Innovative technologies to develop offshore wind farms in China

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Abstract

The Chinese government has approved 44 offshore wind projects in 11 provinces in China with a combined installed capacity of 10 gigawatts (GW). This was according to the National Energy Administration (NEA) in 2015. This ambitious goal is to install 10 GW of offshore wind farms in China by 2020. Learning from Europe's offshore wind experience is crucial. However, the site conditions of most offshore wind farms in China are different from the conditions of most offshore wind farms in Europe. Moreover, the supply chain related to the offshore wind farm construction in China is also different from that in Europe. This study results from Statoil's participation in a European collaborative project which includes the case study into how the Chinese offshore wind industry has developed its approach to mitigate technical and non-technical barriers.

Innovative technologies developed for Chinese offshore wind farm conditions

The first Chinese offshore wind farm

Several innovative technologies have been developed for the conditions found in Chinese offshore wind farms. Firstly, a new foundation with a concrete cap and eight steel piles were invented for the first Chinese offshore wind farm (Donghai Bridge). This site specifically has both a high velocity ocean current and deep soft soil sea bed conditions. The wind farm phase one has 34 3-MW wind turbine units made by Sinovel. The turbines are situated approximately 8 to 13 km from shore in an area with an average water depth of 12 m. The site conditions include both a high velocity ocean current (more than 3 m/s) and a soft sediment layer of 25 m thickness at the sea bed. The new foundation technology developed consists of a concrete cap (diameter: 14 m, height: 4.5 m) and eight steel piles (diameter: 1,7 m, height: 80 m, about 68 m in the soil) (Fig. 1). The operational results confirmed that the new foundation is both cost-effective and also mitigates the deleterious local conditions. Furthermore, two large-scale crane vessels, designed for the Donghai bridge construction, were used to install the fully assembled wind turbine unit shown in Fig. 2.

Fig. 1 New foundation Fig. 2 Installation of fully assembled wind turbine (courtesy Yifeng Lin)

The second Chinese offshore wind farm: Rudong offshore wind farm

The second offshore wind farm in China: Rudong is located in an intertidal zone, more than 200 MW capacity have been installed in phase one. These include 40*2.5MW (Goldwind); 17 *3MW (Sinovel) and 21*2.3MW (Siemens). Goldwind monopile foundations without transition pieces were installed with precision, and the service vessels and tractors were creatively integrated for the operation and maintenance of the wind turbines. For the operation and maintenance of the wind turbines were the water depth might vary from zero to more than eight meters within a few hours, the service vessels and tractors are creatively integrated to transport both personnel and small equipment to and from the wind turbines as shown in Fig. 3. The workers also walk to the wind turbines.

Fig. 3 Transport to wind turbine by vessel and tractor (courtesy Goldwind)

The largest offshore wind farm in China: Nanri 400 MW

The largest on-going offshore wind farm construction project in China is Fujian Nanri 400MW shown in Fig.4. It will install 100 units of 4 MW Siemens turbine of SWT-4.0-130. Four of the wind turbines have been connected to the electrical grid for power generation by the end of 2015.

Fig. 4 Installation of Nanri 4MW wind turbine and an aerial view of the wind farm (courtesy CPNN)

Learning from the offshore wind experience of Europe, the design of Nanri offshore wind farm has explored the potential to co-use ocean space with aquaculture to achieve cost effective solutions and to reduce conflicts with the fishery industry. The aquaculture cages shown in Fig. 5 have been proposed to co-use the space within the offshore wind farm under open sea conditions. The co-location of aquaculture (small scale) provides insights into the real barriers and risks encountered. The operational experience gained will encourage the stakeholders' interests in the development of commercial co-location.

Fig. 5 Proposed aquaculture cages for open sea conditions

Using offshore wind technology has the potential to help accelerate the movement of aquaculture to open water sites where the water quality is better. Combining both offshore wind farm with aquaculture meets the challenge of both the production of clean energy and high quality seafood while maintaining minimum environmental impact.

Finally, in order to achieve the goal of 10 GW of offshore wind farms in China, 44 new offshore wind farms have been planned in different time frames. One of the challenges is a novel and expeditious method for the installation of these new offshore wind farms. Designs for cost-effective installation and service

Conclusions

Several innovative technologies have been successfully developed to meet the challenges arising from Chinese offshore wind farm site conditions including supply chain conditions. Learning the offshore wind experience from Europe and both developing innovative technologies to achieve cost effective solutions and to co-use ocean space with other industries are crucial to achieve the goal of 10 GW offshore wind farms in China.

Reference

Innovative technologies to achieve 10 GW offshore wind energy in China, EWEA OFFSHORE 2015, PO. 134, Copenhagen, Denmark, 10 – 12 March, 2015