Utility-Scale Solar Suitability Modeling

An analysis of site suitability and land conversion for large-scale solar development in Wisconsin

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Introduction

As Wisconsin has no substantial in-state fossil fuel resources, reliance on a non-renewable-based energy profile leads to an energy spending deficit of $14.4 billion. This profile is rapidly shifting, however. There is increasing development of utility-scale (greater than 100 megawatts) photovoltaic production, including several projects under construction and in the queue. Through an executive order in 2019, Wisconsin Governor Tony Evers pledged that net-zero CO2 emissions by 2050. In doing so, plans in 2020 to eliminate coal from its generation portfolio by 2040 and achieve net-zero CO2 emissions by 2050. In doing so, they have simultaneously set about increasing their solar production. They are on track to add over 1000 megawatts of solar power by the end of 2023 with the creation of 12 solar farms across nine Wisconsin counties.

Methods

This methodology is based, in part, off the work of Janke and Carlisle and Grandstrand. The flowchart (Figure 2.1) illustrates the GIS suitability modeling process, completed in ESRI ArcGIS Pro software. Several input datasets were considered. Proximity to Infrastructure: Line and point features of current electric power transmission lines and substations were sourced from Homeland Infrastructure Foundation-Level Data (HIFLD). While the HIFLD data may contain some inaccuracies, the most current data are retained as confident due to security concerns by the Public Service Commission of Wisconsin (PSC) and individual utilities. The Euclidean Distance geoprocessing tool was utilized to create distance rasters of these two features. Each was reclassified with rankings to favor land within one mile of existing transmission lines and within two miles of substations.

Land Use & Cover: Parcel polygons and assessor-assigned property classes were retrieved from the Wisconsin Statewide Parcel Map Initiative. Property classes are one way to help account for potential human interests within the suitability model (e.g., NIMBY). Areas designated as exclusively agricultural or undeveloped were ranked most favorable. All “exempt” parcels were excluded from analysis, which accounts for protected lands, such as state parks, and other public land.

Land cover was classified from the National Land Cover Database (NLCD). Agriculture, pasture, and barren lands were ranked most suitable. Grasslands, while generally favorable terrain-wise, were assigned a lower ranking to account for their significance as a natural resource. Forests, wetlands, open water, and developed areas were ranked lowest.

Terrain: Lastly, a percent slope raster was derived from the U.S. Geology Survey’s 10-meter resolution National Elevation Dataset as compiled by the Wisconsin Department of Natural Resources. Given its ability to hinder, or entirely prevent, a solar development, terrain was given significant consideration. While there is no consensus on what is too steep for large-scale solar, some studies have addressed this question. The slope model was reclassified into two classes: areas less than or equal to 5% and areas greater than 5% rise. The terrain of the latter class is not suitable for solar development and was assigned a suitability score of 0.

Weighted Analysis: The group of re-classified input data were subsequently weighted and combined using Weighted Sum Analysis. The assigned weights (Table 2.1) serve as multiples of the assigned individual suitability ranking. For example, an area ranked as 3 (most suitable) given its proximity to transmission lines, is multiplied by a weight of three. As transmission lines are considered of the most important considerations in identifying suitable land.

Measuring Suitable Land:
The polygon parcel layer was again used to assign suitability by legal boundary. The mean score was calculated within each non-exempt parcel. This analysis can be further applied by adding other parcel selection constraints (see Case Study: Portage County, at 71 right).

Conclusion

Given a capacity factor of 38% in Wisconsin, a 1 MW solar farm produces 1,576.8 megawatt hours (MWh) annually. Therefore, to meet the COWS projection necessary development totals 24,874 MW solar capacity converting 242,470 to 345,478 acres of land (5-7 acres per 1MW). In considering several land characteristics as criteria in this study, 889,172 acres were found to be highly suitable for UPV solar development and 122,872 acres (26.3% of that required by the projection).

While suitability analysis proves a valuable tool for modeling, the output results remain estimations. Further indepth analysis is critical to determine true suitability on more local levels. For example, consideration of areas of cultural and natural significance may prove decisive for a specific site.

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References

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