**Washington D.C. & Maryland Energy**

*Estimating Solar Potential Using NASA POWER Data to Inform Renewable Energy Policy for Washington D.C.*

**Project Team**

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**Project Overview**

***Project Synopsis:***

NASA DEVELOP partnered with the Washington D.C. Department of Energy and Environment (DOEE) to find areas within Prince George’s and Montgomery counties that had the highest potential for solar energy. The team used solar data, obtained from NASA Prediction of Worldwide Energy Resources (POWER) dataset, and digital surface models created from LiDAR, to analyze rooftop solar potential in the counties neighboring D.C. The resulting solar potential maps assisted the DOEE in informing renewable energy projects to reduce greenhouse gas emissions and achieve the goals laid out in their Sustainable D.C. 2.0 action plan.

***Abstract:***

In line with the Sustainable D.C. 2.0 plan to combat climate change, Washington D.C. aims to decrease its greenhouse gas emissions by 100% by 2050. As solar energy is a clean, renewable energy form, its integration into the region’s power grids lowers energy costs and incentivizes sustainable development. We partnered with the Washington D.C. Department of Energy & Environment (DOEE) to determine how urban areas surrounding D.C. can better be incorporated into decisions regarding renewable energy policy. The team used NASA’s Prediction of Worldwide Energy Resources (POWER) solar data and a Light Detection and Ranging (LiDAR) derived digital surface model, to estimate and visualize rooftop solar potential for Maryland’s Prince George’s and Montgomery counties. POWER provided solar irradiance data adjusted for tilt angle while the digital surface model contributed aspect and slope data. This methodology factored out areas that were unsuitable for solar panel installation while displaying areas that possess a high potential for energy return. The team found the total rooftop solar potential for the study area to be almost 32 million kW, which is equivalent to roughly 660 kW per building. The methodology used to generate the solar potential maps can be applied to other regions of the country seeking to efficiently utilize solar energy. The end users at the DOEE can use our resulting solar potential map and data table to effectively target buildings that have the highest potential to generate solar energy.

***Key Terms:***

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

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

***Study Locations:*** Prince George’s & Montgomery counties, MD

***Study Period:*** 2015 - 2021

***Community Concerns:***

* D.C. must transition to using 100% renewable energy by 2050 to reach the goals set by the Sustainable D.C. 2.0 Plan. Current forms of power generation, like natural gas and petroleum, emit pollutants that impact human health and release greenhouse gases that contribute to global climate change.
* 96% of the District's greenhouse gas emissions result from energy consumption, 75% of which is caused by powering buildings. Building power consumption by heating and colling systems is increasing with the rise of severe weather events, resulting in the increase of household utility costs and household financial strain.
* Renewable energy sources, such as photovoltaic solar energy, are emissions-free and do not pose respiratory health risks for communities and are therefore prime candidates for the transition to renewable energy.
* The total solar energy potential for Washington D.C. has been mapped, but mapping efforts have yet to be expanded to neighboring counties which could contribute to the District’s total emissions and aid in the emissions reduction efforts.

***Project Objectives:***

* Calculate total rooftop solar energy potential for Prince George’s and Montgomery Counties, Maryland, using LiDAR and NASA POWER data
* Inform partners and residents about solar potential through an interactive ArcGIS StoryMap which displays the project findings and development in an accessible format
* Develop code that partners can use to conduct future analyses to understand and compute rooftop solar potential

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Washington D.C. Department of Energy & Environment** | Thomas Bartholomew, Branch Chief | End User | No |

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

The DOEE is the main authority on renewable energy and environmental issues affecting Washington D.C. They work to propagate renewable energy using community outreach, solar energy credits, and financing options to make solar energy generation accessible to residents in D.C. Power grid lines from portions of two adjacent Maryland counties, Prince George's and Montgomery Counties, feed into D.C. and are of interest to the DOEE. In the past year, the DOEE saw that 30% of solar energy credits in the grid were generated in these portions. Therefore, solar panel installation in Maryland presents an opportunity to increase the solar power entering the grid and to generate additional solar energy credits. Currently, the DOEE has access to a solar potential analysis done by Mapdwell, a team of researchers from MIT. This map, however, is restricted to D.C. and does not provide information on solar potential in Maryland. Filling this information gap would provide the DOEE with insight necessary to meet the goals of the Clean Energy D.C. (CEDC) Omnibus Amendment Act of 2018, a clean energy plan inspired by the Sustainable D.C. 2.0 Plan. The CEDC Act mandates that 100% of electricity generated or consumed in-state must come from renewable resources by 2032, and 10% of that electricity must come from solar energy by 2041.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **NASA POWER** | Solar panel tilt, angle, and solar irradiance. | The dataset was used to estimate the solar irradiance photovoltaic panels are likely to experience at different tilts. |

***Ancillary Datasets:***

* D.C. GISgroup, 2018 LiDAR – Digital Surface Model elevation data used to calculate the solar potential of Washington D.C. and MD counties
* MD Internet Message Access Portal (iMAP), 2020 MD LiDAR – DSM used to calculate slope, aspect, and shadowing analysis
* MD iMAP, Maryland Building Footprints – Shapefile of building surface areas, used to calculate the area of rooftop segments
* Pepco, Electrical Feeder Map – Visualizes the extent of solar energy market of D.C., used to refine the study area

***Software & Scripting:***

* Esri ArcGIS Pro 2.8.2 – Process Raster data, develop maps and end products
* Python 3.9 – Interpolate and visualize data
* ArcGIS Online – Create StoryMap

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Solar Potential Maps by Building** | NASA POWER | These maps demonstrate the solar power that can potentially be generated on rooftops in the study area. They will inform the partner of buildings best suited for solar panel installation and thus advance green energy infrastructure beyond D.C. and into the Maryland region. | N/A |
| **Solar Potential Table by Neighborhood** | NASA POWER | This table is a record of the daily average of solar potential by neighborhood. This product will provide insight to identify areas with the greatest potential for solar power within the study area. | N/A |
| **ArcGIS Online StoryMap** | N/A | The StoryMap is a community outreach tool that will inform D.C. and Maryland residents of the potential impact of rooftop solar on climate change, aligning with their goal to make solar energy more accessible. | N/A |

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

Partners at the D.C. DOEE will be able to use the solar potential maps by roof segment and building, along with the methods and data provided by the team, to make informed policy decisions on the locations where solar panels will yield the most energy. The DOEE will also use the end products to gain better insight into the demand for solar power in the area, and how this demand may evolve over time. Additionally, in expanding the range of current solar maps to include Prince George’s and Montgomery counties, the DOEE will be better able to identify the potential for market manipulation for solar energy credits.

**References**

Boz, M. B., Calvert, K., & Brownson, J. R. S. (2015). An automated model for rooftop PV systems

assessment in ArcGIS using LIDAR. *AIMS Energy 2015, 3*(3), 401-420.

<https://doi.org/10.3934/energy.2015.3.401>

Lukač, N., Žlaus, D., Seme, S., Žalik, B., & Štumberger, G. (2013). Rating of roofs’ surfaces regarding their solar potential and suitability for PV systems, based on LiDAR data. *Applied Energy*, *102*, 803-812.

<https://doi.org/10.1016/j.apenergy.2012.08.042>

NASA Langley Research Center (LaRC) (2018). NASA Langley Research Center (LaRC) POWER Project

funded through the NASA Earth Science/Applied Science Program [Data set].

<https://power.larc.nasa.gov/data-access-viewer/>

*Solar initiatives.* DC.gov (n.d.).

<https://doee.dc.gov/service/solar-initiatives>

Stackhouse, P. W., Taiping, Z., Westberg, D., Barnett, A. J., Bristow, T., Macpherson, B., & Hoell, J.

M. (2018). *POWER release 8.0.1 (with GIS applications) methodology.*

<https://power.larc.nasa.gov/documents/POWER_Data_v9_methodology.pdf>