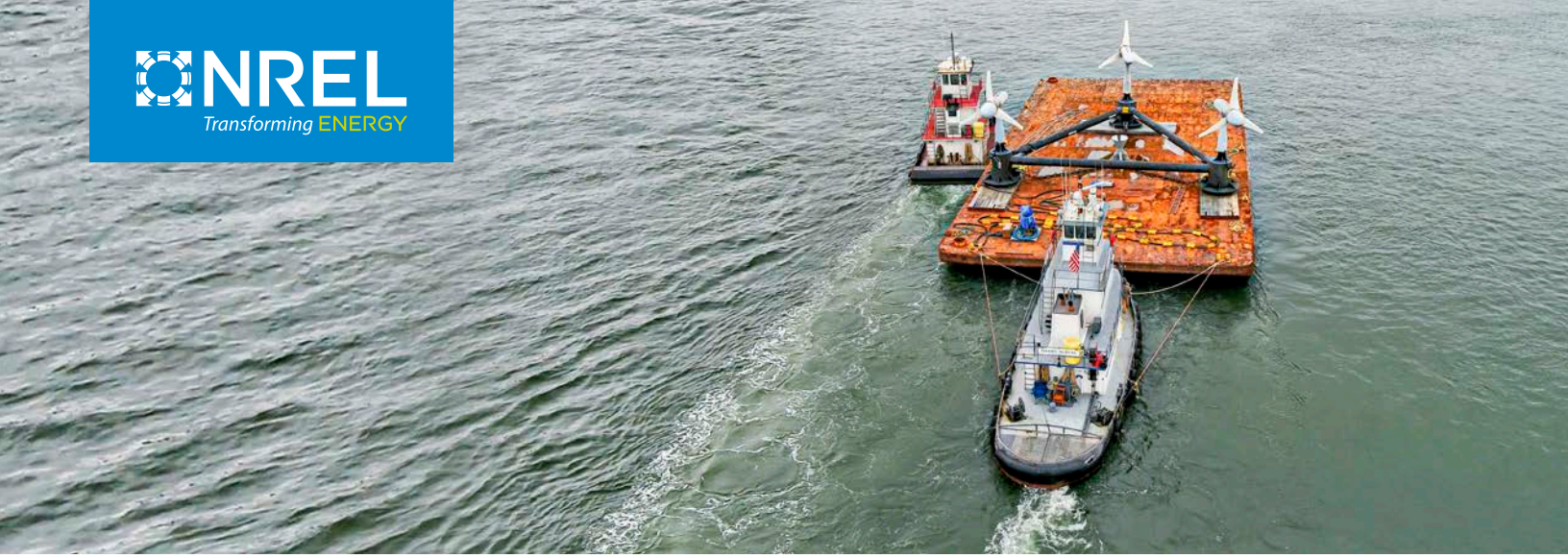

Verdant Power successfully installed an array of tidal turbines at the Roosevelt Island Tidal Energy Project in New York City's East River. *Photo from Paul Komosinski, Verdant Power.*

Verdant Power: Thermoplastic Blade Validation at Full Scale

For the first time in history, thermoplastic composite blades, which have the potential to revolutionize the marine energy industry, have been validated on a large-scale tidal power turbine. Thanks to funding from the U.S. Department of Energy's Water Power Technologies Office, National Renewable Energy Laboratory (NREL) researchers constructed and deployed thermoplastic composite blades on a tidal turbine in New York City's East River.

This illustration shows how the Verdant Power TriFrame is installed at the bottom of New York City's East River. NREL has been working with Verdant Power since 2008 to develop new tools for marine energy applications *Graphic from Verdant Power.*

For several years, NREL researchers have been exploring the use of thermoplastic composite materials, which can be more easily recycled than thermoset materials commonly used for wind turbine blades. Now, this research will help determine how thermoplastic composites perform underwater.

Project Demonstrates Thermoplastic Composites for Marine Applications

The project began in October 2020 with the installation of Verdant Power's TriFrame mount, which holds three three-bladed underwater tidal turbines, at the Roosevelt Island Tidal Energy project site in New York's East River. With strong tidal currents that change direction multiple times per day, the East River offers an ideal location for demonstrating the performance of marine energy turbines.

During their first 6 months in the water, the tidal turbines, which featured thermoset epoxy resin blades, generated almost 200 megawatt-hours of energy—a U.S. record for marine energy production.

The next step in this research was to swap out one set of the thermoset resin blades in the TriFrame mount with thermoplastic resin composite blades manufactured by NREL. This enabled researchers to compare the underwater performance of a thermoset resin system and a thermoplastic resin system. Thermoplastic resin systems have shown

improved structural properties when submerged in lab settings and have the potential to be recycled and reused at the end of their lives.

The research was intended to confirm if the innovative thermoplastic blades experience less structural degradation in water than traditional thermoset materials.

NREL Manufactures Thermoplastic Resin Replacement Blades

Verdant Power provided NREL Research Engineer Robynne Murray and her team with the blade tooling and geometry details to produce thermoplastic blades nearly identical to the traditional epoxy blades initially used on the TriFrame mount. Working at NREL's Composites Manufacturing Education and Technology Facility, Murray's team built the replacement blades using a vacuum infusion method with Elium® thermoplastic resin.

After the researchers confirmed that these blades had similar structural performance to Verdant Power's traditional epoxy resin blades, they were ready for deployment in the East River.

NREL researchers Robynne Murray and David Barnes lay fiberglass that will be infused with thermoplastic resin in a turbine blade mold at NREL's Composites Manufacturing Education and Technology Facility at NREL's Flatirons Campus. *Photo by Dennis Schroeder, NREL.*

Blade Swap Begins Underwater Performance Validation

In May 2021, the Verdant Power team raised the TriFrame out of the river and replaced the epoxy blades on one of the tidal turbines with three new, NREL-manufactured thermoplastic blades. Identical to the original epoxy blades except for their material, these full-scale, thermoplastic, tidal power turbine blades then began generating power in the East River.

In May 2021, Verdant Power performed a retrieve-and-replace operation, during which one of the turbine rotors was replaced with a rotor comprising three thermoplastic blades manufactured by NREL. *Photo from Paul Komosinski, Verdant Power.*

The Results

In October 2021, the Verdant Power team once again raised the TriFrame out of the river—this time, retrieving NREL's thermoplastic blades.

The results? During the underwater deployment, the thermoplastic blades produced the same amount of energy per day as the thermoset blades.

What's Next

The team is now measuring the blades' structural response to applied loads to determine the impact of seawater on the thermoplastic materials.

This work demonstrates that thermoplastic resin materials could be a viable, recyclable option for marine energy applications. Under this project, NREL is also working with Sandia National Laboratories and the Pacific Northwest National Laboratory to answer a range of fundamental research questions that the tidal power industry is facing. Together, NREL and its project partners are helping solve some of marine energy's biggest challenges while lowering the cost of energy.

More Information

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