Understanding How Siting Ordinances Impact Wind and Solar Resource Availability

Wesley Cole, Anthony Lopez, Brian Sergi, Aaron Levine, Jesse Carey, Cailee Mangan, Trieu Mai, Travis Williams, Paul Pinchuk, and Jianyu Gu

Publicly Available State & Local Data

We surveyed state and local zoning ordinances across the contiguous United States to understand the types and frequency of ordinances that could impact the development of wind and solar—and influence the ability to achieve decarbonization.

The publicly available data sets include over **1,800 ordinances for wind and 800 ordinances for solar in 2022**.

Solar Ordinance Database: https://data.openei.org/submissions/5734
Wind Ordinance Database: https://data.openei.org/submissions/5733

Wind (multiplier by tip height)		Percentile			
Feature(s)	Counties	25%	50%	75%	90%
Road, Transmission, Rail	587	1.1	1.1	1.45	2
Property Line	350	1.1	1.1	1.5	3
Structure	372	2	2	3	5
Water	66	1.2	1.2	5.3	10.6

PV (fixed meters)					
Feature(s)	Counties	25%	50%	75%	90%
Road, Transmission, Rail	140	18	30	46	76
Property Line	226	12	15	30	46
Structure	135	46	61	122	152
Water	11	23	30	38	76

Setback distances for the 25%, 50%, 75%, and 90% percentiles based on the 2022 summary of ordinances. Wind setbacks are a multiplier of the tip-height. Solar PV setbacks are fixed meters.

Increasing Siting Ordinances

During our ordinance collection effort, wind ordinances alone **increased more than 6-fold in 4 years**. Zoning ordinances are wide-ranging. The most common types in 2022 were setbacks (required distance) from structures, roads, and property lines; sound restrictions; and height limits.

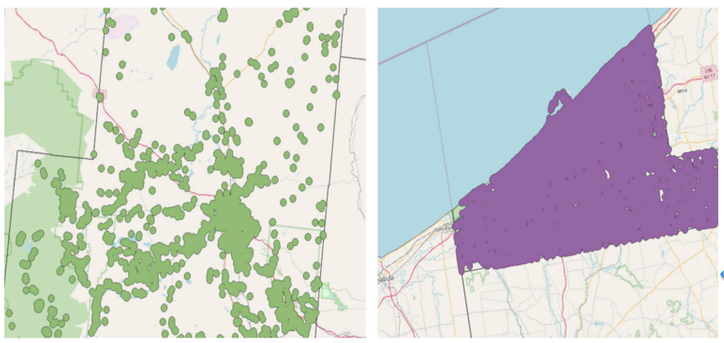
The massive growth in zoning ordinances for wind demonstrates that jurisdictions have actively been developing ordinances for their regions.

Modeling Setback Ordinances

Using geospatial modeling, we conducted analysis of siting ordinances and the impact on available land, focusing specifically on setbacks because:

- They are the most common siting constraint
- They have previously been shown to limit wind potential
- Information is readily available for modeling.

NREL extrapolated ordinances to the rest of the county using ordinance percentiles in the scenarios.

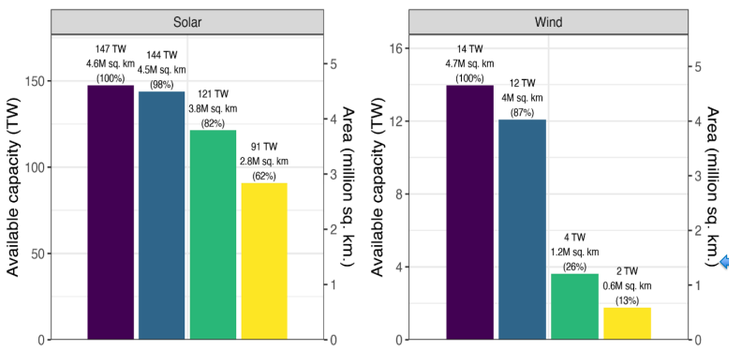


Example structure setbacks for Albany County, Wyoming (left), and Erie County, Pennsylvania (right), using a 5.5 × tip-height setback for Albany County and a 5 × setback for Erie County.

Profound Impact on Wind Potential

Solar and wind have approximately the same available land area with no zoning ordinances imposed but because of the higher capacity density of solar, its available capacity is approximately an order of magnitude higher than wind.

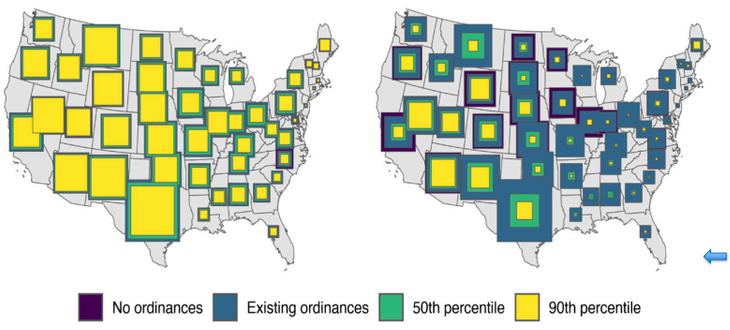
Modeling results show existing zoning ordinances have a marked impact on wind, **reducing wind resources by 13%. Solar resources reduce solar by 2%.**



Available land for solar PV (left) and wind (right) development in the contiguous United States. The baseline with No Ordinances is based on an open-access siting regime where only legally excluded land has been removed. The values over the bars show the absolute amount of the bar as well as the percent reduction from the No Ordinances case.

Extrapolating the 50th percentile of ordinance setbacks to all counties without an existing ordinance **reduces wind resources by nearly three-quarters**, **while solar declines by a more modest 17%**.

Using the 90th percentile of setbacks drops wind to 13% of its original potential, or approximately **2 terawatts of available capacity**. Solar still maintains over one-half of its original potential, with **91 terawatts of capacity**—meaning even if the most stringent setbacks are proliferated to all U.S. regions, there could be sufficient solar to meet the needs envisioned in fully decarbonized futures.



Land area available for solar (left) and wind (right) for the four levels of siting ordinance restrictiveness. For both solar and wind, more land is reduced in the east compared to the west, although wind is impacted to a much greater extent than solar.

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding was provided by U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) Solar Energy Technologies Office (Award Number 38421) and Wind Energy Technology Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Siting and Environmental Compliance Conference 2023
Albuquerque, New Mexico
March 28–29
NREL/PO-6A40-85461