

A sustainable solution: Compostable wind turbine blades

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Valeria La Saponara, a professor in the Department of Mechanical and Aerospace Engineering, has a vision to develop compostable, ecologically sound wind turbine blades from bamboo and mycelium. Credit: Gregory Urquiaga/UC Davis

It is the year 2035. In a world facing climate catastrophe, the human enterprise is powered by fields of wind farms, with turbine blades made

from fast-growing grasses and the roots of a million-year-old fungus.

It may sound like a scene from a climate-fiction movie, but polymer composites expert Valeria La Saponara, a professor in the UC Davis Department of Mechanical and Aerospace Engineering, has a vision to develop compostable, ecologically sound wind turbine [blades](#) from bamboo and mycelium, the fungal rootlike system that bears mushrooms.

La Saponara, co-principal investigator Michele Barbato in the Department of Civil and Environmental Engineering, and a diverse team of students and researchers in the Advanced Composites Research, Engineering and Science laboratory are testing a prototype on campus.

The environmental challenge of wind turbine blade disposal

Wind is one of the fastest growing sources of renewable energy in California and around the globe. It is a key part of California's path to carbon neutrality by 2045. China, which accounts for more than half of global wind power, is planning to build a wind farm that could power 13 million homes by 2025 as it works toward its 2060 net-zero goal.

The expanding role of wind is largely good news. But as this key source of [renewable energy](#) grows, an environmentally sound solution is needed for the exponentially growing number of wind blades bound for landfills. Wind turbine blades are huge: The average rotor diameter in the U.S. in 2021 was 418 feet, so a single blade is almost as big as a Boeing 747's wingspan. Designed to be resilient against heavy winds and weather conditions, the blades have a lifespan of about 20 years before they are retired or replaced. Most are constructed using a composite structure of fiberglass/epoxy built on top of balsa wood, which adds stability and

flexibility. Recycling options are very limited, costly, and incur the additional carbon footprint impacts of transportation.

Most wind turbine blades end up in landfills. In the U.S. alone, more than 2 million tons of decommissioned blades are projected to be sent to landfills by 2050 according to a recent study; globally, the mass of all the blades expected to be retired by 2050 may be as high as 43 million metric tons. The use of balsa wood is an additional, devastating ecological impact. Rapid growth in the wind power industry has caused overlogging in the Ecuadorean Amazon rain forest, resulting in unchecked deforestation and societal harm to Indigenous communities in the region. Some manufacturers have been switching to PET plastics, adding to the millions of tons of PET waste in the environment.

Designing compostable wind turbine blades

For La Saponara, wind blade pollution is an urgent problem.

"We want to have clean energy, but clean energy cannot pollute the environment, and it can't cause deforestation," La Saponara said. "If we're doing clean energy, it's not to deforest the Amazon rainforest. We want to be good citizens for everybody."

La Saponara envisions a compostable wind turbine blade built with woven bamboo, mycelium and biomass from the agricultural waste from California's Central Valley in place of fiberglass and balsa wood. She first began working with mycelium in 2019, when she sought an alternative to the fossil-based plastics of bike helmet liners. Mycelium is an amazingly versatile substance, and La Saponara's lab has been researching possibilities to leverage it as a low-carbon emission, low-toxicity, compostable alternative to non-degradable materials like polyurethane and acrylic.



Mycelium is the fungal rootlike system that bears mushrooms and is incredibly versatile as a material. Credit: Gregory Urquiaga/UC Davis

Scaling up to a project as large and complex as wind turbine blades is a next-level move involving a highly collaborative group.

"The project is mushrooming," La Saponara joked. "Creating this design requires work from multiple disciplines."

In addition to co-principal investigator Barbato, who will support structural development, and research engineer Shuhao Wan, the project includes a diverse group of student researchers in engineering and design.

Combining sustainable materials: Bamboo and mycelium

As luck would have it, La Saponara has a highly multidisciplinary researcher in her team, who is also a skilled bamboo artisan. Shuhao Wan, the lab's instrumentation and design research engineer, has worked with bamboo as a hobby, crafting model ships in bottles. Wan is testing different ways to weave the bamboo reeds.



The team is investigating ways to build the blades, including structuring the bamboo layer. Credit: Gregory Urquiaga/UC Davis

Meanwhile, the team is working on optimizing media for growing and attaching the mycelium layer. Mycelium is an amazing material because

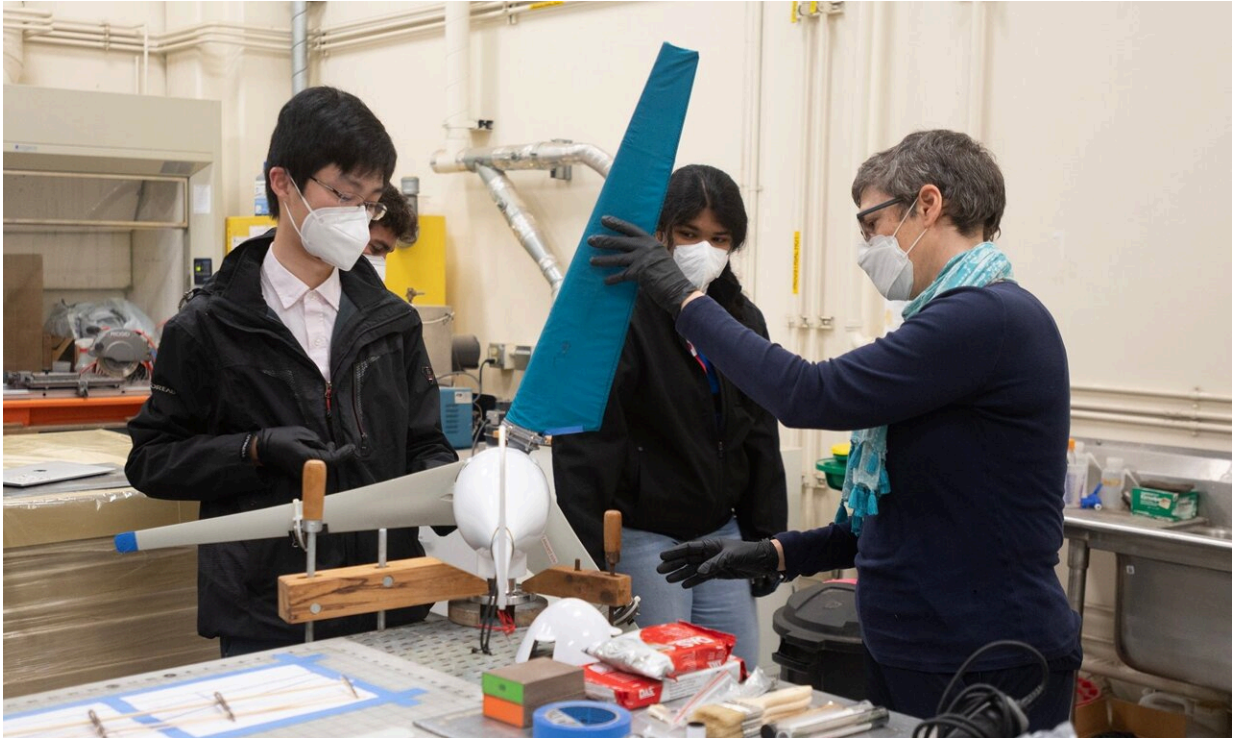
it can be grown where it's going to be used—as long as the conditions are right. The fungal mass can thrive in waste streams from coffee grounds to discarded plastics, with its feedstock influencing its properties. But mycelium doesn't eat everything, and naturally anti-fungal bamboo is not on the menu. The team is testing to incorporate post-consumer textile waste, which may offer the bonus outcome of growing the mycelium using waste otherwise bound for landfill.

Testing mycelium-bamboo wind blades

The team recently built a prototype to begin testing.

"We want to do structural testing to find out how fast a rotation we can have, how much power we can generate," La Saponara said.

The mycelium-bamboo composite will replace blades on a commercial 1-kilowatt turbine set up near the STEEL Lab, part of the Western Cooling Efficiency Center, away from central campus. La Saponara said they also will test the resilience of these blades, making sure they can withstand 85-mile-per-hour winds.



The team examines a prototype wind turbine blade. Credit: Gregory Urquiaga/UC Davis

"Once we have the proof of concept for 1 kilowatt, which is a reasonable amount of power, then we can start working with companies for the commercialization of this concept for distributed energy applications," La Saponara said.

These are early days toward the eventual goal of scaling the blades for global use. In fact, the blades could help in areas affected by natural disasters, where energy solutions are needed quickly, and wind power could be paired up with solar panels.

"What we're doing right now doesn't work anymore," she said. "We're at a tipping point in the environment, and our next generation are the ones

who will pay the highest price. Ultimately, there's no way we can talk about environmental engineering without talking about environmental justice."

Provided by UC Davis

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