ONSHORE WIND POWER

Onshore wind energy production is one of the most affordable types of renewable energy, competitive in price with coal and natural gas.[1] The global weighted average cost of onshore wind energy in 2019 was $0.053/kWh (with the lowest being around $0.03/kWh without financial support).[2] In the U.S., onshore wind power can cost as little as $0.01/kWh to $0.02/kWh after federal production tax credits are applied.[3]

In the U.S., total potential capacity for onshore wind is estimated at 11 TW,[4] while current installed capacity in the U.S. is only 0.12 TW,[5] indicating that there is still plenty of room to grow. In the U.S., all states have some technical potential for onshore wind power, but the greatest resource is located in the western and central Great Plains (see Figure 1). In the eastern and western U.S., the wind resource is more limited in coverage and more likely to be affected by competing land uses. Texas leads the nation in installed capacity and accounts for roughly 17% of the entire U.S. technical potential.[6] Onshore wind produces the majority of in-state electricity usage for some states (Iowa, North Dakota, and Kansas), and sixteen states produce at least 10% of their in-state electricity through onshore wind.[7] Like solar, wind is intermittent, requiring it to be paired with energy storage or other electricity sources in order to provide round-the-clock supply.

Often, the best locations for wind power generation are far from urban centers, which requires the electricity they generate to be transmitted long distances, which drives up costs. At the same time, wind farms can help rural communities diversify their economies while providing affordable clean energy.[8] Although wind farms as a whole take up a lot of space, each turbine does not, enabling farming to take place between turbines. In theory, co-siting wind turbines with agricultural use can provide many co-benefits; some studies even suggest that placement of turbines can increase corn and soybean yields by improving the microclimates for these crops.[9] However, there are also potential downsides: leasing farmland to wind farm developers

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[1] Project Drawdown. “Onshore wind turbines.” https://drawdown.org/solutions/onshore-wind-turbines

[2] IRENA. Wind power. https://www.irena.org/costs/Power-Generation-Costs/Wind-Power

[3] DOE. “Advantages and disadvantages of wind energy.” https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy

[4] IRENA. 2021. *Renewable capacity statistics 2021.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Apr/IRENA_RE_Capacity_Statistics_2021.pdf

[5] DOE. 2020. “U.S. installed and potential wind power capacity and generation.” https://windexchange.energy.gov/maps-data/321

[6] NREL. 2012. *U.S. renewable energy technical potentials: A GIS-based analysis.* https://www.nrel.gov/docs/fy12osti/51946.pdf

[7] DOE. 2021. *Land-based wind market report: 2021 edition.* https://www.energy.gov/sites/default/files/2021-08/Land-Based%20Wind%20Market%20Report%202021%20Edition_Full%20Report_FINAL.pdf

[8] World Resources Institute. 2020. *America’s new climate economy: A comprehensive guide to the economic benefits of climate policy in the United States.* https://files.wri.org/d8/s3fs-public/americas-new-climate-economy.pdf

[9] Retik, Benjamin (May 11, 2021). “The mutual benefits of wind energy and agriculture.” *Guidehouse Insights. https://guidehouseinsights.com/news-and-views/the-mutual-benefits-of-wind-energy-and-agriculture*

can imply a loss of autonomy for farmers; construction can cause soil compaction; turbines can make it impossible to use crop-dusting planes; and turbines can be unpleasant and potentially even dangerous to live and work around.[10]

Wind power (onshore and offshore combined) is responsible for an estimated at 13 grams CO_2e/kWh in lifetime carbon emissions, which is one of the lowest values of any energy source.[11]

Onshore wind sometimes faces opposition from community members who are concerned about viewshed impacts and noise, and from conservationists concerned about bird and bat collisions. Additional ecological impacts may occur if forests are clear-cut to make room for wind turbines. Like offshore wind and solar PV energy, onshore wind requires various minerals (e.g., aluminum, chromium, copper, iron, lead, manganese, molybdenum, neodymium, nickel, and zinc) and it is important to consider environmental, social, and geopolitical aspects associated with sourcing these minerals. Copper use for onshore wind is around 2,900 kg/MW, which is higher than for conventional fossil fuel energy and solar PV, but lower than for offshore wind.[12]

- Fishery friendliness: Impacts on aquatic and marine ecosystems and resources are not a major concern for onshore wind. Since the surface power density of onshore wind is far lower than that of conventional energy sources, widespread deployment of onshore wind will inevitably alter land use patterns, and planning efforts should endeavor to avoid any negative impacts to watersheds. Like many renewable energy and energy storage technologies, onshore wind depends on minerals, including copper, the sourcing of which can have negative implications for the health of fishery ecosystems and resources.[13]
- Co-benefits: Onshore wind can provide income diversification for farmers when located on farms.
- Environmental externalities: Onshore wind turbines can pose obstacles to bird migrations and can cause bird and bat mortalities through turbine strikes. Onshore wind development can impact forests if sited in forested areas (though this is resolvable through proper siting).

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[10] McBride Mensching, Leah (August 24, 2017). “Wind energy isn’t a breeze.” *Slate*. https://slate.com/technology/2017/08/why-farmers-in-iowa-hope-wind-energy-will-blow-over.html

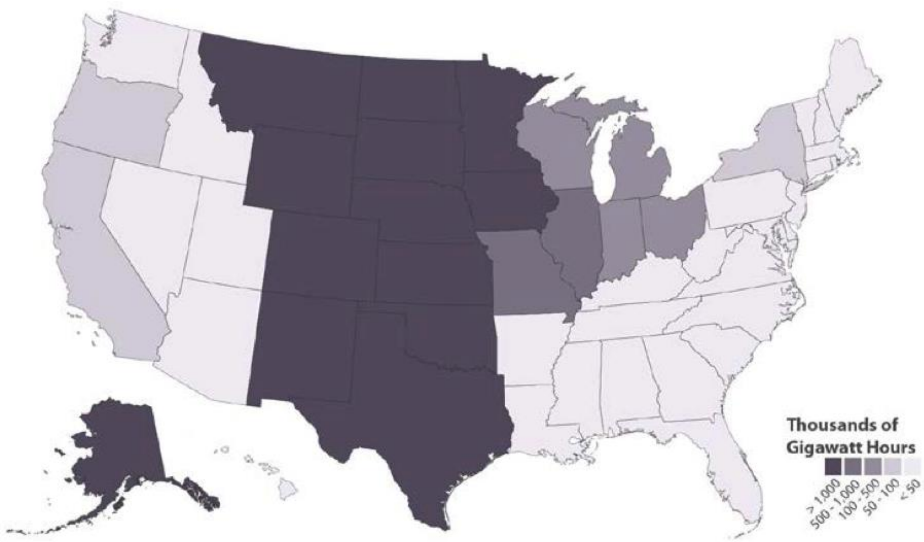
[11] NREL. 2021. “Life cycle greenhouse gas emissions from electricity generation: Update.” https://www.nrel.gov/docs/fy21osti/80580.pdf

[12] IEA. 2021. *The role of critical minerals in clean energy transitions.* https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

[13] Woody, Carol Ann and Sarah Louise O’Neal. 2012. *Effects of copper on fish and aquatic resources.* Prepared for The Nature Conservancy. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/sw/cpa/Documents/W2013ECopperF062012.pdf

- Policy catalysts: Wind energy development is already progressing rapidly, but could be accelerated by through tax incentives, standard offer contracts including feed-in tariffs, net metering programs, interconnection standards, grants, financing mechanisms, utility green power options, renewable/clean energy standards, and carbon pricing.
- More information:
  - Drawdown: Onshore wind turbines
  - Department of Energy: U.S. installed and potential wind power capacity and generation
  - Wikipedia: Wind power in the United States
  - Department of Energy: Advantages and challenges of wind energy
  - Wind Exchange: Land-based wind energy economic development guide
  - Energy Sage: Wind energy pros and cons

Figure 1. Total estimated technical potential for onshore wind power in the U.S. Source: NREL 2012. [14]



Continue reading at https://fisheryfriendlyclimateaction.org/solutions

[14] NREL. 2012. *U.S. renewable energy technical potentials: A GIS-based analysis.* https://www.nrel.gov/docs/fy12osti/51946.pdf