



OHIO ENERGY

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

Hannah Besso

Yiyi He

Crystal Wespestad

Sihang Chen



Study Area & Period



▶ Cleveland

Land area: 77 mi²

Population: 383,793

▶ Cuyahoga County

Land area: 457 mi²

Population: 1,248,371

▶ Study Period

2017 to 2018

Objectives



Evaluate the solar potential of rooftops and open areas in Cuyahoga County and the City of Cleveland using LiDAR and NASA Earth observations



Estimate the average energy generation potential for selected rooftop segments in kilowatt hours per year



Identify the socioeconomic and land use attributes for buildings with high solar potential

Partners



Cuyahoga County,
Department of Sustainability

City of Cleveland,
Office of Sustainability

Community Goals

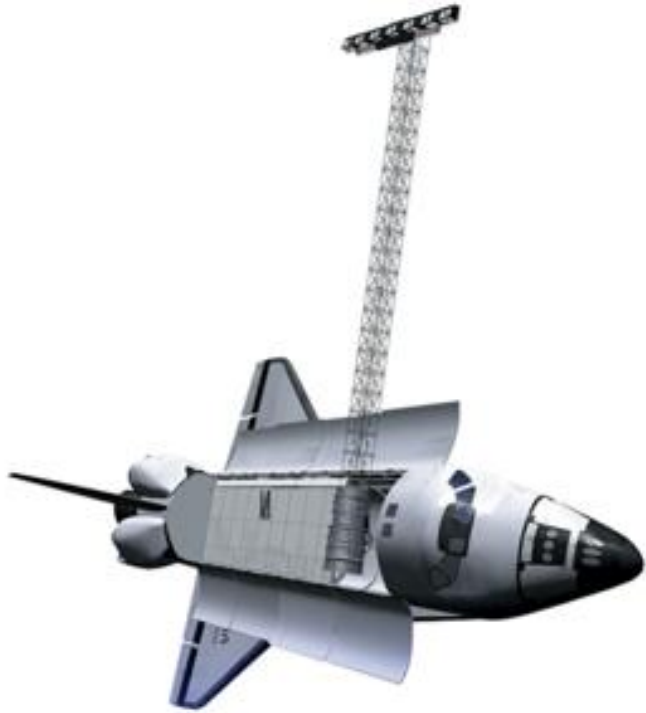


Cuyahoga County Climate Change Action Plan

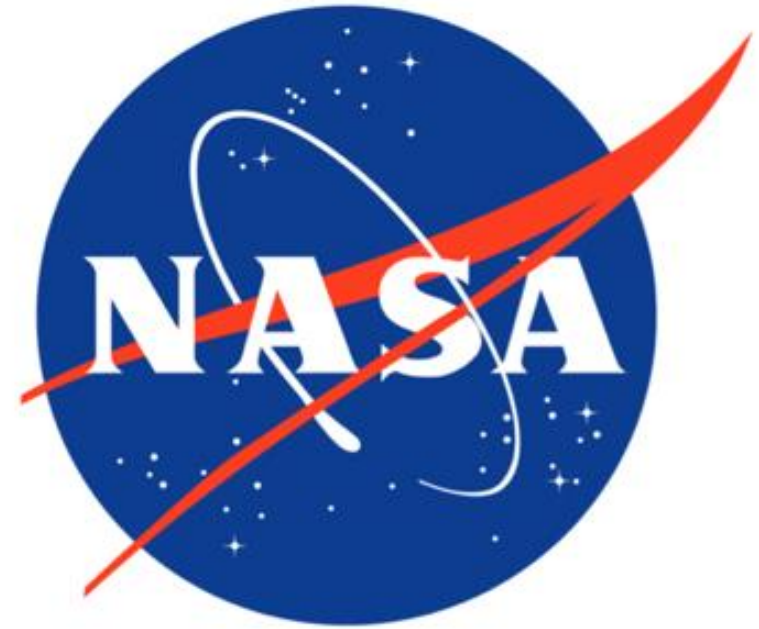


100% Renewable Energy by 2035 (City) and 2050 (County)

NASA Satellites and Sensors Used

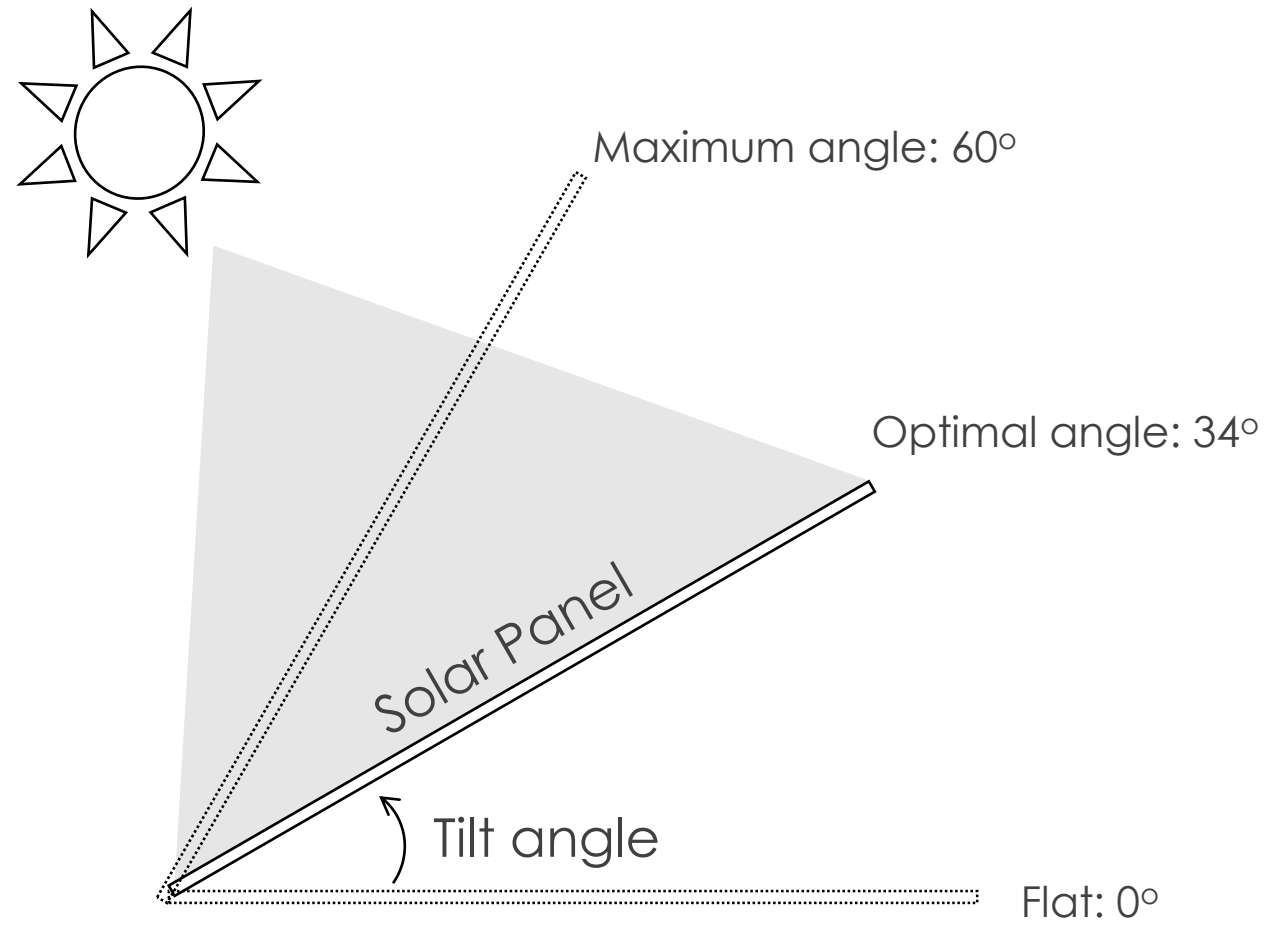
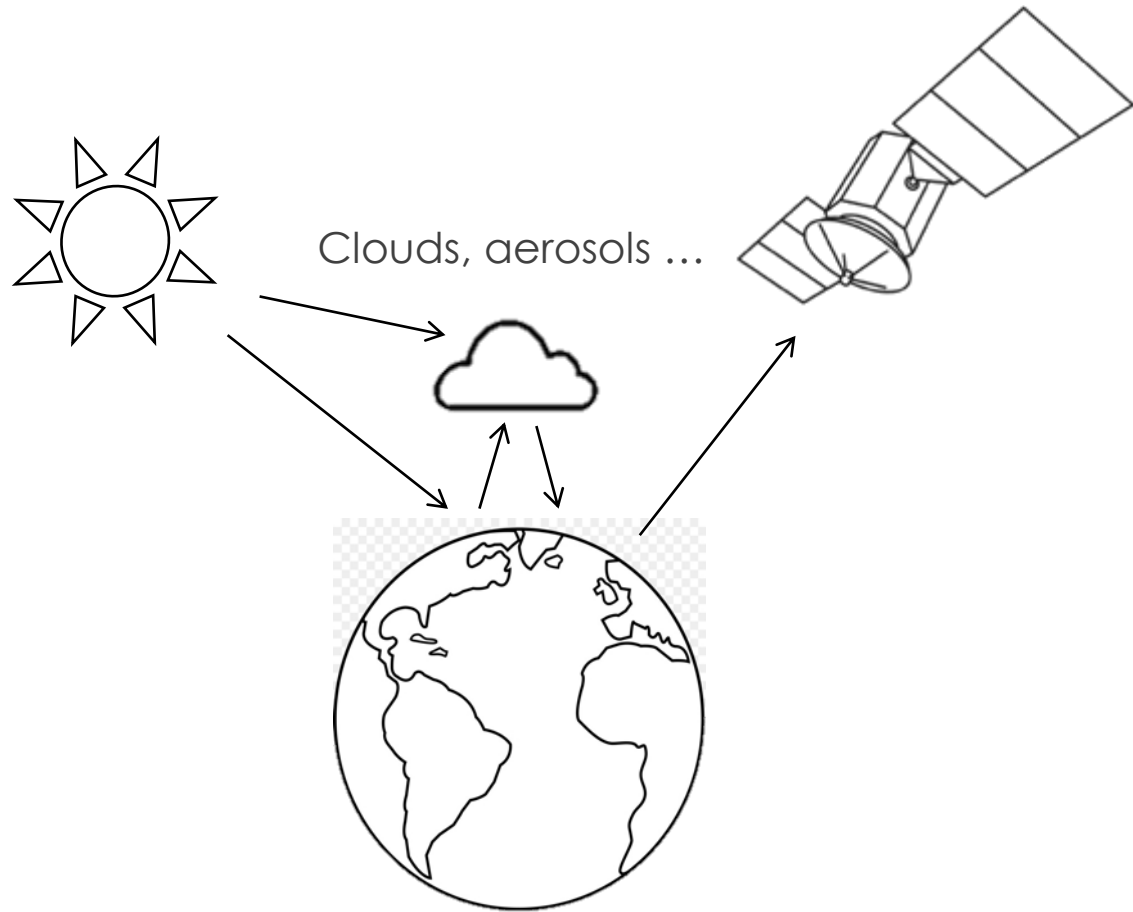


Shuttle Radar Topography Mission (SRTM) version 2

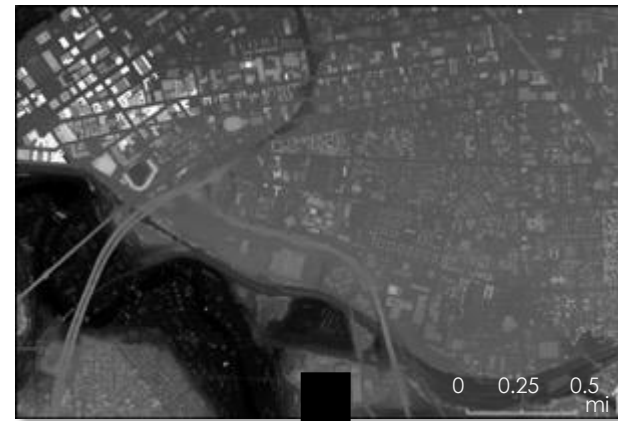
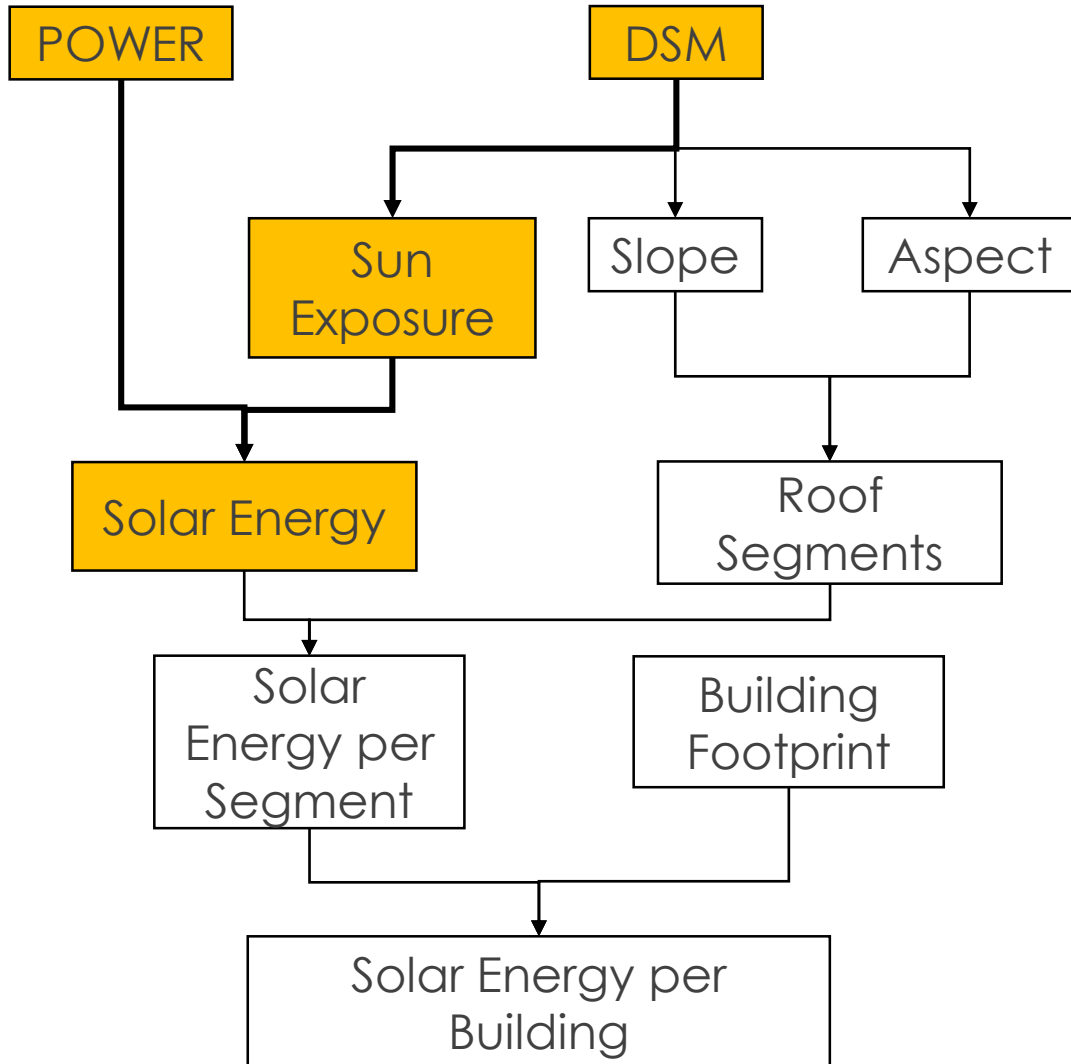


NASA Prediction of Worldwide Energy Resources (NASA POWER)

NASA POWER



Methodology



Digital Surface Model

1-ft resolution
(LiDAR)



Sun Exposure

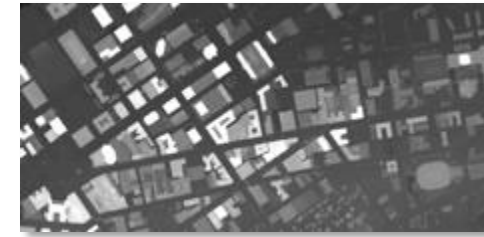
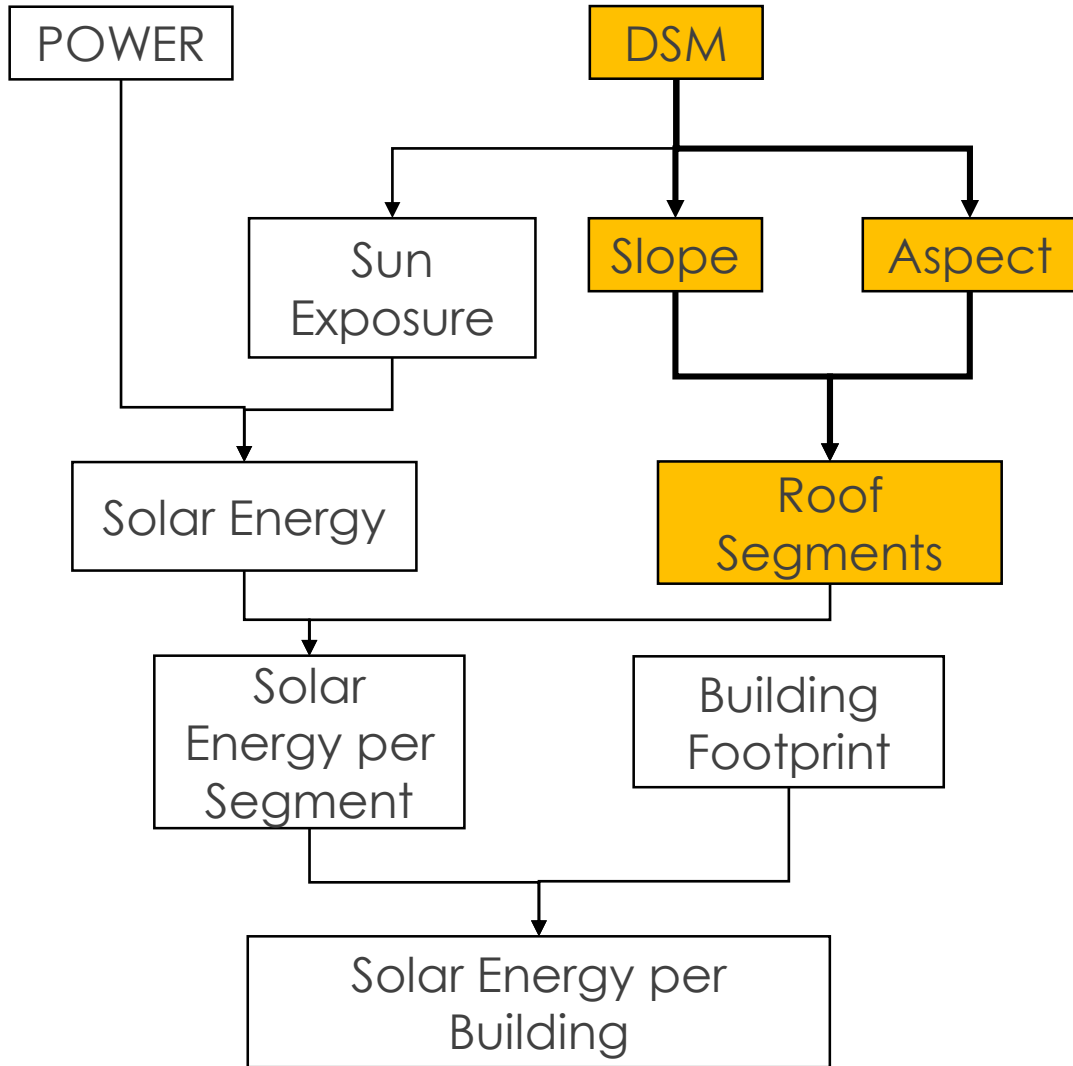
Duration of Direct Incoming Solar Radiation
(Esri Area Solar Radiation Tool)



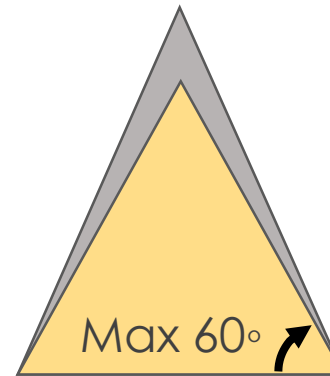
Solar Energy

Irradiation on tilted surfaces
(POWER data)

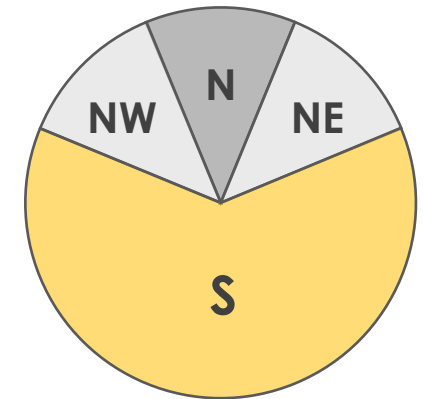
Methodology



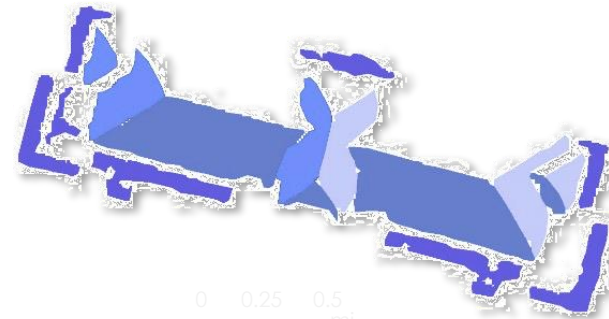
DSM



Slope

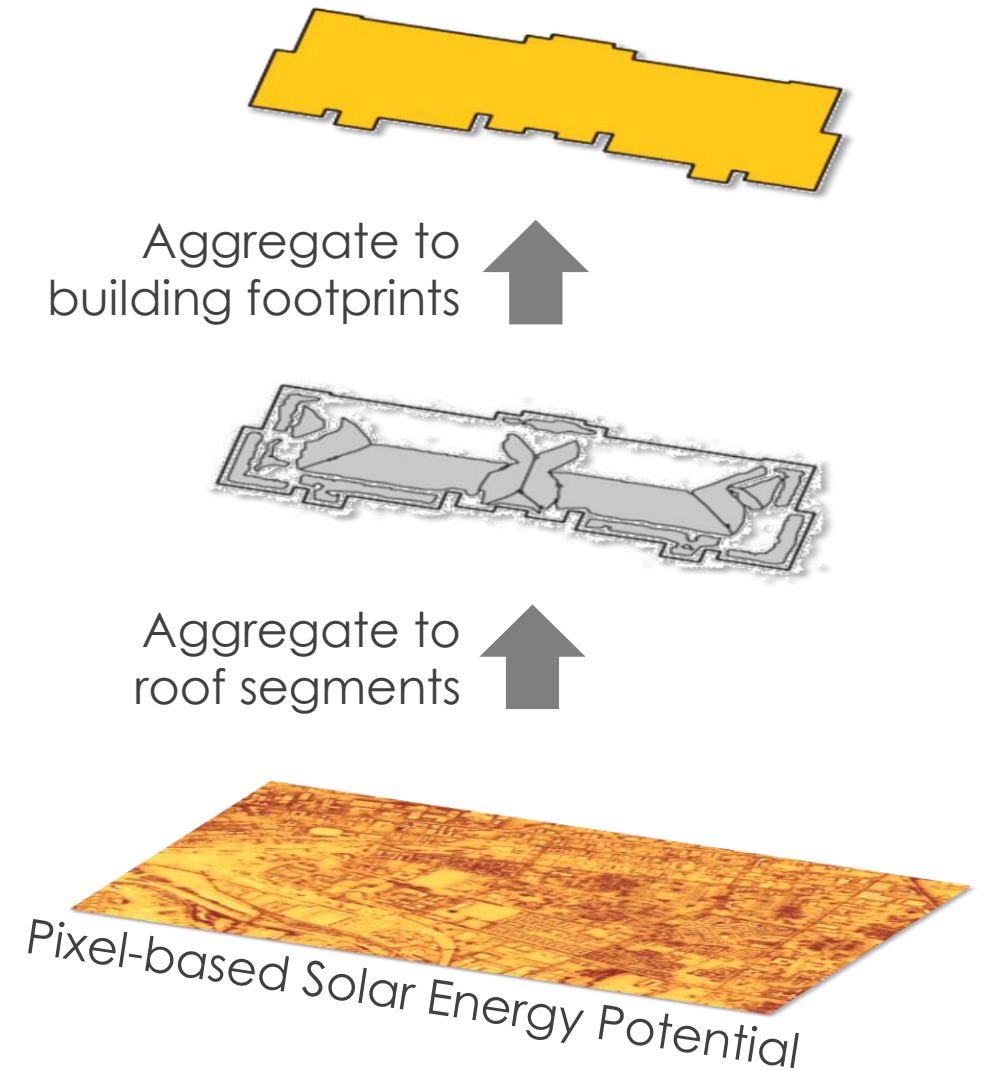
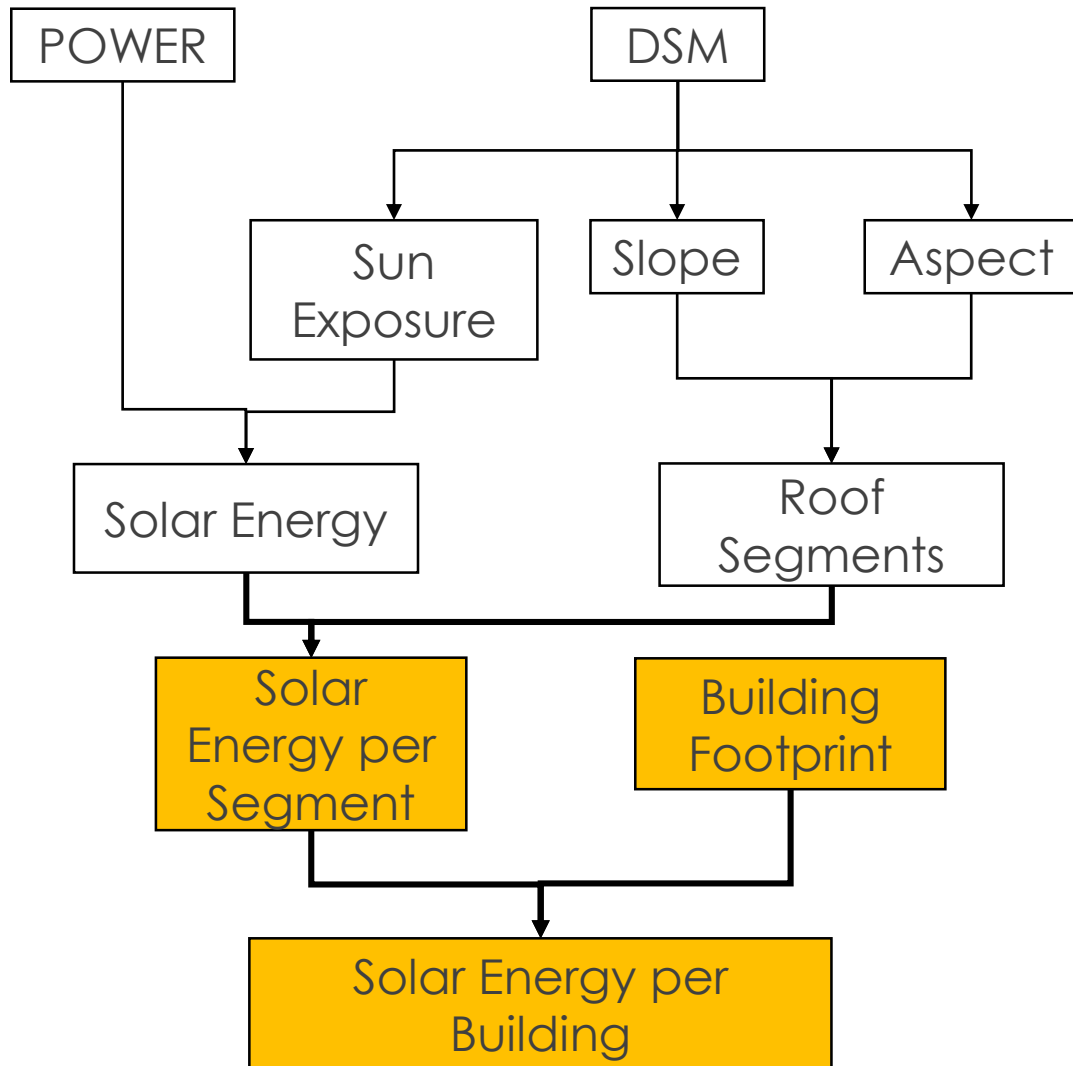


Aspect



Viable Roof Segments

Methodology



Results

Total Annual Solar Energy Potential by Building

0-50

50-100

100-150

150-200

200-250

250-3500

Total Energy (MWh/yr)

Total Annual Solar Energy Normalized by Surface Area

0.7-5

5-6

6-7

7-8

8-9

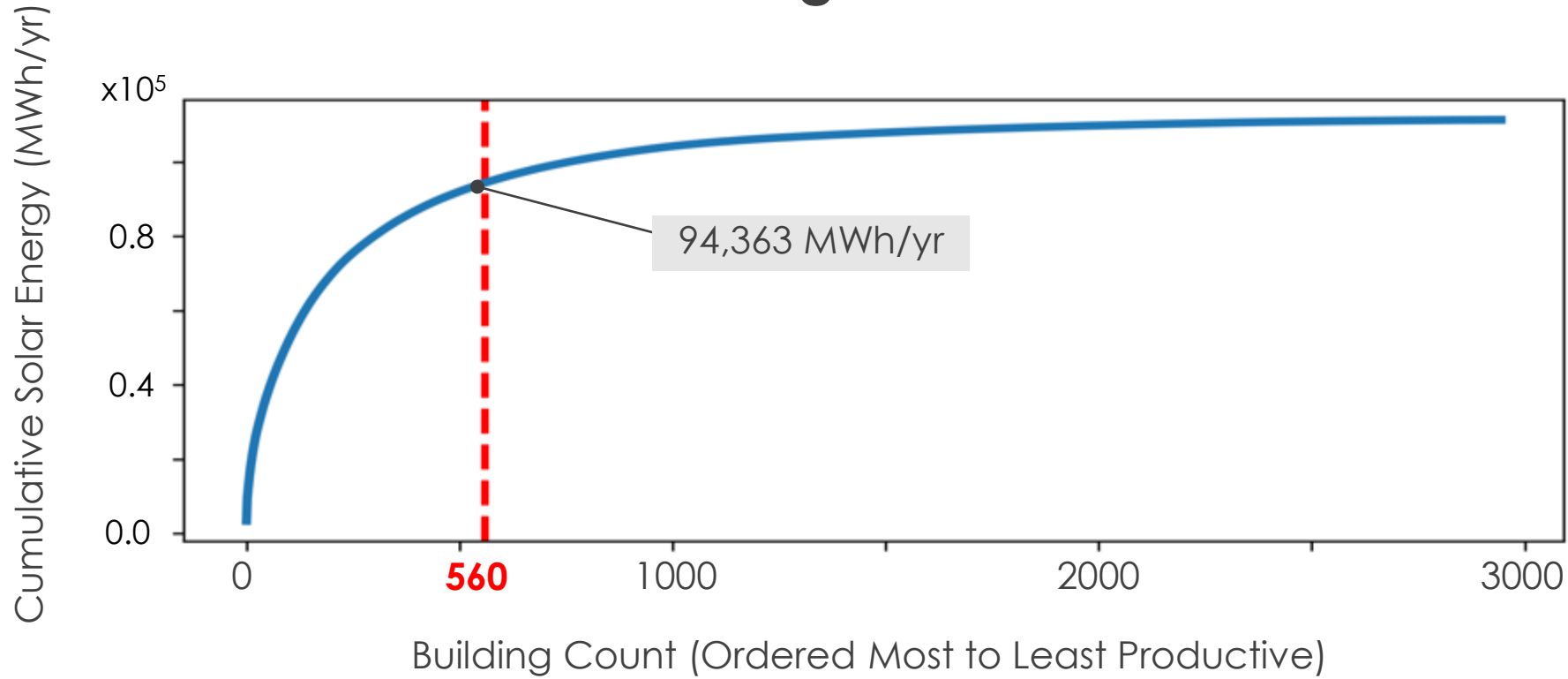
9-10.8

Normalized by Area (kWh/yr · ft²)



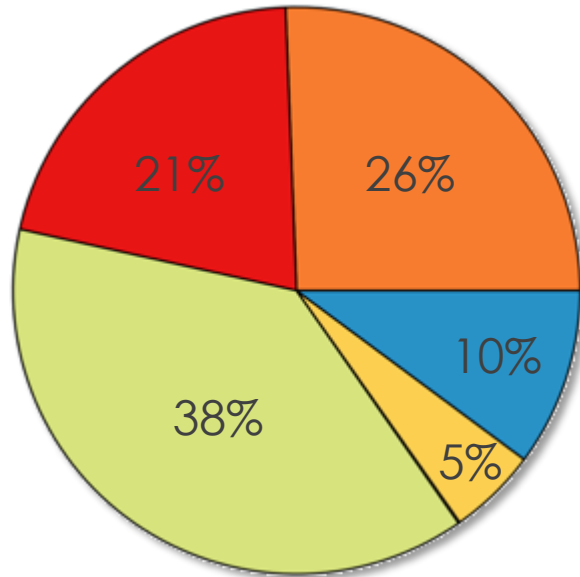
Results

85% of solar energy could be generated by 19% of buildings in test area

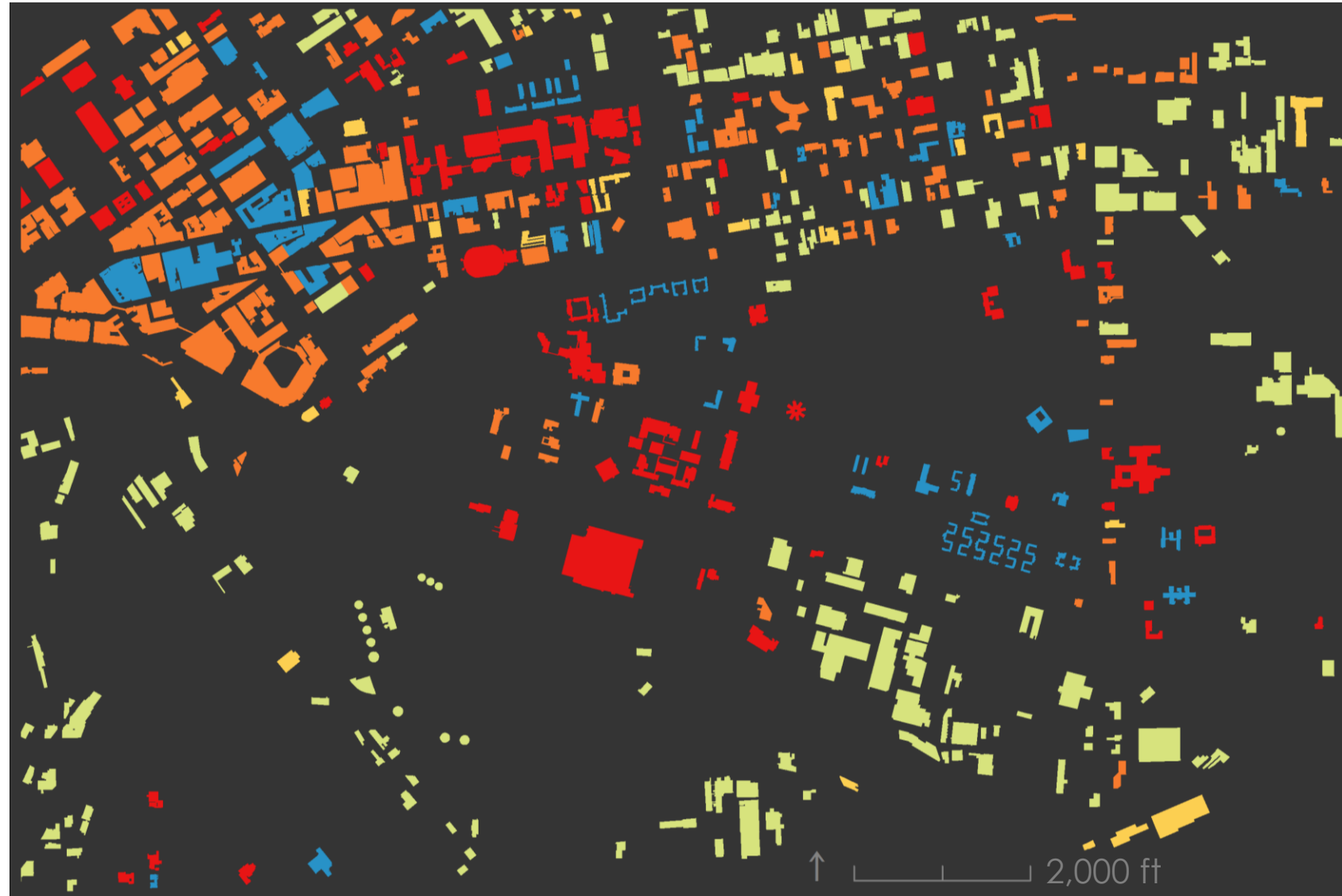


Results

Potential Energy Distribution
of the Top 560 Buildings by
Land Use



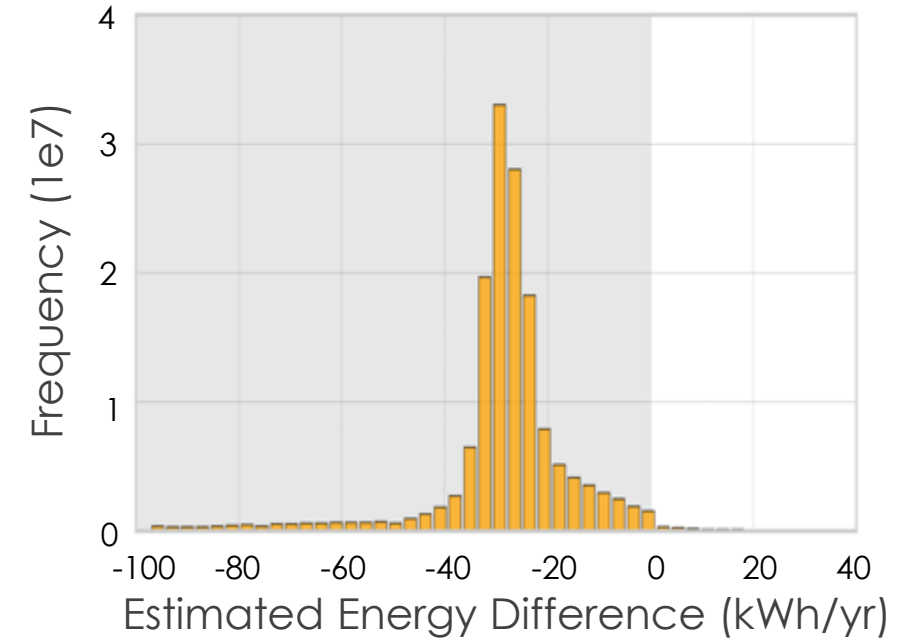
- Commercial
- Industrial
- Institutional
- Other
- Residential (1-2 Families)
- Residential (Multi-Family)



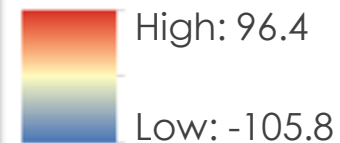
Top 560 Buildings by Land Use

Model Comparison

Solar Energy Difference by Pixel (Ohio Energy Team Estimate – Esri Area Solar Radiation Estimate)



Difference
(kWh/yr)



Max: 96.32
Min: -105.85

Conclusions



Installing solar panels on the top 560 buildings would power 9,000 typical homes for one year



Targeting the top 19% of potential rooftops across all land use types would help Cuyahoga and Cleveland reach their 100% renewable energy goals



These methods will be applied to the entirety of Cuyahoga County

ACKNOWLEDGEMENTS



NASA DEVELOP:

- ▶ **Dr. Nicholas B. Rajkovich** – Science Advisor, University of Buffalo
- ▶ **Dr. Dave Hondula** – Science Advisor, Arizona State University
- ▶ **Erika Higa** – Center Lead
- ▶ **Megan Seeley** – Geoinformatics Fellow

NASA POWER:

- ▶ **Dr. Paul Stackhouse Jr.** – Senior Research Scientist and Principal Investigator
- ▶ **Bradley Macpherson** – Geospatial and Technology Developer
- ▶ **Brian Tisdale** – Booz-Allen and Hamilton, Inc.

Partners:

- ▶ **Mike Foley** – Department of Sustainability Director
- ▶ **Dan Meaney** – Cuyahoga County Planning Commission Manager
- ▶ **Anand Natarajan** – Mayor's Office of Sustainability Energy Manager
- ▶ **Elizabeth Lehman** – Mayor's Office of Sustainability Energy Analyst

Solar Panel Experts:

- ▶ **Robert Martens** – Better Together Solar President/CEO
- ▶ **Al Frasz** – Dovetail Solar and Wind President