Abstract

Technip, in association with Nenuphar, Converteam and EDF Energies Nouvelles are launching the Vertiwind project to test a pre-industrial prototype of a vertical-axis offshore floating wind turbine. The partners of the project are Seal Engineering, Institut des Sciences de l’Ingénieur Toulon – Var (ISITV), IFP Energies Nouvelles, Arts et Métiers, Bureau Veritas, Oceanide.

Free of the constraints related to the foundation of fixed wind turbines, the Vertiwind concept opens new perspectives for offshore wind farms in numerous countries, notably in the Mediterranean basin, in Europe and the United States.

The Vertiwind project has been labeled by the Sea Cluster of the Provence Alpes Côte d’Azur (PACA) region. It is among the first beneficiaries of the program “Investing for the Future”, a component of the “Grand Emprunt”, sponsored by the French Government through the French Environment and Energy Management Agency.

Concept Overview

Coming from a strong and complementary partnership between a utility, industrial companies and universities, the Vertiwind project plans to build, install and operate, in real offshore conditions, a full scale floating vertical axis wind turbine of 2 MW. This is a real step change in the technology compared to the vast majority of offshore wind turbines with horizontal axes.

The floater is a semi submersible concept. It skillfully combines an excitation response out of the wave frequency spectrum, a shallow draft to facilitate the fabrication with a very simple installation procedure only requiring one or two tugs. The vertical axis wind turbine is located in the centre of the floater ensuring that the centre of gravity, the buoyancy and the convergence point of the mooring lines are all on the same axis. This geometrical property significantly reduces the sway and yaw response of the floater subject to non co-linearity or heading variation of wave and wind. Due to the architecture and principle of this Darrieus turbine, the power production is not really impacted by the floater motions such as the inclination of the axis relative to the wind direction.

The vertical axis wind turbine (VAWT) design is carried out in parallel with the floater. It integrates, at an early stage, every offshore environment in terms of loads, accessibility and ease of maintenance.

The complete unit will be anchored to the seabed, and connected to the electrical network by a compliant subsea cable.

A boat landing will be located on the floater to allow access for inspection and maintenance. A second landing may be necessary depending on the maintenance procedures. A high level of safety will be reached for operations at sea.

Advantages

The VAWT developed by Nenuphar for the Vertiwind project is a combination of several innovative components and manufacturing technologies. The main goal is to develop a simple and robust wind turbine optimized for floating offshore conditions. The main technological advantages can be summarized as follows:
• Adaptability to the marine environment
• A lower centre of gravity, reducing both structural cost and visual impact
• Robustness and simplicity (no complex gear box or orientation systems for the blades)

These mechanical parts are generally subject to failure and need regular maintenance. By avoiding them, the availability is significantly increased (failure ratio is divided by two). The simplicity and robustness of the wind turbine architecture leads to a significant reduction of maintenance cost throughout the total life time of the unit.

In addition to the lower centre of gravity the floating VAWT has an increased afloat stability. This type of wind turbine is well fitted for a floating offshore application.

This new concept breaks through the relative low water depth barrier for today’s fixed foundation wind turbines. This means that the locations of offshore wind farm projects are no longer limited by the depth of the sea-bed, such as shallow continental shelves, and that more harmonious solutions can be found to take into account environmentally sensitive areas and to reach a competitive cost of producing energy and competitively.

Results

The onsite measured power curve has validated the predictions. The dynamic behavior of this 35 kW prototype is very stable, and in line with the aero dynamical and mechanical calculations.

Equipped with a jack, the onshore prototype is hinged and will be inclined to simulate the tilt angle of the floater. It will also simulate the dynamic motion of the floater.

Conclusions

Officially kicked-off in January 2011, in presence of ADEME representatives, the Vertiwind project will design, build, install and operate a 2 MW floating vertical axis wind turbine. The joint development of the turbine and the floater allows to take into account every requirement of the offshore environment in terms of loads, accessibility and ease of maintenance. A maximum number of operations are carried out onshore or in the harbor to greatly improve the safety aspect of this concept for the environment and for the personnel involved in the fabrication and installation.

The design of this innovative floating wind turbine is executed within the Vertiwind project by a strong and complementary partnership of involving a utility, industrial companies and universities; it addresses every aspect of the life time cycle of such a floating unit.

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