

Could Cambridge Host Solar Energy?

SOLAR PANEL PLACEMENT BASED ON BUILDING ELEVATION, ROOF AREA AND LAND USE IN SOUTHEASTERN CAMBRIDGE, MA

OVERVIEW

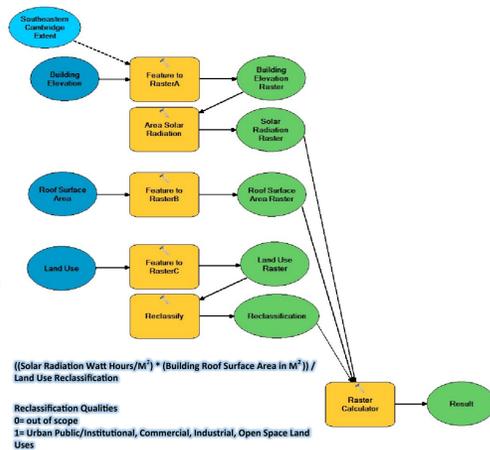
Renewable systems are a new margin of the energy sector with a growing significance. While investment has been a historically expensive process, the list of over eighty-one new Massachusetts state subsidies reduce upfront costs and interest fees, making Massachusetts one of the most cost effective states for solar energy implementation.

Cambridge, MA is a young city next to Boston, with a population of 105,162 residents and a goal of 80% reduction in greenhouse gas emissions by 2050. Catering to the young demographic, solar energy installation is a likely solution for progress, with its large return on investment, minimal visual impediment, and environment benefit. Looking to the future, where is the most efficient and cost-effective location for Cambridge to build a solar energy system? The City of Cambridge should consider building elevation, building roof area, and land use to place a solar panel field in the city's southeast corner.

METHODOLOGY

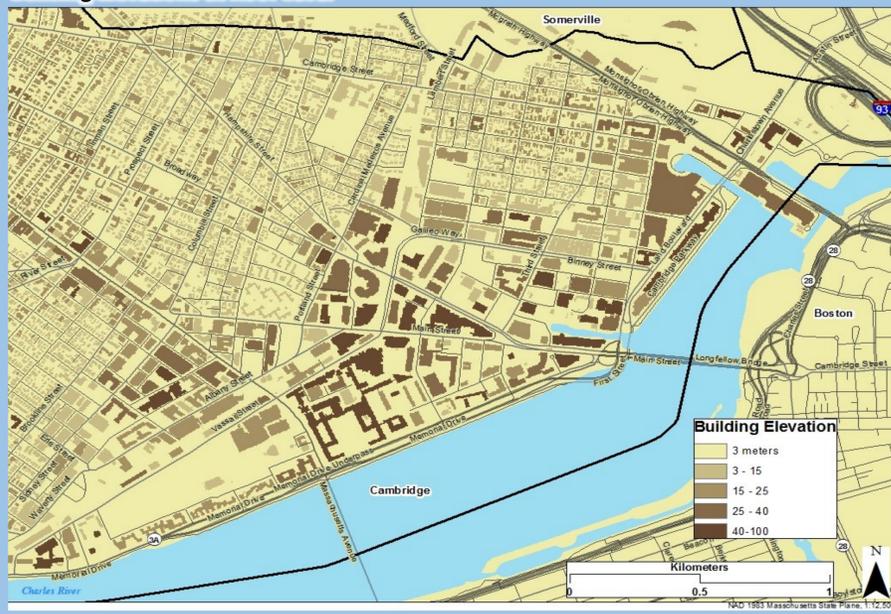
Solar panel systems are most effective when duration of sun exposure is maximized. Thus, building elevation at roof level was converted to a raster to form the input value to the Area Solar Radiation tool.

Because the height of the buildings affects solar exposure, this tool evaluates the radiation potential in watt hours per square meter on the building roofs in Southeastern Cambridge. Next, the monetary expense of system construction indicates that greater roof surface areas are most cost-effective for construction. An analysis of building roof areas was generated to identify buildings with the largest roof areas. These two aspects were factored to highlight the most ideal locations for solar panel field installation in this city. The equation used multiplies the surface area of the roof plots in square meters, by the solar radiation watt hours per square meter, to determine the total amount of watt hours each building receives on a yearly basis.

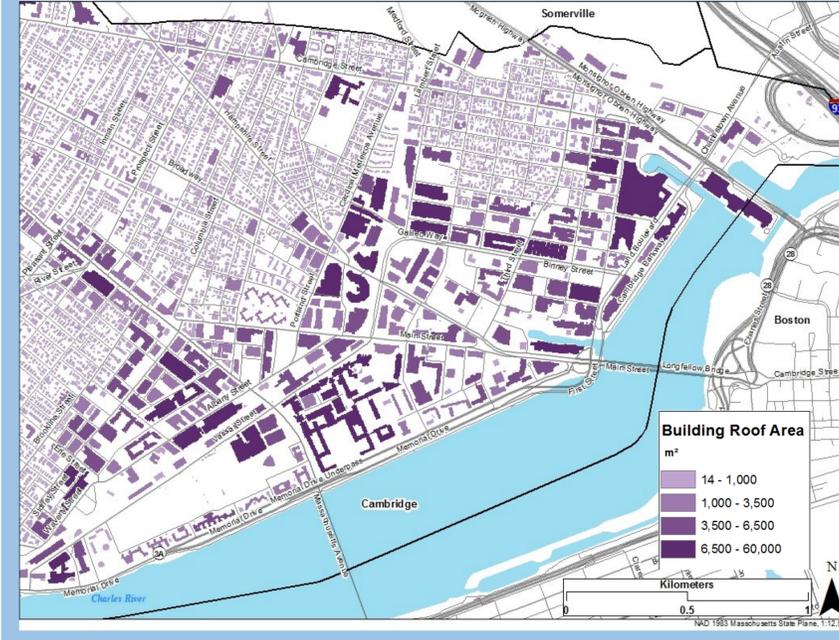


Finally, the city must consider where it has greatest authority to implement this system. The land use graphic provides the best visual understanding for placement, with a focus on urban public and institutional buildings, because of accessibility. Additional possible land uses include commercial, industrial, and open space land use; however are likely to present more of an obstacle in terms of cost, interference, and environmental impact. To focus upon these four specific land use qualities, the reclassification is included in the raster calculator to produce results only within desired land use qualities.

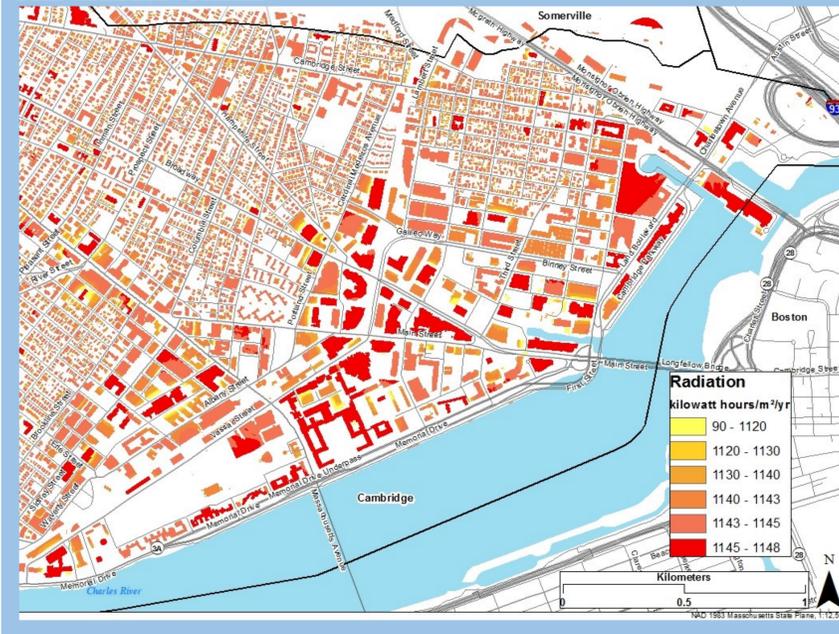
Building Elevations at Roof Level



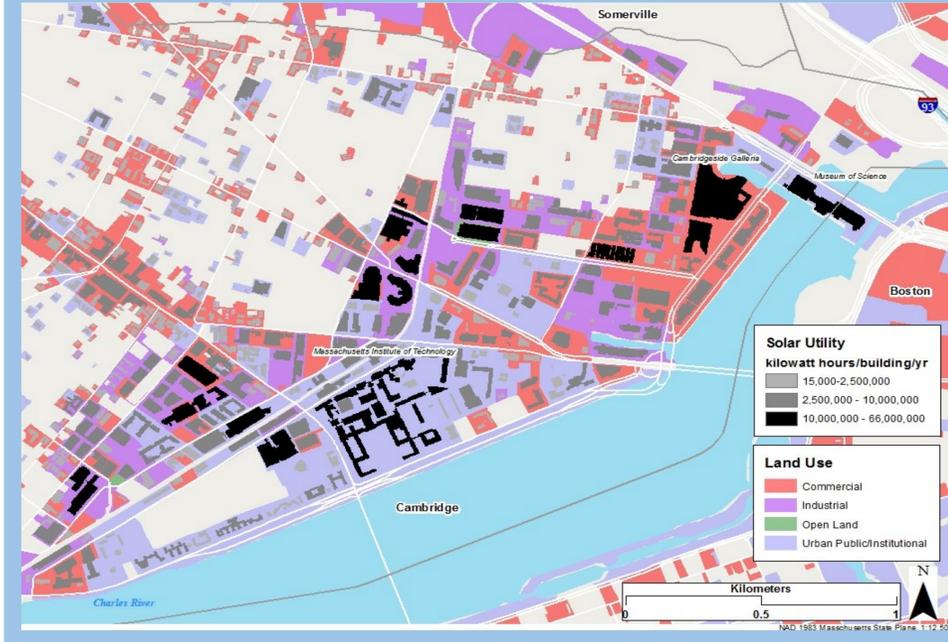
Building Roof Surface Area



Solar Radiation Potential



Solar Utility



RESULTS

The results of this model, displayed by the grayscale classes, indicate the buildings that the City of Cambridge should consider for solar panel field implementation. The land use parcels overlain represent the feasibility of implementation. Some of the most efficient and cost-effective building spaces include Massachusetts Institute of Technology, Cambridgeside Galleria, and the Museum of Science, located on urban public and institutional land and commercial land. The solar potential of these three buildings alone sum to over 400 million kilowatt hours of energy potential per year. While panels cannot yet convert all potential energy to realized energy, these structures can expose panels to the greatest amount of potential energy possible.

This series of visual overlay maps may be used as a visual informant for Cambridge Community Development decision-makers as this department works to address energy efficiency goals. The maps can be used individually depending on weight of the variables, leaned with interest toward a stronger radiation potential or a greater building area, in addition to the final computed map effect for hotspots. All data can be quantified for specific impact.

CONCLUSION

Ultimately, this data representation serves as an initial analysis. Because there are so many factors that determine feasibility of installation, it is impossible to highlight individual buildings as hotspots of focus for installation. Additional aspects important for consideration also include slope of roof, in addition to building ownership, business and working relations, city authority, and cost. Site visits and conversations are necessary, though this model serves as an initial start for planning and further analysis.

LIMITATIONS

As with any modeling process, it is important to consider the external validity of this model's inputs and results. In this model, there are select limitations. Primarily, this subject area is only a small portion of Cambridge, so a broader subject base might be more valuable. A second critical aspect concerns how the building roofs are mapped. The Cambridge building roof elevation layer polygons are mapped using a slightly different shape and size than the polygons of the MassGIS building roof area polygon layer. This discrepancy, due to analysis techniques and minimum mapping units and scale, affects the accuracy of the final solar utility values. If closely comparing location options, the City should consider that the values combining solar radiation potential and building area might have mild skew. Finally, this analysis assumes that the roof areas within the land use boundaries are flat, as public/institutional, commercial, and industrial buildings and open space often are. Slope of roof and obstructions on the roofs mean that this model is likely an overestimate of reality, and should be noted accordingly. Despite this overestimate, these overlay maps have implications for decision-making at the City level. A more comprehensive model would include the entirety of Cambridge, data about available roof capacity, and data from site visits that better define polygon accuracy.

Data Sources

MassGIS: Land Use 2005, Building Structures 2015, Roads 2014, Hydrography 2010.

City of Cambridge: Building Elevation 2010, published by GeoData at Tufts; Community Development Department 2015; Statistical Profile, 2011.

U.S. Department of Energy, North Carolina Clean Energy Technology Center 2015.

State of Massachusetts, Energy and Environmental Affairs 2015.

