New types of wind turbines

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Still, in its March-released 2021 Global Wind Report, GWEC suggests the world will need a trebling in the volume of wind energy projects worldwide over the next decade to meet global climate challenges. The sector’s growth, though, faces an assortment of new challenges, including structural barriers, such as energy access shortfalls and affordability gaps.

The supply chain, too, will need a shakeup. The number of wind turbine suppliers, GWEC’s Market Intelligence arm notes, has declined from 63 original equipment manufacturers (OEMs) in 2013 to 33 OEMs in 2019. Today, the top six turbine suppliers “now control nearly three-quarters of the global market,” it says.

Innovation will be key to address these issues, but technology advancements to meet future demand and functionality won’t be easy without a new or integrated approach to all aspects of the wind turbine, some experts say. As pointed out by 21 experts from European and U.S. public and private energy research institutions in a landmark paper published in the journal Science in October 2019, one significant barrier to future wind technology innovation ironically stems from the “extent of progress that has been achieved already.”

Among examples of notable recent breakthroughs are aeroelastic tailoring, “which passively reduces the loads through coupling blade bending and twist”; thicker flat-back airfoils, which enable improved aerodynamic performance from the load-bearing section near the hub; and add-ons such as vortex generators and flow fences; as well as a variety of manufacturing improvements.

However, continued wind technology innovation in this respect is limited, partly because it is challenged by “classical problems,” the experts said. To make wider progress, more will need to be done, for example, to better understand the atmospheric physics in the regions where taller turbines will operate, as well as the materials constraints associated with the scale-up, they said.

Today’s conventional wind turbine market is nearly exclusively dominated by horizontal-axis wind turbines (HAWTs), and OEMs continue to make them bigger to reap economies of scale. Citing a recent research survey, the U.S. Department of Energy (DOE) this April suggested that wind turbines will be two to three times larger by 2035, with a median of 5.5 MW for land-based turbines, and 17 MW for offshore turbines. That in turn will drive substantial cost declines of between 35% and 50% by 2050 for both land-based and offshore wind installations, it said.

One newer concept, meanwhile, turns entirely away from blades, seeking instead to harvest energy through the air flow-induced vibrations of mechanical systems—through “aeroelastic phenomena.” Vortex Bladeless, a Spanish tech startup that has received funding from the European Union’s Horizon

2020 research and innovation programme, recently garnered Equinor’s backing to develop “aerogenerators” for the residential market.

Meanwhile, taking unconventional wind energy to another level—but soaring on investor interest—are concepts that fall within the airborne wind energy (AWE) category. According to Airborne Wind Europe—an association for the burgeoning subsector—AWE concepts are essentially “based on flying blades or wings attached to the ground by a tether.”

The concept relies on two main principles to turn wind energy into electricity—through “mini-wind turbines and generators mounted on the flying wing, or by having the wing pull on the tether and having the tether unwind from a drum on the ground, which is driving the generator. This ground generation method requires reeling the tether back in, which leads to a pumping or ‘yoyo’ motion,” it said.

The organization’s members have marked notable collaborations with larger utilities over the past year. In February, German companies RWE Renewables GmbH and SkySails Power GmbH agreed to pilot a 200-kW project to fly a 120-square-meter kite up to 400 meters above ground to harness high-altitude winds for generating electricity. “RWE Renewables will operate the SkySails Power system and evaluate the technology during the three-year pilot project. Currently, suitable locations in Germany are being assessed,” the companies said.

But the project’s emphasis on thermoplastics is also notable because the emerging material could boost efforts to make wind turbine blades recyclable. As experts have noted, 85% to 90% of a wind turbine is recyclable, except for turbine blade material, which is typically made from thermoset composites.