**NASA DEVELOP National Program**

**2020 Summer Project Proposal**

**Arizona – Tempe**

**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 Overview**

***Project Synopsis*:** DEVELOP will partner with the cities of Satellite Beach and Orlando, Florida in an effort to quantify key parameters associated with Satellite Beach’s effort to efficiently convert to clean energy, mostly solar, by 2050. The DEVELOP team will use NASA POWER solar data and a digital surface model to analyze the rooftop solar energy potential throughout Satellite Beach. These energy potentials will be associated with each building’s address and average energy usage for targeted outreach strategies. Land surface temperature and greenness maps will be made using Landsat 8 OLI/TIRS and Aqua MODIS observations to better understand urban heat stress leading to higher energy demands for air conditioning. Solar panel installation and cooling initiative prioritization decisions will be informed through the developed tool, which will be adjustable for use in other locations.

***Community Concern:*** In 2019 Satellite Beach adopted a resolution stating, “it is the goal and policy of the Satellite Beach City Council, in cooperation with other local governments, private organizations, and individuals, for 100% of all electricity consumed in the City of Satellite Beach to come from renewable energy resources and associated technologies by the year 2050.” Wind is not a viable source of clean energy in this part of Florida, since urban communities on the barrier island lack open space on which to install wind turbines. Also, National Renewable Energy Laboratory wind maps at 30 and 80 meter heights indicate land-based wind is, at best, marginally viable. Additionally, no ocean-based capabilities appear to be viable in the near future. The City of Satellite Beach must now figure out how best to proceed with adopting solar energy technology in order to maximize efficiency and meet their goal of 100% clean energy.

***Source of Project Idea:*** Media coverage of the 2019 Summer Ohio Energy project at the Arizona – Tempe node inspired the partners from Satellite Beach to propose a similar project for their city. They then submitted a project request form to the NASA DEVELOP website. Communication between Amanda Clayton from DEVELOP’s National Program Office and the city staff as well as Volunteer Board Member and resident, John Fergus, PhD, aided in confirming engagement with NASA DEVELOP as a possible addition to the city’s clean energy project.

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

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

***Study Period:*** 1981 – 2019

***Advisors:*** Dr. David Hondula (Arizona State University), Dr. Paul Stackhouse (NASA Langley Research Center)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Satellite Beach** | Alexis Miller, Project Manager; Courtney Barker, City Manager; John Fergus, City Volunteer | End User | No |
| **City of Orlando, Fleet and Facilities Management Division** | David Dunn, Manager; Ian Lahiff, Energy Project Manager | Collaborator | Yes |

***End User Overview***

***End User’s Current Decision-Making Process:***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. This 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 believes the estimate to 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 has taken a lead role in that city’s extensive 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.

***End User’s Capacity to Use NASA Earth Observations:***

*City of Satellite Beach* – Two members of the Satellite Beach staff have training and familiarity with Esri's GIS processing software, for which the city has a license. In 2010 the city determined its vulnerability to sea-level rise based on airborne LiDAR data converted to a digital elevation model file. Over the following decade, the results were ground-truthed and used for multiple adaptation efforts.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*City of Orlando, Fleet and Facilities Management Division* – In 2007 Orlando launched its Green Works initiative to transform the community into one of the most environmentally-friendly communities in the nation. Since then the city has achieved more than $1 million in annual energy savings. The city is installing rooftop PV on ten city buildings each year and converting its vehicle fleet to clean energy. City staff will provide expertise from the successes of their ongoing solar and green energy projects. Specifically, David Dunn, Orlando’s Fleet and Facilities Division Manager who worked at Kennedy Space Center for 23 years, will assist the city with his experience with NASA data utilization.

***Dissemination by Boundary Organizations*:**

*City of Orlando, Fleet and Facilities Management Division* – Orlando is the largest city in Central Florida, with a population of over 280,000 and a budget exceeding $1 billion. The Fleet and Facilities Management Division anticipates using the tool developed by this project to quantify potential solar energy generation capability for the rooftops of buildings owned and managed by the city government. The tool will also be made available to Orlando's Sustainability Directorate, responsible for Green Works sustainability initiatives throughout the Orlando community, where the tool can assist with public outreach involving rooftop solar installations.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The NASA DEVELOP project team will meet with the partners weekly over video chat. There will also be ongoing communication via email. The main POC will be the Project Lead once the Fellow has introduced the team to the partners.

***Transition Plan*:** A handoff will be conducted virtually in the last week of the term via Google Hangouts or Zoom. All processed data products and end products will be sent to the partners by email or NASA Large File Transfer. The reusable tool and tutorial will be released to the partner and collaborator after software release. The products will be in the form of spreadsheets of potential solar energy estimates by street address and a geodatabase of maps for annual and seasonal energy generation potential by roof segment and building.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **NASA POWER** | Local optimal solar panel tilt angle, solar irradiance, & albedo | The solar data will determine the energy viability of different roof angles and give an estimation of the solar irradiance experienced by PV panels at different tilts. Additional albedo data could be used for further informing cooling initiatives. |
| **Landsat 8 OLI** | Normalized Difference Vegetation Index (NDVI) & Land Surface Temperature (LST) | The NDVI and LST will be additional informative layers for outreach purposes, but will not be integrated into the tool. |
| **Landsat 8 TIRS** | LST | LST will be an additional informative layer for outreach purposes, but will not be integrated into the tool. |
| **Aqua MODIS** | Nighttime LST | Aqua MODIS will provide LST measurements for evaluating heat retention between daytime and nighttime at a lower resolution than Landsat 8 derived LST. |

***Ancillary Datasets:***

* NOAA 2017 USACE FEMA Topobathy Lidar: Florida East Coast, Florida Keys, and Collier County (Post Hurricane Irma) – digital surface model development for slope and aspect analysis of the rooftop viability for PV panels with 1 meter resolution LiDAR
* Satellite Beach LiDAR – will be used to derive a Digital Surface Model (DSM) for slope and aspect analysis of the rooftop viability for PV panels
* Satellite Beach Building Footprint Shapefile by Street Address – extraction of LiDAR data by building
* Brevard County Roof Material Spreadsheet – for adjustments to emissivity calculations for improving the LST Maps, and for inclusion in the Spreadsheet of Solar Potential
* Satellite Beach City Gas Annual Utility Tax Receipt by Street Address – proxy for natural gas usage
* State of Florida Annual Motor Fuel Tax Receipts within Satellite Beach – estimation of the increase in energy demand if/when battery electric vehicles become the predominate private mode of transportation (i.e., would local rooftop PV also be adequate to meet this potential increase in electric demand)
* Florida Power and Light Total Aggregate Annual Electricity Demand for Satellite Beach – for comparing current demand to solar energy generation potential
* Florida Power and Light Annual Utility Tax Receipts by Street Address – proxy for current energy usage by individual properties

***Software & Scripting:***

* Esri ArcGIS – data processing, geodatabase creation, map creation, and spreadsheet development
* Python – geographic data processing
* R Statistical Software – mathematical data processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Spreadsheet of Solar Potential by Street Address** | The partners will use this information for organized, targeted outreach to owners of buildings with high solar potential and for 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, efficiency by area, or difference between potential energy and current consumption. | This will be developed using the NASA POWER irradiance on a tilted surface dataset, LiDAR DSM (for slope and aspect analysis), and the building footprints (for raster clipping) tagged by address and current energy demand data. Analysis with raster calculations for annual and seasonal solar energy potential as well as energy generation efficiency by surface area will be performed and included in the spreadsheet. | N/A |
| **Geodatabase of Solar Potential Maps by Roof Segment and by Building** | These maps will quickly show which roof segments would be ideal for PV panel installation on each building and which buildings could potentially produce the most energy. This will aid in informed outreach targeting to building owners. | This will be developed using the NASA POWER irradiance on a tilted surface dataset, LiDAR derived DSM (for slope and aspect analysis of each roof segment), and the building footprints (for raster clipping). | N/A |
| **Code for Regional Scale Solar Potential Analysis** | This code will allow partners to perform the analysis again if a significantly more up to date DSM becomes available. The code could be shared with other regions interested in utilizing solar energy by the boundary organization. | This script will be written in Python and R and will output all the other end products. It will utilize information from the NASA POWER irradiance on a tilted surface dataset, a DSM, and a building footprints shapefile with energy demand and address data. | III |
| **ArcGIS StoryMap** | This will be used to conduct community outreach displaying the results of the project to potential PV panel consumers in Satellite Beach, FL. | This will use images from the maps in the geodatabase. | N/A |
| **Land Surface Temperature Maps** | These informative maps will show urban heat for the Satellite Beach partners, which they may use as part of their outreach strategy. | Landsat 8 OLI/TIRS will be used to calculate daytime LST. Aqua MODIS will be used for nighttime temperature maps. | N/A |
| **Normalized Difference Vegetation Index Map** | This will be an informative map showing urban greenness for the Satellite Beach partners, which they may use as part of their outreach strategy. | Landsat 8 OLI/TIRS will be used to calculate NDVI. | N/A |

***End User Benefit*:** 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 to 100% clean energy. They will allow the city to target building owners with the most potential for generating solar power that meets individual and overall energy demands. The city and FPL with have reliable data on which to base 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 LST and NDVI maps will identify areas with higher urban heat effects, informing cooling initiatives to reduce air conditioning energy demands.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2020 Summer

***Related DEVELOP Work:***

2020 Spring (AZ) – Philadelphia Health & Air Quality: Assessing Land Surface Temperature and

Compounding Vulnerability Factors to Identify High Priority Areas for Cooling Initiatives in

Philadelphia, Pennsylvania

2019 Summer (AZ) – Ohio Energy: Restructuring the Energy Balance in Ohio by Quantifying

Energy Loss and Solar Potential Using NASA Earth Observations and LiDAR

2019 Summer (JPL) – Douglas County Energy: Identifying Areas with High Solar Power Potential in

Kansas via NASA Earth Observations and LiDAR

2019 Summer (AZ) - Ashville Urban Development: Using NASA Earth Observations to Quantify the Impact of Urban Tree Canopy Cover on Urban Heat and Identify Community Vulnerability in Asheville, North Carolina

**Notes & References:**

***Notes*:**

* The current DEVELOP Arizona – Tempe Lead/Fellow (Crystal Wespestad) was a participant on the 2019 Summer Ohio Energy project, and is familiar with the technical processing issues discovered by that team and its partners, which will need to be overcome in this project.
* In 2017 the U.S. Department of Energy's SunShot Initiative designated the City as one of the 22 municipalities in the first set of "SolSmart" municipalities in the United States selected "for making it faster, easier, and cheaper to go solar." <http://www.satellitebeach.org/residents_visitors/solar.php>
* Green Works Orlando history and accomplishments: <http://www.cityoforlando.net/greenworks/about/>
* NASA Prediction of Worldwide Energy Resources (POWER) dataset:

[https://power.larc.nasa.gov/data-access-viewer/](https://power.larc.nasa.gov/data-access-viewer)

* Project Sunroof by Google that is currently being used by partners for solar potential estimations <https://www.google.com/get/sunroof>
* PVWatts Calculator alternative tool for calculating solar potential on building at a time by address <https://pvwatts.nrel.gov/>
* Office of Energy Efficiency & Renewable Energy, U.S. Annual Average Wind Speed at 30 Meters, <https://windexchange.energy.gov/maps-data/325>
* Office of Energy Efficiency & Renewable Energy, Florida 80-Meter Wind Resource Map, <https://windexchange.energy.gov/maps-data/24>
* Florida Public Service Commission, November 2017, Review of the 2017 Ten-Year Site Plans of Florida Electric Utilities, <http://www.floridapsc.com/Files/PDF/Utilities/Electricgas/TenYearSitePlans/2017/Review.pdf>

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