Offshore wind turbines at a depth of 800 meters are not a utopia

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TetraSpar's foundation for floating wind turbines was assembled at the Port of Grenaa before being shipped to Norway. Illustration: TetraSpar Demonstrator ApS.

Floating offshore wind turbines offer unimaginable opportunities for wind power, and we already have the technology. Now it is down to reducing their cost.

Malin Westerlund

Artiklen er ældre end 30 dage

Wind turbines rocking on the sea surface on colossal floating structures several hundred meters above the seabed. Due to the

nature of things, this is not something we will ever see in the shallow Danish waters. But globally, it is the future, and it is not just the large energy companies that are now eyeing a market for growth.

Henrik Bredmose, professor at DTU Department of Wind Energy, also sees it coming. He has now been researching wind turbines and their impact on waves for 12 years, and he has no doubt that the technology has matured.

“It is clear that wind turbines on deeper water must be able to withstand harsher weather and larger waves,” he says.

On the other hand, further away from the coast there are also more wind resources and lower turbulence.

“And we know from demonstration projects off the coast of Portugal, Scotland, and Norway that it can be done.”

Near Portugal, WindFloat Atlantic has three 8.4 MW wind turbines mounted on floating structures moored at a depth of 100 meters, 20 kilometres off Viana do Castelo. Since July 2020, they have supplied electricity that corresponds to the consumption of 60 000 inhabitants, with a production of 75 MWh in the first year.

TetraSpar at its location at the METCentre test site in Norway. The floating offshore wind turbine produces electricity at a location with a depth of 200 meters. Illustration: TetraSpar Demonstrator ApS.

At Hywind Scotland, five 6 MW turbines are moored at a depth of 200 meters, 29 kilometres off the coast of Peterhead. Hywind Tampen's 11 wind turbines, which with a total capacity of 88 MW will from this autumn supply power to five drilling platforms in the Snorre and Gullfaks fields 140 kilometres off Norway's west coast. They will be moored at a depth of 300 meters.

"Of course, it requires special vessels. But the structure is the same regardless of depth, and you don't have to go down to the bottom to attach the cables," Henrik Bredmose says and refers to an upcoming 3000 MW demonstration wind farm in the Pacific off the coast of California.

The project, called Morro Bay, will be California's first offshore wind energy project and is expected to be operational by 2027. According to the plan, it will contain several hundred wind turbines on floating platforms moored between 27 and 48 kilometres off the USA's West Coast, where the ocean depth is over 800 meters.

"Although the mooring cost is higher at greater depths, it's not a critical challenge for the project's implementation," he says.

In fact, the floating offshore wind turbines even require a certain depth, so there is room for the floating structure's draught and mooring system.

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There are currently four different types of floating structures. Spar buoys, which are long, pillar-shaped, and have an immersed length of 80–100 meters. Semi-submersibles, which typically consist of three cylinders in triangular formation with a draught of 20–30 meters. Barges that float directly on the surface and tension-leg platforms that are moored with taut mooring lines.

The turbines themselves are standard turbines, i.e. the same as the bottom-fixed ones. At WindFloat Atlantic, the turbines are, for example, three 8.4 MW MHI Vestas turbines. But the turbines differ from the bottom-fixed ones in their motion response.

“It’s like with a moored ship, the floating substructure responds to the forces of wind and waves with a slow motion, just like a moored ship. The wake effect of floating wind farms can also differ from the fixed ones’ due to the inclination of the rotors and their movements,” Henrik Bredmose says.

He does not expect to see floating offshore wind turbines in Danish waters.

On the other hand, floating wind turbines are the main prerequisite for most of the world to be able to use offshore wind energy. As he says:

“It’s far from everywhere in the world that one is as lucky as we are, in the countries around the North Sea, to have access to such large areas of the sea where the water is not much deeper than 60 meters.”

And the deeper the water, the more materials and the stronger foundations are needed to withstand the pressure and possible resonance from the rotor’s movement.

“Right now, for example, we don’t expect that it will ever pay off to use bottom-fixed offshore wind turbines at depths over 60 meters,” he says.

The costs

Sea depth is no obstacle when it comes to the floating offshore wind turbines. They can be installed in virtually all places where they already make sense. But first, the costs must be reduced. The cost is currently 150–160 euros per MW, and according to Henrik Bredmose, it must be reduced to around 50 euros to be profitable.

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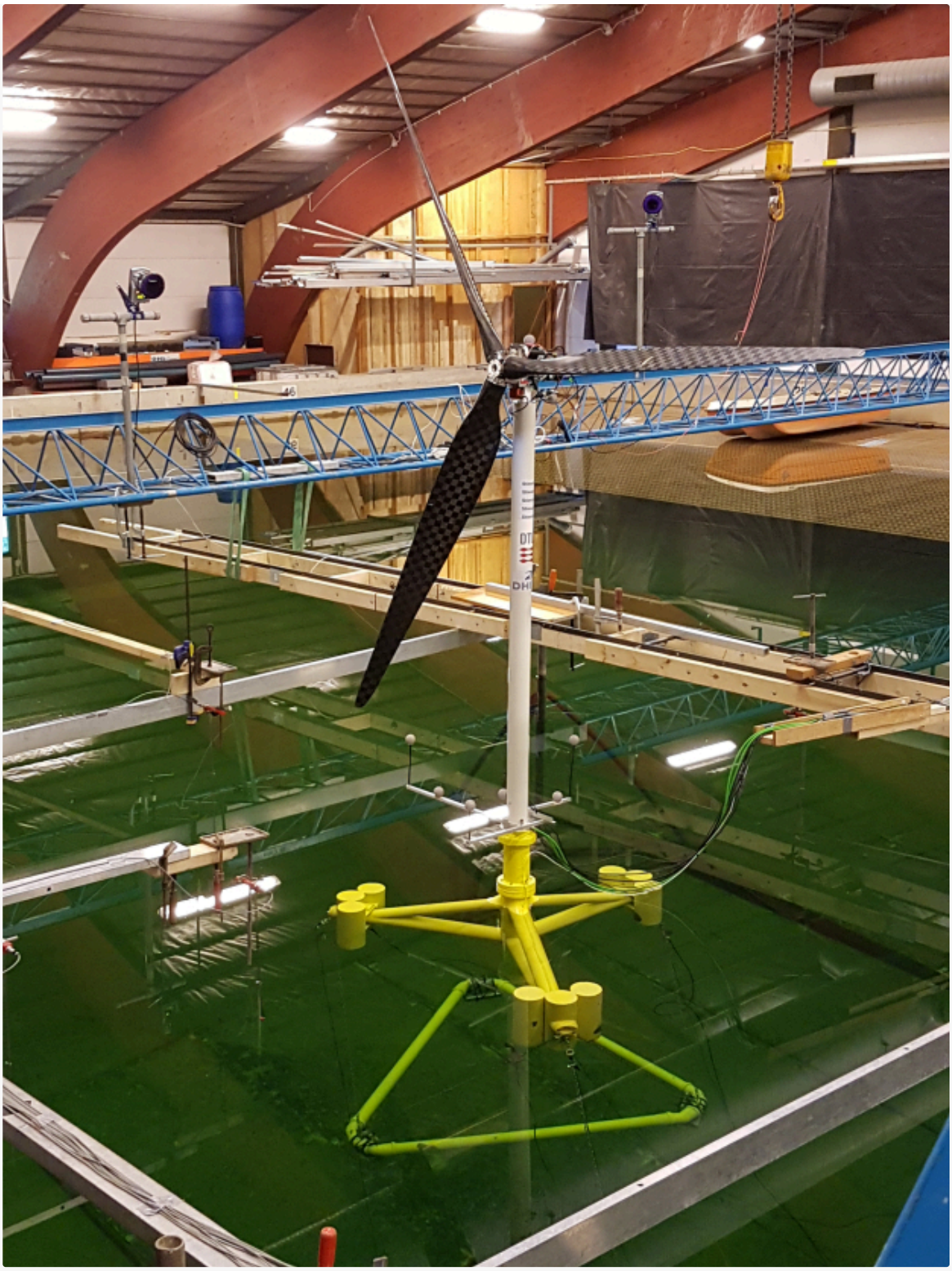
"So down to a third," he says.

This is the same cost development that bottom-fixed offshore wind turbines have undergone. Ten years ago, in 2012, it was 160 euros per MW. Four years later, in 2016–2017, the first zero-grant wind farms appeared. Today, the cost is 50 euros, and the DTU professor describes the growing number of demonstration projects around the world as "the first step of floating offshore wind farms moving the same way".

"It's helping to get costs down, and it gives hope that over the next eight to ten years, floating offshore wind turbines can be rolled out worldwide and have an impact on the green transition and the entire huge global electricity market," he says.



The first model tests were performed by DTU and DHI in 2017. Photo: The TetraSpar Demonstrator Project ApS and DTU Illustration: TetraSpar Demonstrator ApS.

Denmark is already a prominent player in floating offshore wind, both by virtue of its pioneering role in offshore wind energy and the market-leading role of Danish wind turbine manufacturers.

Danish turbines have been installed on a large part of the floating demonstration projects, and with a Danish-developed floating structure—TetraSpar—well on its way, Denmark is also involved in achieving efficient production of floating foundations.

TetraSpar from Stiesdal Offshore Technologies is based on elements that can be manufactured by tower manufacturers, assembled at the port, and towed out with the wind turbine on it.
In 2017, DTU and DHI helped test a prototype of the floating structure with their 10 MW model wind turbine. Since then, they have continued to collaborate on the FloatStep project and have further validated the calculation models against the model tests. In July 2021, the TetraSpar floating structure, which is moored to the seabed with three anchor lines, was installed at the Marine Energy Test Centre off Karmøy in Norway.

“It’s very gratifying that we have a Danish competitive floating structure, which has now been demonstrated in full scale. The global market for floating wind turbines will be enormous, and through initiatives such as this, the Danish wind turbine industry can maintain its leading position in offshore wind energy,” Henrik Bredmose says.

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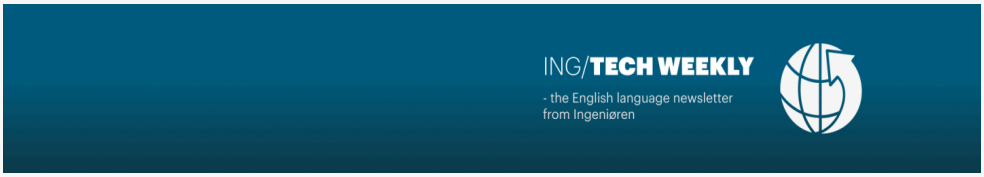

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