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Scheduling and cost estimation simulation for transport and installation of floating hybrid generator platform

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ABSTRACT

Concerns such as global warming, depletion of fossil fuels, and the dangers associated with the nuclear energy have led to the research and development of offshore wind and wave energy sources. However, the transportation and installation (T&I) planning for offshore energy platform is still being conducted in an unmanaged manner. In this paper, the T&I process of floating hybrid generator platforms is investigated. The schedule and cost estimation are simulated as a discrete event process, an alternative T&I process is evaluated, and the optimum T&I plan (with respect to the shortest duration or the lowest cost) is identified using various techniques.

1. Introduction

1.1. Outline

Transportation and installation (T&I) planning can affect the design of offshore structures [1]. However, the T&I processes are planned and executed in an unmanaged manner even today. In this study, we analyzed the T&I processes for floating hybrid generator platforms and developed a simulator for scheduling and cost estimation.

In this section, we briefly present the concept of the conventional wind turbine and wave generators and the floating hybrid generator platform considered in this research. We then describe the T&I processes and the related research. In section 2, we explain the suggested simulation framework, model, scenario editor, and result viewer. In section 3, the weather information implementation methodology is described. In Section 4, we describe the estimation of a simulation scenario and two T&I scenarios. Finally, in Section 5, we present the conclusion of this paper and the planned future research.

1.2. Conventional wind turbine and wave generator

A wind turbine is a device that converts the wind energy into electric power. The power generating capacity of the present day offshore wind turbines has increased to more than 3.6 MW. The increased output of wind turbines makes their installation further out in the sea more feasible than in the past. Offshore wind turbine installations have some advantages over onshore installations, including the improved performance of lower altitude installations for a given wind speed [2]. However, the drawbacks of offshore installations include the extra cost of building and installing floating foundations, installing the wind turbine tower and blades, and installing transmission lines from the platform to the onshore power grid. These additional expenditures can increase the cost of an offshore wind turbine project by approximately 20% [3].

The foundations of offshore wind turbines can be designed as fixed or floating structures [4] depending upon the depth of water as shown in Fig. 1. A fixed foundation can be installed as a monopile platform with a single cylindrical geometry for a depth of water of up to 30 m and as jacket or tripod structures for a depth of water ranging from 30 m to 50 m. Floating structures have cost advantages over the fixed ones for installations at sites having a depth of water of 50 m or more. The structure of offshore wind turbine

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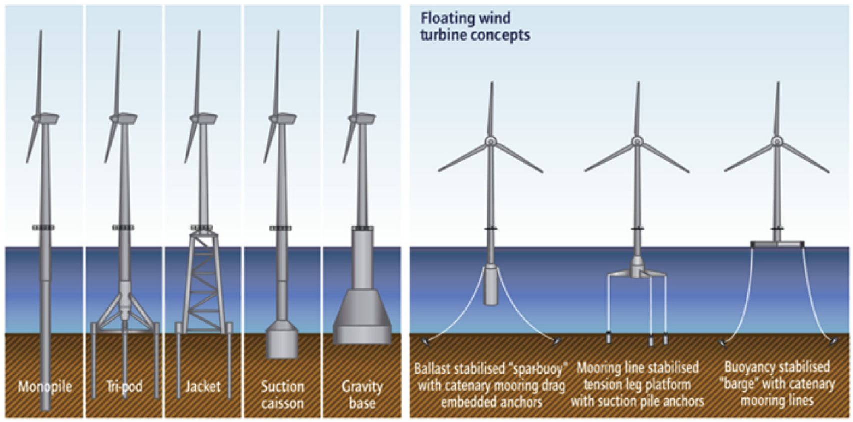

Fig. 1. Conventional offshore wind turbines [5].

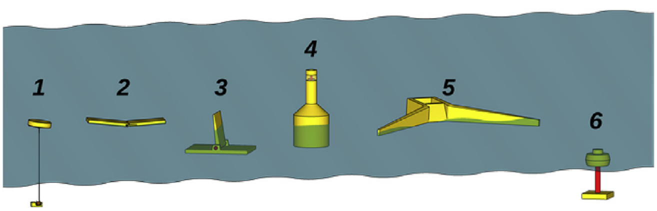

Fig. 2. Wave energy concepts [6].

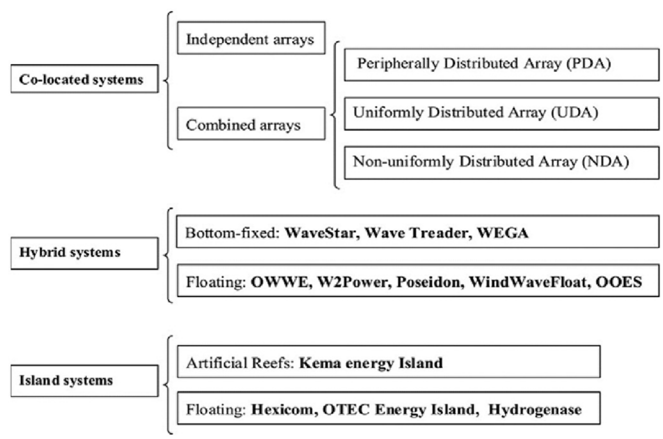

Fig. 4. Classification of combined wave–wind technologies [9].

platforms can be the same as that of oil and gas production platforms, such as tension leg platform, semisubmersible platforms, and cylindrically shaped spar platforms.

The role of a wave generator is to convert the ocean surface wave energy into electric power. Fig. 2 shows six types of wave generators: point absorber, attenuator, oscillating wave surge converter, oscillating water column, overtopping device, and submerged differential pressure configurations [6]. The point absorber configuration is widely used. Fig. 3 shows various types of point absorbing wave generators.

1.3. Concept of floating hybrid generator platform

The wind is a major source of energy for ocean waves; therefore, a suitable site for offshore wind turbines is also appropriate for wave generators. This has led to the development of combined wave–wind technologies including co-located systems, hybrid systems, and island systems, as shown in Fig. 4. In the co-located systems, independent wind turbines and wave generators are co-located and connected to the same grid. The hybrid systems can be installed on a bottom-fixed or floating platform. The island system is conceptually similar to the hybrid system, however, it is realized at a massive scale of an island. Co-located wind turbines and wave generators have increased accessibility for operations and maintenance [8].

The Korean Research Institute of Ship and Ocean Engineering developed the conceptual design of a 10 MW-class hybrid power generation platform [10]. The conceptual design is shown in Fig. 5

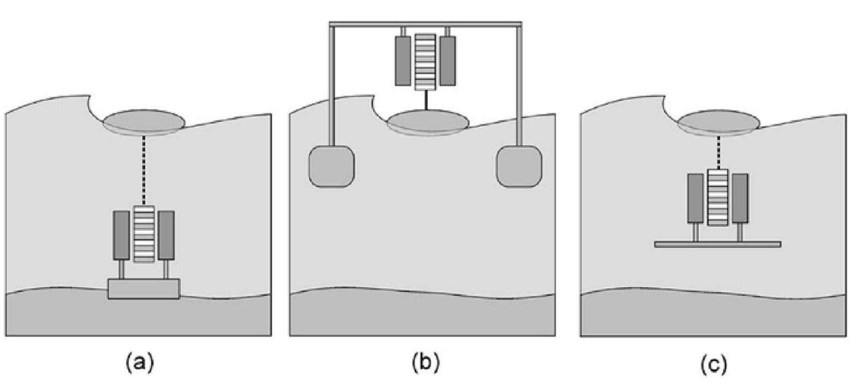

Fig. 3. Point absorbing wave generator [7]. Floating point absorber (a) at the sea floor, (b) with a floating structure, and (c) with a submerged damper plate.