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Revisiting Old and New Technologies for Floating Offshore Wind Development: Vertical-Axis Wind Turbines

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A new trend in technological development is emerging for floating offshore wind power generation, for which large-scale deployment is increasingly expected in Japan. That trend is vertical-axis wind turbines. Today, the majority of wind turbines, regardless of whether onshore or offshore, are horizontal-axis wind turbines in which a nacelle containing the power generator is installed on the top of a tower, with blades at the head (and in which the axis of rotation is horizontal to the ground). In comparison, vertical-axis wind turbines, in which the axis of rotation is vertical, have not seen wide usage due to the fact that power generation efficiency is low and there are difficulties in rotational control and self-starting compared to horizontal-axis turbines.

However, numerous attempts to adopt vertical-axis turbines for floating offshore wind power generation are observed recently. Vertical-axis turbines are more stable due to the lower center of gravity because the heavier components, such as the power generator, are placed at the bottom, which also makes maintenance easier. Accordingly, these advantages are being revisited for use in offshore wind power generation. Furthermore, vertical-axis turbines also have the advantages of being independent of wind direction (there is no need to adjust the direction of the turbine to the wind), and blades can be manufactured more easily and even mass-produced.

For example, World Wide Wind[1] of Norway is developing a floating offshore wind turbine that adds a new concept to the vertical-axis turbine. That concept is called the Contra-Rotating[2] Vertical Turbine (CRVT). In this concept, the turbine uses a double rotor configuration with one inner and one outer rotor spinning around the same axis in opposite directions, and serving as the rotors and stators for each power generator (see left figure). Accordingly, the power generation is increased because the relative rotational speed between the counter-rotating rotor and stator becomes faster. In addition,

[1] https://worldwidewind.no/

[2] This contra-rotation concept has already been used in the past for airplane propellers and helicopter rotors. The approach stabilizes flight through the mutual cancelation of the counter-torque produced by the two propellers or rotors spinning in opposite directions.

turbulence in the turbine wake is constrained by allowing the turbine to tilt significantly in the wind direction, which also reduces the influence on other turbines downstream.

In Japan, a company called Albatross Technology (see right figure) is also working on vertical-axis floating offshore wind turbines. The company concluded a joint research contract in May of this year with several major electric power companies and maritime transport companies.[3] The company uses a concept, called the Floating Axis Wind Turbine (FAWT), in which the turbine and float are connected directly and rotate together while supporting overall wind power generation. The advantages of the approach are that power generation performance does not decline at an angle of up to 20 degrees, and the design can withstand instantaneous wind speeds of up to 90m/s, making it compatible with applications in the seas around Japan that are heavily affected by typhoons. Meanwhile, the blades can be manufactured in sections, alleviating the requirement for large-scale manufacturing facilities, and easing transportation, making them appropriate for domestic manufacturing. This is expected to contribute to the development of related industries in Japan.

In another example, Sweden's SeaTwirl is carrying out joint research with the University of Tokyo to modify the company's vertical-axis floating wind turbines for use in the seas around Japan.[4] Japan's Challengergy Inc.[5] is also working on deploying vertical-axis wind turbines that have high typhoon-resistance primarily for land-based installations.

While onshore wind power and fixed-bottom offshore wind power both essentially use the same technology as they both use fixed foundations, floating offshore wind power requires a different design concept due to the need to handle oscillation on the sea surface. The increasing interest in floating offshore wind power in recent years has led to a revisiting to the benefits of vertical-axis turbines, which in turn has given rise to a trend of implementing numerous new ideas and modifications and leading to the technological developments described above. Vertical-axis turbines may even play as a game-changer to change the landscape of floating offshore wind power moving forward.

New novel technologies are often focused on when seeking technological innovation, but depending on the needs, it is important to sometimes look back and rediscover technologies that have already been considered.

[3] https://www.albatross-technology.com/news/article-365
[4] https://seatwirl.com/sv/news/seatwirl-in-cooperation-with-the-university-of-tokyo/
[5] https://challenergy.com/

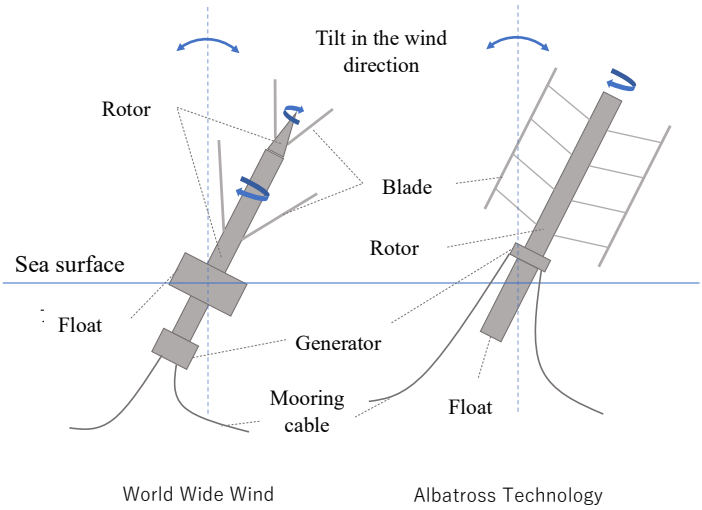

Figure Examples of new vertical-axis floating offshore wind power generation systems

Source: prepared using data from each company's website.

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