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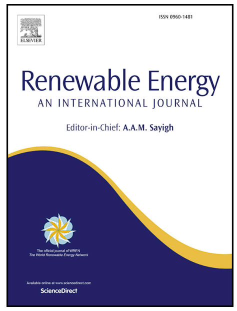

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An Analytical Cost Model for Co-located Floating Wind-Wave Energy Arrays

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Abstract

Offshore wind and wave energy are co-located resources, and both industries are driven to reduce cost of energy. Due to the maturity of offshore wind technology and continued growth of both offshore floating wind and wave energy converter (WEC) technology, there is new opportunity to combine wind and wave technologies in the same leased ocean space through co-located array development. Co-location is projected to have synergistic effects that reduce direct and indirect costs for developments, but few of these synergistic effects have been quantified, and many have not been related to cost. Moreover, there is currently no cost model that incorporates these effects. In this study, we address this need by developing a cost model that represents co-located array developments, particularly for floating offshore wind and WEC technologies. We exemplify the use of this cost model through a case study. Results suggest floating wind-wave co-located arrays are advantageous to WEC-only or floating wind-only. These results are contingent on our assumptions regarding cost categories and values included in the model and also the power production and reliability of the devices. We conclude by identifying research gaps and uncertainties to be minimized in future improvements of the model.

Keywords: co-location, wave energy, cost model, floating offshore wind energy, offshore renewable energy

1. Introduction

In the offshore renewable energy industry, offshore wind is the only technology that has reached global commercial installation. In 2017, global offshore wind capacity reached 18,814 MW, with 3.9 GW of combined capacity for projects expected to achieve financial investment decision (FID) in 2018 [1]. Although Europe began installation two decades ago and still contributes half the global capacity, emerging markets in Asia and North America are indicative of increasing global adoption. Further cost reduction remains critical for offshore wind energy to remain competitive and continue to grow in global implementation.

In areas where fixed-bottom offshore wind structures are infeasible, floating offshore wind platforms could provide access to plentiful resource further offshore in deeper waters. Moreover, floating offshore wind turbines are potentially economically competitive with (and in some cases, even advantageous to) fixed-bottom offshore wind turbines in deep waters [2]. With the first grid-connected floating offshore wind array recently installed [3], there is renewed motivation to rapidly reduce floating offshore wind array costs and improve power production.

Although wave resource is plentiful, wave energy technology is still at an early stage of development in comparison with offshore wind technologies. However, offshore wind and wave resources often coexist in the same locations, and the technologies share similarities that could provide opportunities for mutual benefits.

Co-location of offshore wind turbines and wave energy converters (WECs) in the same leased ocean space exploits these similarities to improve power development and lower costs of the array. However, not enough is known about the costs of co-location to provide a quantitative conclusion to developers and investors about its potential economic advantages. Accurate levelized cost of energy (LCOE) estimations for co-located arrays could enable commercial installation for these novel technologies as they try to prove credibility, gain industrial experience, and compete with cheaper forms of renewable energy.