**Ohio Energy**

*Restructuring the Energy Balance in Ohio by Quantifying Energy Loss and Solar Potential Using NASA Earth Observations and LiDAR*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:*** The NASA DEVELOP Ohio Energy project developed a method to find areas with the highest potential to generate solar energy in Cuyahoga County and Cleveland, OH. This analysis utilized highly detailed elevation data as well as solar and atmospheric data gathered by NASA Earth observations. The end products of this study will assist local governments in targeting outreach to landowners within these high solar potential areas, helping the County and City achieve their 100% renewable energy goals.

***Abstract:***

The City of Cleveland and Cuyahoga County in Ohio are joining local governments around the globe in committing to 100% renewable energy goals by encouraging the use of solar technologies. Our team developed a method for estimating rooftop solar power potential using NASA Prediction of Worldwide Energy Resources (POWER) data to assist the City of Cleveland and Cuyahoga County with their renewable energy goals. POWER provides an estimate of incoming solar irradiation on a tilted surface by accounting for the light scattering and filtering effects of clouds and aerosols. Our methods improve on existing solar potential estimation tools through the inclusion of POWER data adjusted for roof slope and a high-resolution (1 ft) digital surface model derived from LiDAR data, which allowed for detailed shadow, slope, and aspect modeling. To avoid overestimation, we calculated the solar potential for individual roof segments and removed those unsuitable for solar panel installation. We then applied our methods to a 5.38 square mile test area within the county and found a total rooftop solar potential of over 100,000 MWh/yr. Of all the buildings with solar power potential, 19% could supply 85% of the total potential energy. These methods have the capacity to be applied to the entire county and to other regions seeking to efficiently utilize solar energy.

***Keywords:***

remote sensing, POWER, LiDAR, photovoltaic, solar irradiation

***National Application Areas Addressed:*** Energy, Urban Development

***Study Location:*** City of Cleveland and Cuyahoga County, OH

***Study Period:*** January 2017 to August 2019

***Community Concerns:***

* Cuyahoga County has joined the Global Covenant of Mayors for Climate and Energy and has created green energy initiatives as well as climate variation mitigation goals of increasing solar power infrastructure throughout the county.
* Cuyahoga County and the City of Cleveland want to provide targeted outreach to the public sector about local solar energy potential to help them reach their 100% renewable energy goals.

***Project Objectives:***

* Evaluate the solar potential of rooftops and open areas in Cuyahoga County and Cleveland, Ohio, using LiDAR and NASA Earth observations
* Estimate energy generation potential for selected areas of high solar potential
* Determine which areas with low socioeconomic status have high solar potentials

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Cleveland, Office of Sustainability** | Anand Natarajan, Energy Manager; Elizabeth Lehman, Energy Analyst | End User | Yes |
| **Cuyahoga County, Department of Sustainability** | Mike Foley, Director;  Dan Meaney, County Planning | End User | Yes |

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

In 2008, Ohio passed a Renewable Energy Portfolio Standard, which mandates that all investor-owned utility companies must source 12.5% of their annual electricity sales from renewable energy by 2026. Cuyahoga County and the City of Cleveland have also set goals of 100% renewable energy by 2050 and 2035, respectively. Public sector investment in solar panels will likely comprise a large component of the anticipated increase in renewable energy sources in the City and County. As a first step toward providing community outreach, the Cuyahoga County Department of Sustainability has conducted preliminary analyses of solar power potential using the Google Project Sunroof and the National Renewable Energy Laboratory (NREL) PVWatts calculator. These analyses have been limited to potential solar panel customers who request an analysis of their properties.

***Project Benefit to End User:***

The end users will use the methods, products, and data generated during this project to make policy decisions on the best buildings and areas to target for solar panel installation to maximize solar energy generation. They will also use the outputs for educational outreach to community members and businesses who would benefit the most from installing solar panels on their properties. Using high-quality data and methods for these analyses improves the chances of Cuyahoga County and the City of Cleveland reaching their goals of 100% renewable energy use by 2050 and 2035, respectively.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **SRTM** | Elevation | Shuttle Radar Topography Mission (SRTM) data were input into the Esri Area Solar Radiation tool to confirm that the topography outside the county boundary had no significant effect on the annual solar duration for the county. |

***Ancillary Datasets:***

* NASA Prediction of Worldwide Energy Resources (POWER) data – Solar irradiation data that accounts for atmospheric solar interactions, solar geometry, and tilted solar panel calculations
* University of Vermont Spatial Analysis Laboratory Digital Surface Model – Analyze rooftops and open spaces for solar insolation potential, including aspect, slope, and shadow effects
* Cleveland Metroparks LiDAR data – Combined with Northeast Ohio Regional Sewer District LiDAR data to make the digital surface model
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* Cuyahoga County GIS Department Building Footprints – Estimate surface area available for solar panels
* Cuyahoga County Fiscal Office Parcels Geodatabase – Identify building ownership and land use type
* US Census Bureau Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line Shapefiles – Inspect socioeconomic data and identify low-income areas that overlap with high solar power potential zones

***Software & Scripting:***

* Esri ArcMap – Data visualization, clipping, reprojection, slope, aspect, and shading analysis of the digital surface model
* Python – Interpolation of NASA POWER Solar Irradiation for Equator Facing Tilted Surfaces and data visualization

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Solar Potential Study Area Map** | NASA POWER | This map will allow City and County officials to identify rooftops with high solar potential within the study area. This will allow our partners to contact specific homeowners and business owners with high solar potential properties and will allow users to estimate the solar potential of their homes. | I |
| **Solar Potential Study Area Map with Socioeconomic Factors** | NASA POWER | This map identifies rooftops with both high solar potential and low socioeconomic status within the study area. This will assist our partners in evaluating their initiatives that support equity in green energy distribution. | I |
| **Solar Potential Model Builder** | NASA POWER | This method combined with the Solar Potential Estimation Tutorial will allow our partners, who are familiar with Esri ArcGIS, to calculate solar potential throughout the City and County. | I |
| **Solar Potential Tutorial** | SRTM  NASA POWER | This tutorial will allow our partners to implement the Solar Potential Estimation Model Builder to replicate our method throughout the County and will help build their capacities to work with NASA Earth observations and LiDAR data. | I |
| **Outreach Poster** | NASA POWER | This poster provides an easily understandable solar potential map and explanation of our methods for use at meetings and for public outreach. | I |
| **Solar Potential Raster File** | NASA POWER | Our partners are familiar with Esri ArcGIS and providing this dataset will allow them to continue using the data for future analyses. | I |

**Project Handoff Package**

***Transition Plan:*** We had a webinar with partners on August 8th, 2019. During this meeting, we provided a workshop tutorial on how to interpret our results and how to continue analyzing the data for the entire county. The spatial data were transferred via Box, and the maps and poster were transferred via email.

***Team POC:*** Hannah Besso, hbesso12@gmail.com

***Partner POC:*** Dan Meaney, dmeaney@cuyahogacounty.us

***Handoff Package:***

* Solar Potential Study Area Map
* Solar Potential Study Area Map with Socioeconomic Factors
* Solar Potential Model Builder
* Solar Potential Tutorial
* Outreach Poster
* Solar Potential Raster File

**References**

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