

Renewable Energy Equipment Recover-Reuse Program: Wind Turbine Material Management

PROGRAM BACKGROUND AND HIGHLIGHTS

Established in 1984, the Illinois Sustainable Technology Center (ISTC), a unit of the Prairie Research Institute at the University of Illinois Urbana Champaign, sits at the forefront of pollution prevention research, outreach, and technical assistance to solve environmental problems and conserve natural resources since its creation.

After the Illinois General Assembly passed legislation in 2018 to upgrade the state's energy mix, ISTC began to mobilize a team of diverse experts to address the recovery challenges and opportunities of increasing use of renewable energy technologies required by the state's renewable portfolio standard (RPS).¹



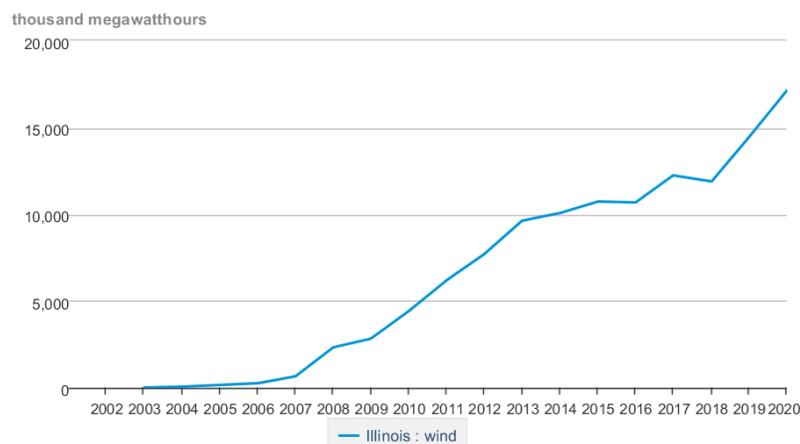
Disposal of wind turbine blades at the Casper Regional Landfill in Wyoming.

Credit: Benjamin Rasmussen for Bloomberg Green

WIND ENERGY GROWTH

Wind energy development has dramatically changed the global energy landscape over the past few decades. In 2006, the first utility scale wind farm was installed in Illinois. Since then, wind energy development has quickly expanded to include over 3,000 utility scale wind turbines installed across most of the state.² Through the RPS requirements, Illinois will continue to see wind development growth across the state in the future.

Net generation for all sectors, annual



Annual Illinois Net Wind Generation³

¹Illinois General Assembly, Public Act 102-0662, 2021

²Hoen, B.D., Diffendorfer, J.E., Rand, J.T., Kramer, L.A., Garrity, C.P., and Hunt, H.E., 2018, United States Wind Turbine Database (v4.1, (July 21, 2021): U.S. Geological Survey, American Clean Power Association, and Lawrence Berkeley National Laboratory data release, <https://doi.org/10.5066/F7TX3DN0>

³U.S. Energy Information Administration

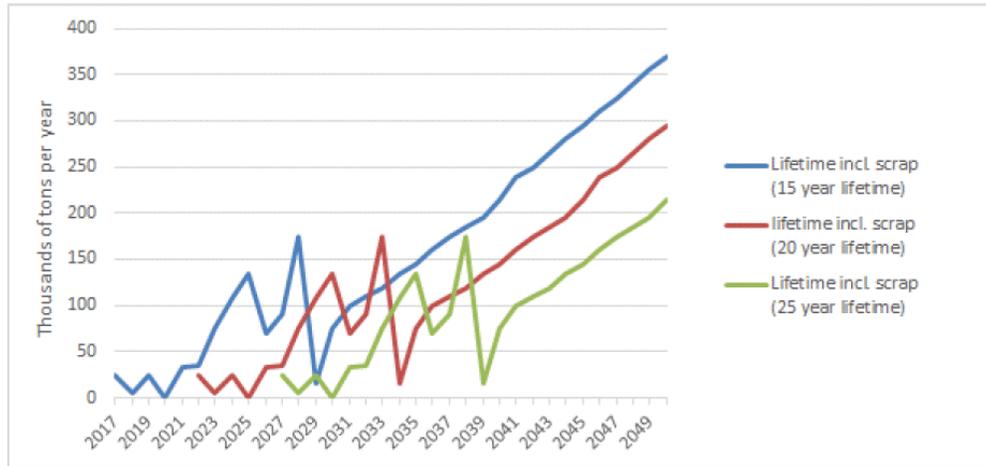
WIND TURBINE MATERIAL MANAGEMENT GOALS:

- ▶ Create stakeholder partnerships and conduct yearly stakeholder meetings to evaluate issues and solutions for the next 5-10 years
- ▶ Creation of a repository of recycling and reuse processes and technologies
- ▶ Coordinate with counties and local governments on decommissioning planning to evaluate recovery efficacy for specific regions across the state
- ▶ Identify, evaluate, and direct research for cost-effective collection, transportation, reuse, recycling, and secondary material markets
- ▶ Build business partnerships and collaborations to create a recovery pilot facility in Illinois

WIND TURBINE MATERIAL MANAGEMENT AND END-OF-LIFE ISSUES AND CONCERNS

Research has found that a wind machine's service life is between 15-25 years. It is estimated that the U.S. will have from 182,000 to 336,000 metric tons of wind blade waste per year by 2050.⁴ Currently most of the mechanical components of the turbine are recycled at the end of the machine's life. However there are challenges with recycling and recovery of blades.

Blades are composed of glass fibers, carbon fibers, thermoset or thermoplastic polymers, and metals, which make them difficult to transport, recycle and landfill. Studies have found that most blades are landfilled or incinerated, which create air emissions and waste management issues.⁵ Researchers have explored processes for recovering damaged and end of life blade materials. These include mechanical recycling, fluidised-bed recycling, pyrolysis recycling, microwave-assisted pyrolysis recycling, chemical recycling, high voltage fragmentation recycling and blade life extension. These processes have been found to be energy and resource intensive due to transportation challenges. This makes it much less cost-effective to recover high-value materials in wind turbine blades.⁶



Estimated Annual U.S. Wind Turbine Waste (used with permission)⁴

ISTC WIND TURBINE END-OF-LIFE WORKING GROUP

Beginning in 2021, the Wind Turbine Materials Management Team in ISTC's Renewable Energy Equipment Recover-Reuse Program is coordinating a group of experts across various sectors in wind energy and waste management to evaluate waste management concerns related to wind energy development in Illinois. The intent of this focus area of the Program is to develop technical and logistical recommendations for end-of-life wind energy materials management in Illinois and other utility-scale wind states in the Midwest.

⁴Electric Power Research Institute, Wind Turbine Blade Recycling Preliminary Assessment report, 2020

⁵Psomopoulos, et al., A Review of the Potential for the Recovery of Wind Turbine Blade Waste Materials, 2019 and Sakellariou, Current and potential decommissioning scenarios for end-of-life composite wind blades, 2017

⁶Jensen, et al., Wind turbine blade recycling: Experiences, challenges and possibilities in a circular economy, 2018



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**ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
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