

# RECYCLING WIND TURBINE BLADES

Wind turbines have solidified their position in the renewable energy portfolio as countries around the world look to cut carbon emissions. Competitive development and operating costs have fueled their growth as fossil-fueled power plants are phased out. But as their numbers grow, so do disposal issues. Since 1980, more than 70,800 individual turbines have been installed in the U.S. alone, according to the U.S. Wind Turbine Database.

JOHN KOSOWATZ

Turbine blades are the biggest and longest problem in disposal. The fiberglass composite blades have about a 25-year design life, so the oldest turbines are shedding their original blades. They are not easy to dispose. Some are burned and recycling is difficult because of their composition. Most go to landfills where they take up a lot of space.

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Here is how researchers and manufacturers are building a new generation of blades

According to the **National Renewable Energy Laboratory**, most utility-scale turbine blades have the same design: two fiberglass blade skins bonded together with adhesive, and the addition of one or several composite stiffening components. They are cast together with thermoset resin systems of epoxies, polyesters, and vinyl esters. Once cured, they cross-link like brambles. That makes the blade difficult to recycle because the materials cannot easily be separated.

**NREL** has developed a thermoplastic process that can be reheated to separate the original polymers, allowing blade components to be recycled. Thermoplastic blade parts can be joined using a thermal welding process that could eliminate the need for heavy adhesives. Additionally, the new process can be produced with 3D printing.

Major wind turbine manufacturers have started producing recyclable blades. In 2021, Denmark's **Vestas** announced its CETEC project, for circular economy for thermosets epoxy composites. The three-year project enables recycling blades and looks for "full circularity" by using the reclaimed material to manufacture new blades.



Credit: Ryan Beach, NREL



Credit: Vestas



Credit: Vestas

**Siemens Gamesa** is now producing blades for offshore wind turbines using a similar process. It also wants to make every component of its wind turbines recyclable by 2014. The firm claims over 200,000 blades could be recycled if the new design were used on all new offshore projects globally projected until 2050, amounting more than 10,000,000 of recyclable material.

