**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**California – JPL**

**Douglas County Energy**

*Identifying Areas with High Solar Power Potential in Kansas via NASA Earth Observations and LiDAR*

**Project Overview**

***Project Synopsis*:** This project will utilize NASA Earth observations from Terra and Aqua CERES, Landsat 8 OLI, and SRTM along with Planet Labs RapidEye data to identify regions of high solar insolation in Kansas. Working with Douglas County, the team will combine remotely sensed data with LiDAR to identify regions that have the highest solar power potential. The project will look closely at areas in Douglas County to determine the potential for rooftop solar energy on both city-owned and privately owned properties. Additionally, underutilized parcels of land that may be potentially used as solar farm sites will be identified. This project will help the County identify the best areas to install rooftop solar panels and build solar farms, ultimately helping them meet their goal of reducing greenhouse gas emissions.

***Community Concern:*** The City of Lawrence and Douglas County are working to reduce greenhouse gas emissions and build a framework to transition to 100 percent renewable energy. Residents and elected officials have voiced their interest in having their community transition away from coal power. Over 85 percent of the population lives in the City of Lawrence, which is dense in size, and 50 percent of residents are renters. There is a high population of renters because of the proximity to the local university. The community would like to have a better understanding of local government-owned and privately owned properties that have the potential to install solar panels since it may be difficult to have panels installed on rental properties. The community is interested to see the potential for community-scale solar and converting tracts of land within Douglas County that are vacant or abandoned to solar farms.

***Source of Project Idea:*** To meet DEVELOP’s goal of impacting all 50 states, the project idea was first formulated when there was a need to have a Kansas-based project. The California – JPL Node leadership first contacted Michael Forrester, Energy Manager for the City of Cincinnati, who suggested we reach out to the City of Lawrence for a potential partnership. Subsequently, node leadership contacted Jasmin Moore, Sustainability Director for the City of Lawrence and Douglas County, and proposed a solar energy project that would enhance their renewable energy initiatives. She became interested after learning about the DEVELOP Program and the potential outcomes from this project.

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

***Study Location:*** City of Lawrence and Douglas County, KS

***Study Period:*** January 2016 – June 2019

***Advisor:*** Qing Yue (NASA Jet Propulsion Laboratory, California Institute of Technology)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Douglas County** | Jasmin Moore, Sustainability Director | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The City of Lawrence and Douglas County make decisions about where to install solar panels on public property based on site feasibility and available funding. Currently, the city and the county are working with the US Department of Energy’s SolSmart program to identify and remove barriers to solar permitting. They also work with policymakers and the city’s Sustainability Advisory Board to identify potential policies to encourage the use of solar energy. There is no remote sensing involved in this process.

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

*Douglas County –* The partner is not familiar with NASA Earth observations and has not used such data directly for their decision-making purposes related to solar panel placement. Their GIS Department has used NASA Earth observations for general mapping purposes.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Douglas County –* The partner plans to share the results from the project with organizations, such as SolSmart, and other interested cities and counties in the Midwest. The partner has strong relationships with these communities and regularly shares best practices, lessons learned, and other knowledge about installing panels. The communities include: Cedar Rapids, IA; Des Moines, IA; Dubuque, IA; Iowa City, IA; Johnson County, IA; Johnson County, KS; Branson, MO; Columbia, MO; Kansas City, MO; Springfield, MO; St. Louis, MO; St. Peters, MO; Lincoln, NE; Oklahoma City, OK; and Brookings, SD. Sharing the results with these cities and counties could build their remote sensing capacity and in turn, increase their opportunities and goals in green energy.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with the partner weekly or biweekly by email or teleconference meetings to give updates on the project. The Project Lead will be the main POC for email communications, and the entire team will communicate during the partner calls.

***Transition Plan*:** Since software release is not required, it is expected that the handoff of the end products will be given during the last week of the term by email or through NASA Large File Transfer. The team members will give a final presentation to explain their methods and results to the partner and answer any questions. We foresee the results being disseminated within the partner organization to consider future solar panel locations in addition to being shared with other interested cities and counties outside of Kansas to replicate the methods.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | It will be used to downscale the surface solar radiation data from Terra/Aqua CERES |
| **Aqua CERES** | Solar radiation | The Level 3 Synoptic TOA and surface fluxes and clouds (SYN1deg) and Level 4 Energy Balanced and Filled (EBAF) product will be used to identify general regions where there are high solar radiation values in the state of Kansas. |
| **Terra CERES** | Solar radiation | The Level 3 Synoptic TOA and surface fluxes and clouds (SYN1deg) and Level 4 Energy Balanced and Filled (EBAF) product will be used to identify general regions where there are high solar radiation values in the state of Kansas. |
| **SRTM** | Elevation, slope, aspect | SRTM data will be used to create a hillshade product to calculate solar insolation in Kansas. It will also be used as an input into the Esri ArcGIS Pro Area Solar Radiation tool. |
| **RapidEye** | Spectral reflectance | Planet Labs RapidEye imagery will be used to examine spatial resolution and capability to classify rooftops that have the highest energy potential in the City of Lawrence and Douglas County. The data will also be used to estimate the potential number of solar panels per roof and calculate energy output on city-owned buildings and multi-family homes for comparison. |

***Ancillary Datasets:***

USGS LiDAR Point Cloud Dataset – create a Digital Elevation Model to calculate solar insolation for Kansas

City of Lawrence and Douglas County Properties Shapefile – quantify solar power potential for known City- and County-owned properties

City of Lawrence and Douglas County Aerial Imagery Dataset – use this high resolution 2018 imagery to classify rooftops in addition or replacement to RapidEye imagery

NOAA GOES Surface and Insolation Products (GSIP) – use as a dataset to compare the solar radiation maps created from Terra MODIS and Terra CERES

***Software & Scripting:***

Esri ArcMap– create quality maps for presentations and reports

Esri ArcGIS Pro – create maps and run solar radiation tools

Exelis ENVI – raster manipulation and analysis, image enhancement, and image classifications

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **City of Lawrence Solar Power Potential Map** | This product will allow partners to observe the amount of solar radiation received in the City of Lawrence. The data will be upscaled with RapidEye data to see the highest energy potential and impact by comparing the energy output from large buildings to multi-family homes in the city. | The map will be created using Terra/Aqua CERES, Landsat 8 OLI, hillshade from SRTM, and solar insolation from a LiDAR-derived DEM. The map for the City of Lawrence will be created by analyzing rooftops from RapidEye imagery and by quantifying solar power potential by determining the number of panels that could fit onto eligible homes and buildings. | N/A |
| **Highest Impact Opportunity Analysis** | This product will be used as supplementary material for the partner to decide which buildings and sites have the highest potential to increase the city’s goal of increasing green energy use. The partner can learn if it is better to target city-owned properties or privately-owned buildings. | This is a follow-up analysis after creating the City of Lawrence Solar Power Potential Map above from using RapidEye imagery. Potential kilowatt per hour calculations will be estimated based on the number of panels that could fit on the rooftops. | N/A |
| **Ground-mounted Solar Panels Potential Map for Douglas County Map** | This product will help the partner assess underutilized, vacant areas with high solar potentials that could benefit the community by being converted into solar farms in Douglas County. | The DEM created from SRTM will be utilized to create insolation maps during the summer and winter solstices and fall and spring equinoxes. The insolation map will then be overlaid by a County owned properties and vacant properties map to identify underutilized local government-owned lots that could be converted into solar farms. | N/A |

***End-User Benefit*:** The partner aims to meet its greenhouse gas reduction goal by transitioning to renewable energy. Having access to solar power potential maps will guide policymakers and partners in their decision-making processes and help them prioritize parcels that have a high potential for solar energy production. The partner is not familiar with NASA Earth observations, so this project will build its capacity and provide the county with methods of using remotely sensed data in decision making. Furthermore, the results will be disseminated to other cities in the Midwest, which may potentially guide their own solar power planning.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Summer

***Related DEVELOP Work:***

2017 Fall (GA) – Georgia Energy II: Reducing Conflicts in Siting Solar Power Generating Facilities by Identifying Sensitive Habitats and Wildlife Populations in Areas with High Generation Potential

2017 Summer (GA) – Georgia Energy: Reducing Conflicts in Siting Solar Power Generating Facilities by Identifying Sensitive Habitats and Wildlife Populations in Areas with High Solar Power Potential

**Notes & References:**

***Notes*:**

* The outskirts of the City of Lawrence and the area within Douglas County are rural and mostly composed of farmland. There is interest in identifying vacant lots and brownfields within the state with the purpose of converting these areas to solar farm sites.
* NOAA GOES GSIP dataset: <https://www.avl.class.noaa.gov/saa/products/search?sub_id=0&datatype_family=GSIP&submit.x=25&submit.y=11>
* NASA Prediction of Worldwide Energy Resources (POWER) dataset: https://power.larc.nasa.gov/data-access-viewer/
* The team will look at the data products available on NASA POWER and will meet with the POWER team and advisor to decide whether to leverage this dataset in this project or use as an ancillary dataset.
* The partner is interested in estimating the energy output on city-owned buildings and multi-family homes for comparison since they would like to see if there is potential or not for residents to go solar.

***References:***

Mahtta, R., Joshi, P. K., & Jindal, A. K. (2014). Solar power potential mapping in India using remote sensing inputs and environmental parameters. *Renewable Energy, 71*, 255-262. https://doi.org/10.1016/j.renene.2014.05.037