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Comparative evaluation of different offshore wind turbine installation vessels for Korean west–south wind farm

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Abstract

The purpose of this study is to evaluate various means of wind power turbines installation in the Korean west–south wind farm (Test bed 100 MW, Demonstrate site 400 MW). We presented the marine environment of the southwest offshore wind farm in order to decide the appropriate installation vessel to be used in this site. The various vessels would be WTIV (Wind turbine installation vessel), jack-up barge, or floating crane … etc. We analyzed the installation cost of offshore wind turbine and the transportation duration for each vessel. The analysis results showed the most suitable installation means for offshore wind turbine in the Korean west–south wind farm.

Keywords: Offshore wind turbine installation; West–south wind farm; Installation cost; WTIV; Jack-up barge

1. Introduction

Various natural disasters caused by global warming and lack of energy due to the depletion of fossil fuels are accelerating deep-sea oil exploration and development of shale gas which emerges from concerns of the environmental problem. In addition, the nuclear accident in Japan amplified anxiety about the nuclear energy. The world is putting multilateral efforts to secure renewable energy industry, and to move away from carbon-dependent economy paradigm by developing green energy technologies.

The wind power industry, the best economical option among the renewable industries, is growing 30% annually. However, onshore wind power is already reached saturation and the development is only rising moderately. As an alternative, development of offshore wind power farm has led to a lot of attention and investment.

Recently, on 24th March 2014, KEPCO (Korea Electric Power Corporation) and Six power generation companies announced a long-term plan to increase renewable energy capacity to 61.2%. In order to achieve the national goal of renewable energy, they will invest 42.5 trillion won (by 2020) on developing 11.5 GW (72% of national newly developed renewable energy capacity) which the current capacity being at 19%.

According to the plan, complete the construction of test bed and demonstration site by 2020 for development of 2.5 GW on west–south offshore wind farm, which would build a track-record for overseas expansion of offshore wind turbine generator market. The turbine manufacturer involved herein is Doosan Heavy Industries & Construction (3 MW) (Fig. 1). The offshore wind power is more efficient than the onshore wind power in terms of farm size, the turbine capacity and the development cost which leads to the lower power cost. Fig. 2 depict the capital cost breakdown of offshore wind farm.

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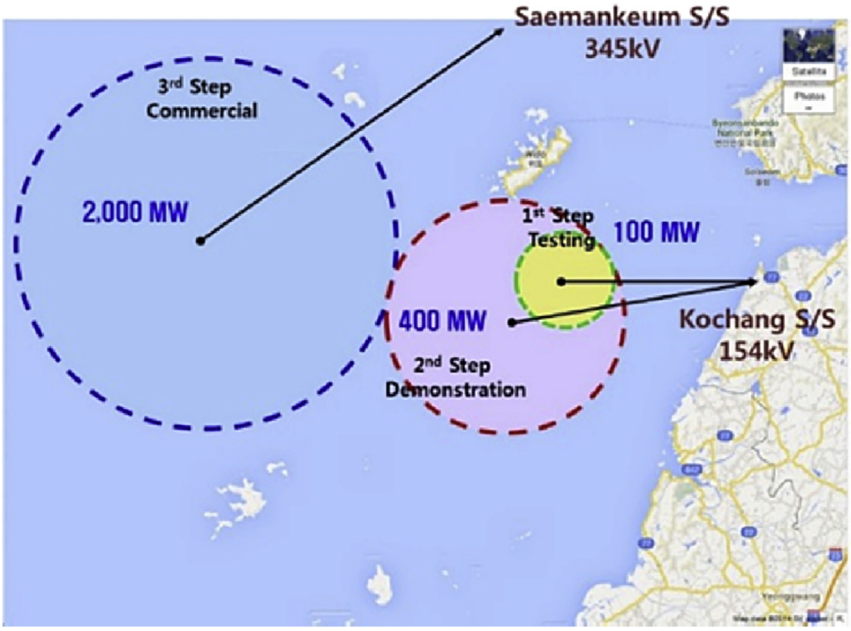

Fig. 1. West–south wind farm layout.

Logistics and installation cost takes 19% of total construction cost meaning.

In Korea, there is no domestic experience of installing offshore wind turbine generator more than 2 set (2 MW and 3 MW). Because of that, it is difficult to assume the proper installation time. The offshore wind turbine generators installed in Jeju island are pilot model. Those generators are installed above the substructure of a jacket which is placed on the sand type seabed. Because of lack of installation experience of offshore wind turbine, difficulties are expected during the installation of west–south wind farm. In addition, the environment of west–south sea is totally different compared to the that of Jeju island.

This study suggests appropriate installation means and methods for successful construction of west–south wind farm. To achieve this, case studies on installation of major offshore wind farm in Europe and studies on types and features of installation vessels have been carried out. In addition, we identify the offshore environment and the delay factor for installation of wind power farm. Installation time and costs have been selected as a factor to find appropriate installation means. We suggest the optimal installation means according to the analysis of the factors for installation of wind farm.

Therefore, this study reviews and compares the 3 types of construction methods on test bed site and demonstration site. And propose the appropriate means and methods to install offshore wind farm on the west–south Sea.

2. Means and methods to install offshore wind turbine

2.1. Offshore wind turbine installation vessel

Vessels used in offshore wind farm construction are as shown on Fig. 3 and Table 2. The characteristics of these vessels are as shown on Table 2. Table 3 shows the installation vessels used in the construction of offshore wind farms in Europe (Table 1).

Herman (2002) developed a computer model that calculates the transport and installation costs of a wind farm, it has been composed and implemented in the OWECOP (Offshore Wind Energy Cost and Potential) II model. Transportation and installation costs have been derived from known offshore techniques and they are structured according to the possible wind turbine assembly procedures. Besides the cost of offshore equipment, an estimation of delays due to bad weather and the simultaneous use of several vessels have been included. Alexander (2011) investigated the reliability, availability and maintenance of offshore wind farms while considering various maintenance strategies, and helps understand which is fundamental in light of the technical and economic viability of existing and future offshore wind farms.

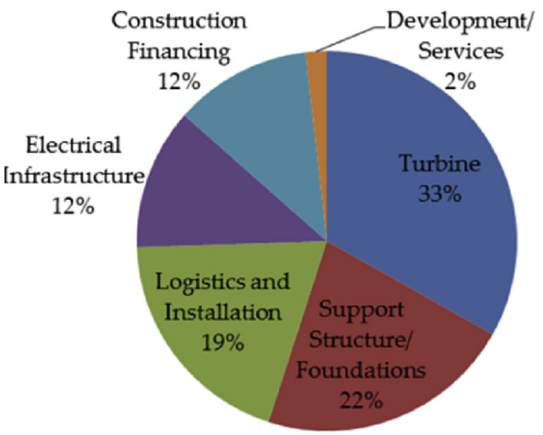

Fig. 2. Offshore wind farm plant capital cost breakdown.

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