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Fact Sheet: Wind Turbine Blades

The Compliance Monitoring and Enforcement (CME) Task Force within the ASTSWMO Hazardous Waste Subcommittee and the Sustainable Materials Management (SMM) Task Force within the ASTSWMO Materials Management Subcommittee collaborated to produce a series of three fact sheets on emerging wastes from renewable energy sources: lithium-ion batteries with a focus on electric vehicle batteries; solar panels; and wind turbine blades. The fact sheets are intended to be living documents to be periodically updated with new information.

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Wind Turbine Blades

A wind turbine, or windmill, is a machine that utilizes wind to make electricity. There are two types of wind turbines, the horizontal-axis and the vertical-axis wind turbine. The most commonly installed wind turbine is the horizontal-axis wind turbine (HAWT). HAWTs have three blades and operate “upwind,” with the turbine pivoting at the top of the tower to allow the blades to face the wind. Most of the tower materials are composed of steel, copper wire, and electronics that can be recycled or reused. The turbine blades are more challenging to recycle because of the glass fiber and plastics used to manufacture them.

A good amount of detail goes into the engineering and manufacturing of the turbine blades to maximize efficiency and durability. Manufacturing of wind turbine blades uses a process called vacuum assisted resin transfer molding. This involves layering fibers and materials over the molds for the aeroshell structures, and sealing them within a vacuum bag. The resin is then infused and cured at room temperature, after which they are subjected to quality control measures to check for any manufacturing defects. Ensuring defects are minimized is extremely important due to the lack of recycling opportunities and because of the high cost of materials used in the manufacturing of turbine blades. As more wind turbines are being installed throughout the U.S., States that have had wind turbines, such as Nebraska, New York, and Wyoming, have begun examining end-of-life concerns surrounding turbine blade recycling and disposal.

This fact sheet is intended to provide an overview of the potential environmental concerns presented by turbine blade disposal, and a summary of federal regulation and recycling opportunities currently available. Additionally, it provides an overview of State approaches, including laws being enacted or considered, for the handling of wind turbine blades when taken out of service.

Turbine Blade Construction

A common misconception is that turbine blades are made of aluminum, similar to airplanes. Although this was true in the past, aluminum blades proved to be too heavy, so engineers began using glass fabric, carbon fiber, and plastic. These blades pose different challenges as they are made from several layers of glass or carbon fiber infused with a liquid plastic resin. The result of this allows the turbine to operate longer, while withstanding wear and tear from weather changes and temperature fluctuation, but the change to fiberglass has made the blades difficult to dispose of or to recycle.

Handling After Decommission

Today, most wind turbine blades are landfilled when decommissioned because as noted above, the materials used to manufacture wind turbine blades render them difficult to recycle or repurpose. Landfilling the blades presents its own problems due to the material memory. In short, the blades do not easily stack without being cut, and once stacked they do not compact once covered, so premium landfill airspace is lost. The sheer length of these blades also poses management challenges. Per the U.S. Department of Energy (DOE), the average length is over 50 meters and the largest coming in at more than 100 meters. In addition, shredding wind turbine blades to address the compaction issue can be difficult due to the material compositions and specialized equipment necessary to achieve shredding. The typical lifespan of a wind turbine is 20 years and according to a study conducted by the National Renewable Energy Laboratory, if decommissioned blades continue to be buried, 2.2 million tons could end up in U.S. landfills by 2050.

Turbine Blade Recycling

Through specialized processes, turbine blades can be recycled, but markets employing these processes in the U.S. are currently very limited. Companies like Veolia have implemented some of the first recycling management of wind turbine blades in the U.S. Their process involves shredding the blades into a material for use in cement manufacturing. The company signed an agreement with GE Renewable Energy in 2020 to recycle its onshore wind turbine blades in the U.S. Similar recycling processes in Europe have proven to be effective at a commercial scale. The search continues for creative ways to use turbine blades for purposes like powerline structures, towers, and bridges. Many researchers in the U.S. and internationally are working to find more sustainable options for blade manufacturing, which may lead to a more easily recycled product in the future, but for now landfill disposal is the most cost-efficient and accessible option.

Federal Regulation

Wind turbine blades are not uniquely regulated by the U.S. Environmental Protection Agency (USEPA). Rather, they are handled like any other waste stream. Consequently, when a wind turbine blade becomes a solid waste, it is subject to the same hazardous waste determination standards as any other material. With wind farms expanding nationwide, there is an ongoing search for disposal alternatives. The current disposal methodology for the components that do not have recycling capacity, namely the turbine blades, is to place them into landfills. The lack of federal regulation has prompted some States to explore their own regulatory options to address disposal and recycling.

State Approaches

Decommissioned turbine blade disposal is becoming increasingly problematic as landfills have less space that can be dedicated for blade burial, and more wind farms are being constructed. States such as New York, Wyoming, and Nebraska are already seeing the consequences of the lack of regulation and recycling availability. In 2021, multiple cases were noted of decommissioned turbine blades found openly dumped. In response, legislation has been proposed in several States to address this situation.

New York bill A.8353 requires financial security for reclamation of solar and wind electric generating systems. This measure instructs the public service commission to establish the required amount of the bond, considering the estimated cost to reclaim the affected lands used, disposal of decommissioned equipment and the reclamation of spent materials, such as blade recycling or landfill disposal. The status of the bill is currently still active in committee for the 2021-2022 session.

In 2020, the Wyoming Legislature passed House Enrolled Act No. 68 relating to the use of decommissioned wind turbine blades and towers to backfill in surface coal mining sites as part of the mine's approved reclamation plan. To date, this activity has not occurred at coal mining sites. Blades that have been disposed of within Wyoming have been buried at the Casper, WY Regional Landfill.

Lastly, LB775 was introduced in the Nebraska legislature on January 5, 2022. LB775 prohibits land disposal of wind turbine blades and their component parts. As of April 12, 2022, this bill has been indefinitely postponed.

Additional Resources

[Materials for Wind Turbine Blades: An Overview \(nih.gov\)](#)

[Recycling of Mechanically Ground Wind Turbine Blades as Filler in Geopolymer Composite \(nih.gov\)](#)

[Recycling Wind Turbine Blades - NW Renewable Energy Institute \(nw-rei.com\)](#)

[U.S. Department of Energy National Renewable Energy Laboratory News August 2019](#)

[GE Renewable Energy Announces US Blade Recycling Contract with Veolia | GE News](#)