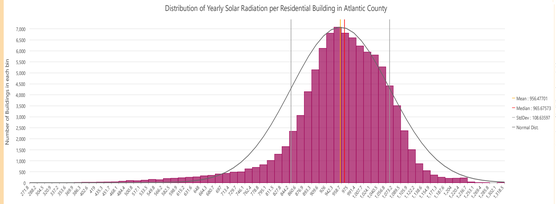


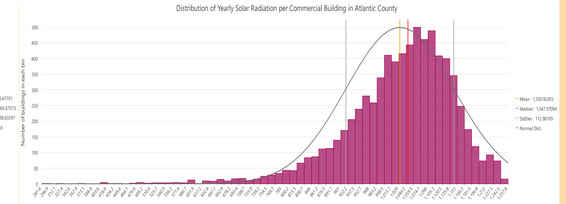
Cluster Analysis of Commercial Buildings Considered Viable for Solar Development

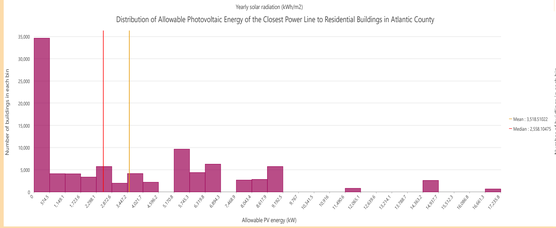


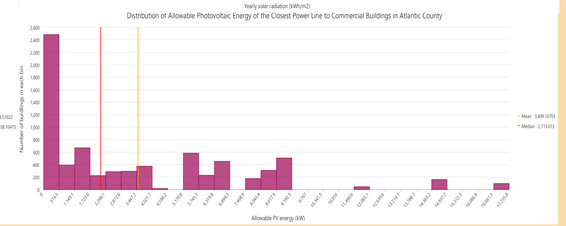












Background:

According to New Jersey's 2023 Executive Order No. 315, energy sold within the state must be 100% clean by the year 2035. As a result, there are several goals for solar development set in place to complete this objective. The most recent iteration of these guidelines is the 2021 New Jersey Solar Act. According to this act, New Jersey must generate 17 gigawatts of solar electricity by 2035, and 32 gigawatts by 2050. To achieve this, 0.4 gigawatts of solar energy must be installed per year through 2030.

To effectively reach this goal, it is imperative that optimal regions for solar development are identified so that statewide solar may be developed in the most efficient manner possible. One such remote sensing method that is rapidly increasing in use is LiDAR technology. Within ArcGIS Pro, the tool that was traditionally used to complete the process of converting a LiDAR derived elevation raster to solar radiation data was Area Solar Radiation. However, as of ArcGIS Pro 3.2, the Raster Solar Radiation tool has superseded the Area Solar Radiation tool. Unlike the previous versions, which only could use a computer's CPU, the Raster Solar Radiation tool can leverage the GPU as well, allowing for exponentially faster conversion time of an elevation raster into a solar radiation raster. Because of this improved processing time, it is now possible to complete solar analysis of expansive areas in a reasonable amount of time. To demonstrate the improvements made to the process by this tool, a solar analysis was completed for the entirety of Atlantic County.

Methods:

LiDAR tiles within Atlantic County were traced and selected for download within the New Jersey Office of GIS (NJOGIS) 2019 South Jersey LiDAR tile collection with a 2ft resolution. This selection included roughly 700 LiDAR-derived LAZ point cloud tiles with a total area of 555 square miles. LasTools was used to merge and uncompress the LAZ files.

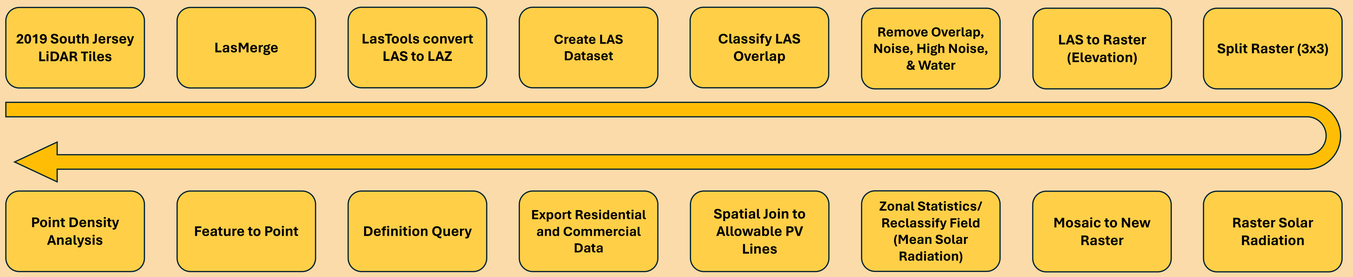
The Create LAS Dataset tool in ArcGIS Pro was used to convert the LAS file into a LAS dataset. Classify LAS Overlap was used to flag any redundant points between differing LiDAR collection sessions. Points classified as overlap, noise, high noise, and water were removed. The LAS to Raster tool was used to convert the point cloud to an elevation raster. A cell size of 2 feet per cell was selected, as smaller cell sizes led to files that were too large to be processed by solar analysis tools.

At 2 feet per cell, the raster of the entire county was still too large to be processed further. To remedy this, Split Raster was used to split the elevation raster by a 3x3 grid. The Raster Solar Radiation tool was used individually on each tile. The time frame for the analysis was from January 1, 2024, until December 31, 2024. The time to complete this total process was only 25 hours. This process was completed using an NVIDIA RTX 4070 as the GPU. With this same GPU, in a professional setting where data storage limits are not an issue, a solar radiation analysis of the entirety of New Jersey may be conducted in as little as 2 weeks. The split tiles were then merged again using the Mosaic to New Raster tool, resulting in the final solar radiation raster.

The NJDEP's 2015 Impervious Surface data for Atlantic County was queried to create a layer of all building footprints within Atlantic County. The smallest 4500 of these were deleted, as they were too small to build solar panels onto. Zonal Statistics was used to determine the mean solar radiation per cell within each building footprint. The mean solar radiation was then reclassified into ten quantiles, each containing a range of 10% of mean values.

NJDEP's New Jersey Community Solar PV Siting tool was used to download the 2021 solar hosting capacity of Atlantic City Electric's solar hosting capacity lines. These lines represent the amount of solar power that each power line can store. Each building footprint was spatially joined to its closest power line with a maximum distance of 0.25 miles.

NJDEP's 2015 Land Use Land Cover map was used to separate buildings between residential and commercial types for individual analysis. For each category, histograms of solar radiation distribution and power line distribution were also created. Each category was then queried to find buildings that were both in the top 30% of mean yearly solar radiation received as well as were near a power line with above 500 kW of PV energy capacity remaining. Each of these buildings was converted to a point, and then a point density analysis was run to determine hot spots of viable buildings for solar development.



Results:

Brigantine City, Egg Harbor Township, and Galloway Township are the three towns with the highest quantity of viable residential buildings for future solar development, while Hammonton Township, Egg Harbor Township, and Pleasantville City are the three towns with the highest quantity of viable commercial buildings for future solar development. Cluster analysis shows similar results to the bar graphs. However, in the cluster analysis map, it is much easier to see the clustered nature of viable buildings. This is due to power lines that are unable to carry more PV energy, notably in the center of the county.

Yearly solar radiation per residential building is normally distributed. The median is slightly higher than the mean, giving the data a slight negative skew, where there are several outliers of residential buildings with extremely low yearly solar radiation. Yearly solar radiation per commercial building has a distribution that characteristically is normally distributed. There is a stronger negative skew, as the median is higher than the mean. This is because of several outliers of commercial buildings with extremely low yearly solar radiation. The skew may be stronger for commercial buildings because commercial buildings tend to be larger, and therefore can have more open space for the sun to shine onto.

Distribution of allowable PV energy is not normally distributed for residential or commercial buildings. In fact, 25.3% of residential buildings and 22.4% of commercial buildings are built closest to a power line that is already at maximum capacity for photovoltaic energy load.

This study found two major strategies for developing solar throughout Atlantic County. The first is to target communities within the clusters of viable residential and commercial buildings for solar development. This would be an efficient way of distributing solar panels to the buildings that would be both the most profitable to solar companies, as well as generating more clean energy to reach New Jersey's environmental goals. The second strategy is to further develop power lines so that they may have increased capacity for photovoltaic energy loads. A significant number of buildings are unable to generate solar, not because their roofs lack incoming solar radiation, but because the nearby power lines simply cannot accept more solar energy. This is especially a problem with central Atlantic County, where most power lines are already at capacity. By upgrading the power grid, more opportunities would be available for solar generation.

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Stockton University – April 2024