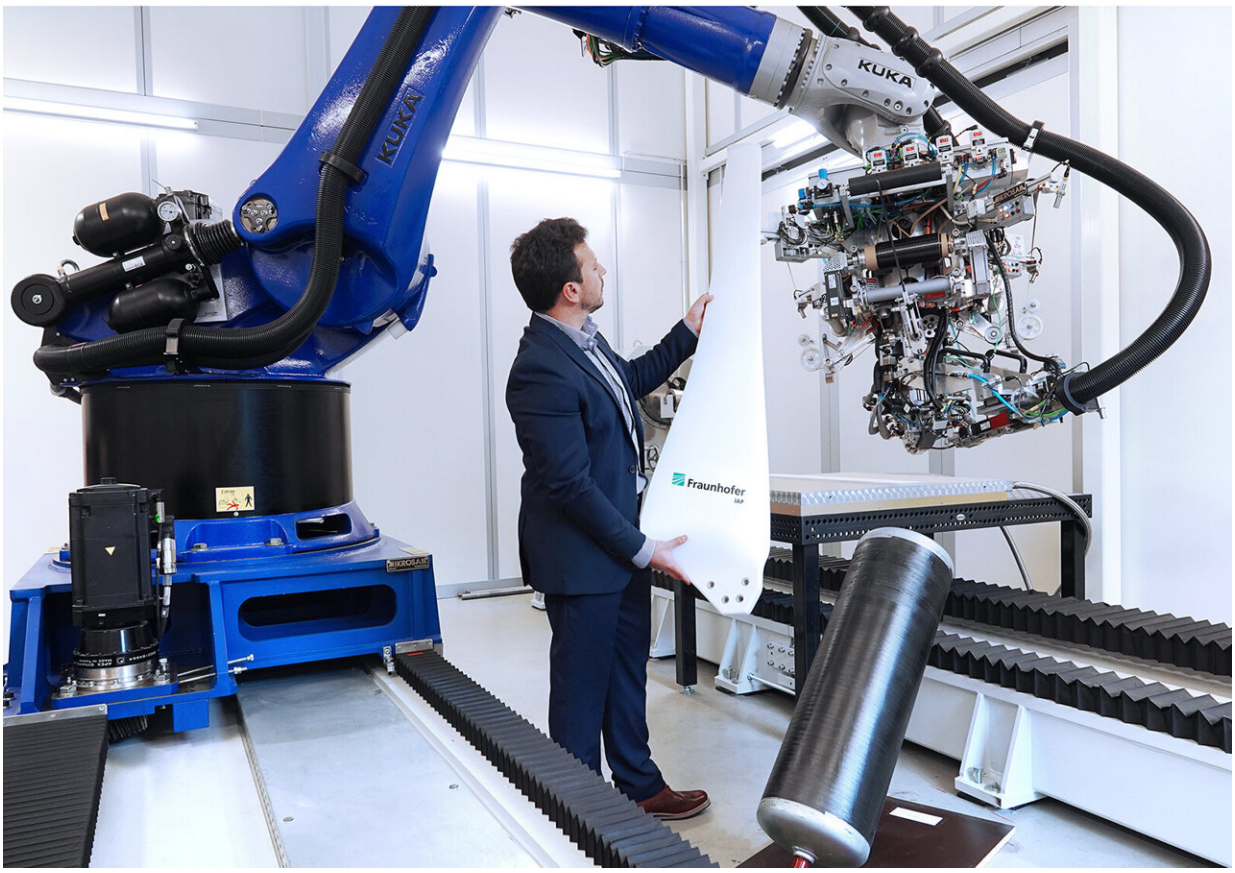
Hydrogen power plant for the garden

May 3 2021, by Sandra Mehlhase



New types of rotors for weak winds and hydrogen tanks with built-in safety sensors are intended to make small wind turbines for private use possible in regions with little wind, such as Lausitz. Credit: Fraunhofer-Gesellschaft

According to data from the German Environment Agency, private households currently are responsible for about a quarter of Germany's

energy consumption in total. A good half of this energy is obtained from natural gas and crude oil. Considering the intensifying climate change, this statistic is a sobering one. "Hydrogen obtained from renewable energies has so much more potential as an energy carrier for the future," says Prof. Holger Seidlitz, lightweight construction specialist at BTU Cottbus-Senftenberg and Head of "Polymer Materials and Composite PYCO" research at the Fraunhofer Institute for Applied Polymer Research IAP at the Wildau location, highlighting the situation. Together with his team and a medium-sized enterprise, he is taking a two-pronged approach to the future of hydrogen: First, he is focusing on sourcing the energy needed for hydrogen production. The cooperation partners are currently developing a small and efficient wind power plant to do this. Second, the team is busy looking at how to store this valuable gas. To this end, they are producing new types of hydrogen tanks made of fiber-reinforced composites.

Hydrogen for fuel cells and vehicles

"The intention is to design the wind turbine small enough to allow private individuals to have a system like this in their garden," explains Holger Seidlitz. "The hydrogen will be generated in-situ in a small electrolyzer and stored in the tank. It can then, for example, drive a fuel cell inside the house that produces heat and power at the same time. And owners of hydrogen-powered cars will, in the future, be able to refuel their vehicle at home. The real key to the concept is that the entire system is designed to be small, yet extremely efficient," emphasizes Seidlitz. Starting with the wind turbine. The lightweight construction experts have devised a new propeller that sets in motion even in a light breeze. "The wind here in the Lusatia region is much weaker than it is in Northern Germany," explains Marcello Ambrosio, the mechanical engineer overseeing the project at Fraunhofer IAP. "We designed the rotor blades to suit these wind conditions and reduced their dimensions by around 30 percent compared to conventional small wind turbines."

Fraunhofer IAP has recently acquired an industrial 3D printer that is able to produce objects measuring around two meters by two meters. Marcello Ambrosio and his colleagues have just used the technology to make a plastic mold for producing their rotors for weak winds from fiber composite. They were assisted by EAB Gebäudetechnik Luckau, a company that likewise specializes in lightweight construction.

Lightweight and agile rotors

Fiber-reinforced composites are produced by precisely inserting fiber strips into a mold and then hardening them using a resin or alternative synthetic materials to form a component. The strips are often placed by hand. At Fraunhofer IAP, this job is done by a modern automated fiber placement machine that precisely positions the reinforcement fibers in the mold. Ambrosio: "The difference between this system and manual placement is that there are fewer overlaps, which allows us to significantly reduce the dimensions."

Although designed for more efficiency in weaker winds the rotors withstand strong winds as well. The rotor blades are designed to yield and bend in a storm and rotate out of the wind. "As a result, the turbine slows down the speed of rotation by itself and escapes any damage," says Holger Seidlitz. This in turn eliminates the need for complex control technology and elaborate mechanisms. The rotors will be tested out in the open over the next few months. They are expected to demonstrate their mastery over conventional small wind turbines.

Tank with built-in safety sensors

The second project also involves lightweight construction technology to produce the hydrogen tank. Conventional hydrogen tanks for industrial applications consist of two pressure-resistant steel vessels. For use in

thousands of private households, however, lightweight tanks made of carbon fiber composites would need far less material, be much easier to handle and offer particular advantages, especially for mobile applications. All that said, they have to be extremely safe. Because hydrogen can form an explosive mixture in the presence of atmospheric oxygen, it must not be allowed to escape. Here too, the Lusatia team is proposing an interesting solution. The tanks are made from carbon fiber strips wound onto a cylindrical body. Impregnated with synthetic resin, these strips then harden to form a tank that can withstand many hundreds of bars of pressure. The experts are also integrating sensors into the tanks to detect leaks. "We are currently using 3D printers that are able to process electrically conductive dyes," explains Marcello Ambrosio. "We work these dyes directly into the fiber composite." The researchers can integrate even tiny electronic components into the tank wall. This early warning system is one of the key criteria for safe use at the end customer in the future.

Holger Seidlitz emphasizes, importantly, that the research cooperation is a boost for the region. "Lusatia is highly influenced by the structural transformation. Coming from this region, I feel it's important to integrate small and medium-sized enterprises into our research projects to establish continuous value creation chains." With the wind turbine and the tank, he is now combining two developments here—renewable energies and hydrogen technology—and both will prove to be crucially important in the years to come.

Provided by Fraunhofer-Gesellschaft