Numerical Simulation of Morphological Changes around Offshore Wind Turbine Foundations in Taiwan Western Coast

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ABSTRACT

The development for renewable energy is highly valued, and offshore wind energy is one of the few kinds of sustainable energy which can be operated reliably and harvested efficiently. The feasibility evaluation of the offshore turbines should include an assessment of the possible long-term morphological evolution, and an assessment of the local erosion caused by the turbine foundations. In this paper, a numerical model is presented for the simulations of the morphological changes in large coastal area and local seabed evolutions near turbine foundation. The target wind farm is located at the Fang-Yuan coast, Chang-hua County in Taiwan western Coast. We investigated the influence of an offshore wind farm on the large-scale morphological evolution of the seabed with the jacket type foundation. The results show that there is slight influence for large coastal area around the offshore wind turbine foundation.

KEY WORDS: Offshore wind turbine; morphological changes; quasi-3D morphodynamic model, jacket type foundation

1 INTRODUCTION

Due to ambitious climate protection targets, several offshore windfarms were built in recent years and offshore wind energy promises to satisfy the increasing demand for green energy. It has been estimated that an enormous wind resource of more than 15 GW can be harvested in Taiwan. To accelerate the development of wind industry, Taiwan plans to shift the focus of wind energy from onshore to offshore, and set up more than 1,000 wind turbines by 2030 have been promoted. It is scheduled that 450 onshore wind turbines of 1,200 MW can be established by 2020, and 600 offshore wind turbines of 3,000 MW by 2030. The total accumulated capacity adds up to 4,200 MW, which makes up 33 % of the renewable energy promotion target. The promotion for Thousand Wind Turbines target is broken down into chronological roadmap for detailed reference, as shown in Table 1.

To accelerate offshore wind power development and to promote green energy economy, Taiwan’s Ministry of Economic Affairs (MOEA) publicly announced the implementation of "The Incentive Program of Offshore Wind Power Demonstration System" on July 03, 2012. According to the program, The Ministry of Economic Affairs of Taiwan has signed construction agreements for two offshore wind farms by 2015, another step forward in the country’s efforts to develop wind power. One will be built off the coast of Miaoli county in western Taiwan and consist of 36 wind power turbines installed in water 5-30 meters deep. The other will be built off the coast of neighboring Changhua county and consist of 30 wind power turbines to be installed in water 18-40 meters deep. The MOEA is scheduled to complete the installation of 4-6 demonstrated offshore wind-power pilot projects by 2015. The demonstration incentive program is a trial model of large scale offshore wind farm development. In the future, offshore wind farms will be developed in zonal scales with 300 MW per year at deeper water area to gradually reach 3,000 MW with 600 turbines by 2030.

Table 1 Wind Power Promotion Target of Commissioned Capacity (Unit: MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore</td>
<td>334</td>
<td>1,200</td>
<td>0</td>
</tr>
<tr>
<td>Offshore</td>
<td>585</td>
<td>600</td>
<td>1,200</td>
</tr>
</tbody>
</table>

To further develop the Taiwan's ample wind resources, there are still some engineering challenges for the stability of the seabed around the foundations of offshore wind turbines, especially for marine environment in Taiwan such as typhoon, earthquake, multi-grain-size sediment in different seasons, and sand transport by wind… etc. At the offshore windfarm planning stage, the physical impact on the seabed caused by installed foundations as part of the Environmental Impact Assessment. With complete understanding of the seabed evolutions over the full life cycle of the windfarm and each wind turbine, there are two issues should be considered. Firstly, there is the large range seabed morphological changes due to windfarm established or not, migration of seabed features such as sandbanks, sandwaves or erosion channels. The other is the local scour around the offshore wind turbine foundations and the morphodynamic influenced regions.