Marine Energy Technologies: Technical Advancements and Cost Reduction Opportunities.

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Overview

Marine Energy Conversion (MEC) (a.k.a. Marine Hydrokinetic (MHK)) technologies' development continues to follow a similar trajectory to the wind energy industry towards larger scale testing and commercialization. Over the last several decades, wind and other renewable energy technologies have moved from experimental to full-scale systems deployment at scales required to make the levelized cost of energy (LCOE) competitive. Similarly, MEC technologies are experiencing similar trends throughout North America, Europe and beyond. The MHK technologies span many conceptual designs, sizes and deployment concepts. A key challenge for MEC technologies is to capitalize on recent technology advancements and translate them into cost reductions. This work describes three main components including, (1) the Department of Energy (DOE) Wave Energy Prize and recent advancement in design and controls show that adopting recent technology advancements could significantly improve the state-of-the-art performance of wave energy converters (WEC), (2) rigorous analyses on permitting and monitoring costs are required for identifying main cost drivers for LCOE, and (3) condition based structural health monitoring can be adopted for MEC to avoid unnecessary outages and, hence, reduce the overall operation and maintenance (O&M) cost. Additionally, this work highlights key areas where future research, development and demonstration (RD&D) efforts could help set up this industry for success in the coming decades.

Methods

Engineering Cost Modelling, Permitting and Monitoring Costs, Materials Science, System Design and Testing

Results

Current research suggests improving standardized and systematic practices for design & testing, permitting and monitoring, and sensor development technologies can reduce capital and O&M costs. Recent results show that the state-of-the-art performance of wave energy converters could improve by two-fold through implementing recent technology advancements and/or advanced technologies developed for various engineering applications (e.g., robotics, aerospace, wind energy). The lessons learned from a standardized testing regime developed a set of metrics to measure the success of wave energy converters (Dalman et al., 2018; Driscoll et al., 2018). Additionally, initial results in current permitting and monitoring costs research illustrate positive developments in best practices on pre-field testing/deployment by adopting feedback from those within the water power converter industry. This feedback presents several findings, one of which compares potential environmental study costs to those from a reference model study (Neary et al., 2014). Finally, prudent, cost-effective sensor placement on water power technologies may reduce O&M costs over time. Informed sensor development and placement can alert operators of performance problems to help optimize scheduled maintenance – similar in spirit to managing the number of 'truck rolls' when servicing remote photovoltaic cell fields and thereby reducing O&M costs over time.

Conclusions

The research presented here illustrates key MEC technology advancements, and engineering opportunities to increase the performance and hence decrease the Levelized Cost of Energy (LCOE) for these technologies. Recent

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advancements in tank testing suggest a doubling of performance output may be possible by integrating appropriate controls algorithms tailored to the resource being harvested by a Wave Energy Converter (WEC) (Coe et al., 2017)). Similarly, work in permitting and related costs offer best practices lessons on identifying and working in new markets to then reduce the potential future costs of field deployment. Advancements such as these and leveraging existing bodies of engineering-economic modelling for assets in the wind, offshore oil and gas platforms and generally the ocean engineering and renewable energy community may help this industry grow in the coming decades.

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