NREL advanced manufacturing research moves wind turbine blades toward recyclability

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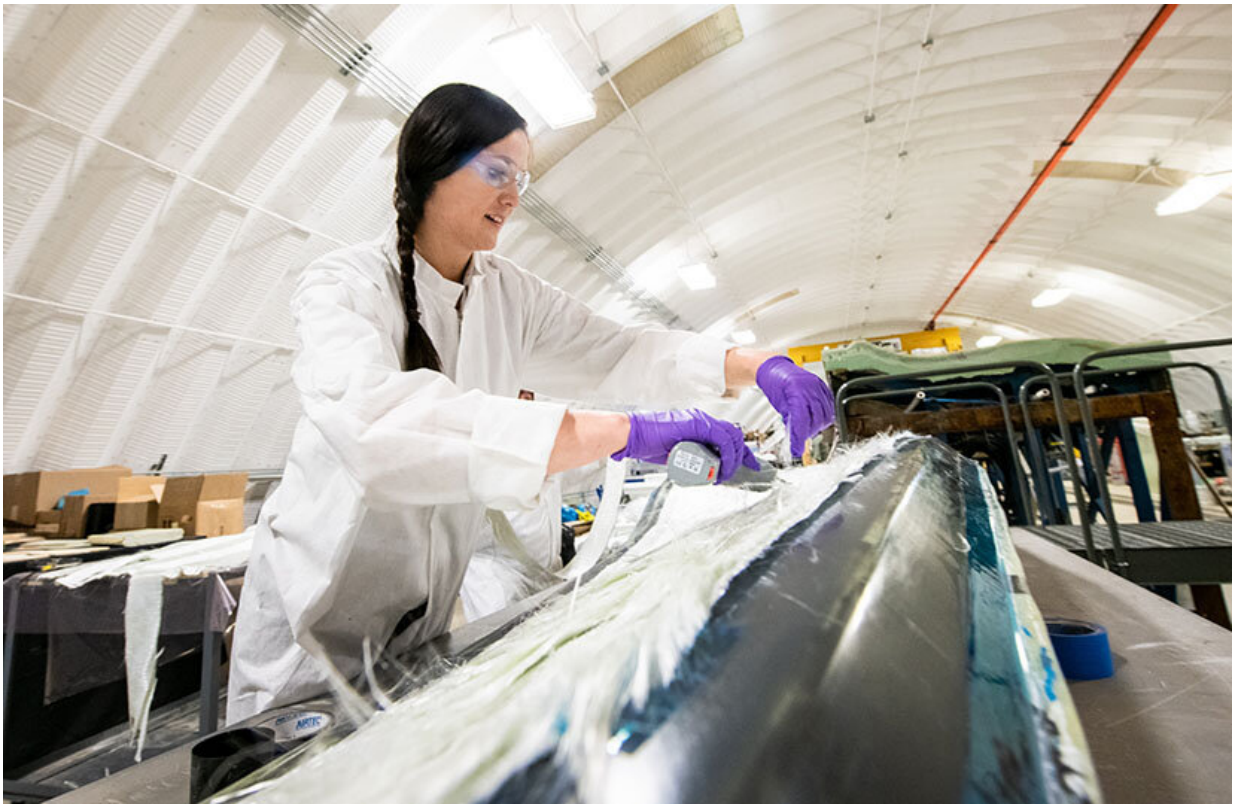

NREL researcher Robynne Murray works on a thermoplastic composite turbine blade at the Composites Manufacturing Education and Technology Facility at NREL's Flatirons Campus. Credit: Dennis Schroeder, NREL

A new material for wind blades that can be recycled could transform the wind industry, rendering renewable energy more sustainable than ever before while lowering costs in the process.

The use of a thermoplastic resin has been validated at the National Renewable Energy Laboratory (NREL). Researchers demonstrated the feasibility of thermoplastic resin by manufacturing a 9-meter-long wind turbine blade using this novel resin, which was developed by a Pennsylvania company called Arkema Inc. Researchers have now validated the structural integrity of a 13-meter-long thermoplastic composite blade, also manufactured at NREL.

In addition to the recyclability aspect, thermoplastic resin can enable longer, lighter-weight, and lower-cost blades. Manufacturing blades using current thermoset resin systems requires more energy and manpower in the manufacturing facility, and the end product often winds up in landfills.

"With thermoset resin systems, it's almost like when you fry an egg. You can't reverse that," said Derek Berry, a senior engineer at NREL. "But with a thermoplastic resin system, you can make a blade out of it. You heat it to a certain temperature, and it melts back down. You can get the liquid resin back and reuse that."

Berry is co-author of a new paper titled, "Structural Comparison of a Thermoplastic Composite Wind Turbine Blade and a Thermoset Composite Wind Turbine Blade," which appears in the journal *Renewable Energy*.

The other authors, also from NREL, are Robynne Murray, Ryan Beach, David Barnes, David Snowberg, Samantha Rooney, Mike Jenks, Bill Gage, Troy Boro, Sara Wallen, and Scott Hughes.

NREL has also developed a technoeconomic model to explore the cost benefits of using a thermoplastic resin in blades. Current wind turbine blades are made primarily of composite materials such as fiberglass infused with a thermoset resin. With an epoxy thermoset resin, the manufacturing process requires the use of additional heat to cure the resin, which adds to the cost and cycle time of the blades. Thermoplastic resin, however, cures at room temperature. The process does not require as much labor, which accounts for about 40% of the cost of a blade. The new process, the researchers determined, could make blades about 5% less expensive to make.

NREL is home to the Composites Manufacturing Education and Technology (CoMET) Facility at the Flatirons Campus near Boulder, Colorado. There, researchers design, manufacture, and test composite turbine blades. They previously demonstrated the feasibility of the thermoplastic resin system by manufacturing a 9-meter composite wind turbine blade. They followed that demonstration by manufacturing and structurally validating a 13-meter thermoplastic composite blade compared to a near-identical thermoset blade. This work, coupled with work by Arkema and other Institute for Advanced Composites Manufacturing Innovation partners, demonstrated advantages to moving away from the thermoset resin system.

"The thermoplastic material absorbs more energy from loads on the blades due to the wind, which can reduce the wear and tear from these loads to the rest of the turbine system, which is a good thing," Murray said.

The thermoplastic resin could also allow manufactures to build blades on site, alleviating a problem the industry faces as it trends toward larger and longer blades. As blade sizes grow, so does the problem of how to transport them from a manufacturing facility.

More information: Robynne E. Murray et al. Structural validation of a thermoplastic composite wind turbine blade with comparison to a thermoset composite blade, *Renewable Energy* (2020). DOI: 10.1016/j.renene.2020.10.040

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