**Satellite Beach Energy**

*Restructuring the Energy Balance in Satellite Beach, Florida, by Quantifying Solar Energy Production Potential using NASA POWER Data Products and LiDAR*

**Project Team**

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**Project Overview**

***Project Synopsis:***

This project partnered with the cities of Satellite Beach and Orlando, Florida, to identify the rooftops with the highest solar energy potential in Satellite Beach and to better understand urban heat stresses that lead to higher energy demands. The analysis utilized highly detailed elevation data as well as solar irradiance data from the NASA POWER data product. NASA Earth observations from Landsat 8 were used to do the urban heat examination. The end products can assist local governments in targeting buildings with high solar potential for photovoltaic installations and help the City of Satellite Beach achieve its goal of 100% clean energy by 2050.

***Abstract:***

The City of Satellite Beach, Florida, has committed to supplying 100% of its energy use from renewable energy, primarily solar, by the year 2050. The team created a methodology for estimating rooftop solar power potential using a high-resolution Light Detection and Ranging (LiDAR) dataset and the NASA Prediction of Worldwide Energy Resources (POWER) dataset to assist Satellite Beach in reaching their solar renewable energy goals. The POWER dataset provides information on direct and diffuse solar irradiation on horizontal surfaces, surface albedo, and effects of local meteorology, such as clouds. The team integrated the solar irradiance data with the LiDAR data to model slope, aspect, and shadowing in the 7 km2 study area to find suitable roof segments for solar panel installation and estimate the solar potential of each segment. This process was supplemented by an analysis of land surface temperature and urban greenness measured through the Normalized Difference Vegetation Index (NDVI) from Landsat 8 Operational Land Imager and Thermal Infrared Sensor (OLI/TIRS) observations. These metrics serve to target areas for cooling initiatives aimed at reducing Satellite Beach’s overall energy consumption. The team found the total rooftop solar potential throughout the city to be 221,919,330 KWh per year with an average annual rooftop photovoltaic, or PV, potential of 55,647 KWh per building. As such, the average building could generate over five timesthe annual energy needs for an average household if PV panels were installed on all viable areas of its roof.

***Key Terms:***

digital surface model, irradiance, LiDAR, NASA POWER, photovoltaic, remote sensing, solar potential

***National Application Area Addressed:*** Energy

***Study Location:*** Satellite Beach, FL

***Study Period:*** January 2008 to December 2019

***Community Concerns:***

* Satellite Beach, Florida, aims for 100% of all electricity consumed in the City of Satellite Beach to come from renewable energy sources, primarily solar, by 2050 while the City of Orlando has a goal of powering 100% of municipal operations using renewable energy by 2030 and reaching 100% renewable energy by 2050.
* Satellite Beach, Florida, seeks to find the most efficient way to implement solar technology through the installation of photovoltaic panels on rooftops throughout the city.
* The city is concerned about the compounding effect of increasing energy expenditures from urban heat effects.
* City officials are concerned about the validity of their initial solar potential estimates from freely available tools such as the National Renewable Energy Laboratory’s PVWatts Calculator and Google’s Project Sunroof because these tools do not describe all of their parameters, assumptions, and methods.

***Project Objectives:***

* Evaluate the solar energy potential of rooftops in Satellite Beach, Florida, using lidar and NASA POWER data
* Develop a reusable and adaptable code-based tool that partners can use to reproduce the solar analysis with updated data in the future and in other areas of Florida
* Create land surface temperature (LST) and greenness maps of Satellite Beach to help partners better understand urban heat pressures on their energy consumption
* Produce a public-facing Esri ArcGIS StoryMap with interactive maps that can educate community members on the background, purpose, methodology, and results of the project

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Satellite Beach**  | Alexis Miller, Project Manager; John Fergus, city volunteer | End User | Yes |
| **City of Orlando, Fleet and Facilities Management Division** | Ian LaHiff, Energy Project Manager; David Dunn, Manager | Collaborator | Yes |

***Decision-Making Practices & Policies:***

The City of Satellite Beach has used Google’s online Project Sunroof solar calculator and the National Renewable Energy Laboratory's online PVWatts tools to estimate the amount of electricity that rooftop photovoltaic (PV) panels could provide toward the city’s power needs on an annual basis. The Project Sunroof tool estimates the potential energy from solar to be about 180% of what the community now uses. However, the parameters that went into this estimate are unclear, and the city is concerned that the estimate may be unreliable. In 2020, city staff and Sustainability Board Members met with representatives of Florida Power and Light (FPL), the local electric power utility, and David Dunn, who is largely involved with the City of Orlando’s sustainability efforts, to open a dialogue regarding cooperative efforts towards reaching Satellite Beach’s 100% clean energy goal. They concluded additional analysis is needed regarding PV potential and the geographic/temporal distribution of this potential but do not have the tools to do a proper analysis.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Normalized Difference Vegetation Index (NDVI), LST, and albedo | NDVI, albedo, and LST were additional informative layers for cooling initiatives. |
| **Landsat 8 TIRS** | LST | LST was an additional informative layer for understanding the distribution of urban heat around Satellite Beach. |
| **NASA POWER** | Climatological average of the optimal solar panel tilt angle, solar irradiance, albedo, and solar geometry | NASA POWER derived data were included in the reusable code through an API download. The solar data determined the energy viability of different roof angles and gave an estimation of the solar irradiance experienced by PV panels at different tilts. |

***Ancillary Datasets:***

* 2018-2019 USGS Florida LiDAR Program, USGS Contract No. G16PC00020 – Digital Surface Model (DSM) for slope and aspect analysis of the rooftop viability for PV panels in Satellite Beach
* Microsoft U.S. Building Footprints Shapefile – Determine eligible roofs in Satellite Beach
* Brevard County Addressed Parcel Centroids and Parcels Shapefiles – Join addresses from Brevard County to building footprints in Satellite Beach
* Brevard County Roof Materials Spreadsheet – Statistical analysis with LST results

***Software & Scripting:***

* Esri ArcGIS Pro 2.5.1 – Database processing, geodatabase creation, map creation, and spreadsheet development
* Python 3.0 – Geographic data processing
* Google Earth Engine – Image processing and creation of LST and NDVI maps

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Spreadsheet of Solar Potential by Street Address** | NASA POWER | The partners can use this information for organized, targeted outreach to owners of buildings with high solar potential and easily searching results for individual addresses. Using this spreadsheet, the roof segments can be grouped by cardinal direction, address, or other parameters and organized by total potential energy generation or efficiency by area. | N/A |
| **Solar Potential Maps by Roof Segment and by Building** | NASA POWER | These maps quickly show roof segments that would be ideal for PV panel installation on each building and which buildings could potentially produce the most energy. This can aid in informed outreach targeting building owners. | N/A |
| **Geodatabase of Shapefiles and GeoTIFF Outputs**  | NASA POWER and Landsat 8 OLI/TIRS | This is a package of all of the processed Earth observation data and code results as GeoTIFFs such as LST, NDVI, roof segment and rooftop irradiance polygons, as well as processed LiDAR data in the form of a DSM. The geodatabase also includes ancillary shapefiles such as building footprints, municipal boundaries, and any other relevant shapefiles used in processing.  | N/A |
| **Code for Regional Scale Solar Potential Analysis** | NASA POWER | This code will allow partners to perform the analysis again if a significantly more up to date DSM becomes available. The code will be shared by the boundary organizations with other regions in Florida interested in utilizing solar energy. | III |
| **ArcGIS StoryMap** | N/A | This can be used to conduct community outreach displaying the results of the project to potential PV panel consumers and municipal employees in Satellite Beach, FL. It will also provide other cities in Florida interested in using the tool in their area with instructions for contacting the partner POC in Satellite Beach. | N/A |
| **Land Surface Temperature Map** | Landsat 8 OLI/TIRS | This informative map shows urban heat island effects in Satellite Beach, which partners may use as part of their outreach strategy for improving energy consumption practices and cooling initiatives. | N/A |
| **Normalized Difference Vegetation Index Map** | Landsat 8 OLI/TIRS | This informative map shows urban greenness in Satellite Beach, which partners may use as part of their outreach strategy for improving energy consumption practices and greening initiatives. | N/A |

***Product Benefit to End User:***

Solar energy potential estimates by building, with knowledge about the assumptions that went into those calculations, will provide invaluable information for decision making as the City of Satellite Beach transitions toward 100% clean energy. These solar energy potential estimates will allow the city to target building owners with the most potential for generating solar power that meets individual and overall energy demands. The more detailed estimates of energy potential by roof segment will be informative for building owners interested in installing PV panels. The city and FPL will have reliable data, from which they can use to inform e policy decisions involving locally generated solar energy in meeting energy demands. The reusable code will allow FPL, Orlando, and other interested organizations to perform the analysis in other communities. The land surface temperature and greenness maps will identify areas with higher urban heat effects, informing cooling initiatives to reduce air conditioning energy demands.

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