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Development of PTO-Sim: a power performance module for the open-source wave energy converter code WEC-Sim

**Abstract (400 Words text only): 370 words currently**

Sandia National Laboratories (SNL) and the National Renewable Energy Laboratory (NREL) have jointly developed WEC-Sim, a publicly available open-source wave energy converter (WEC) design tool capable of running on a standard personal computer. The WEC-Sim code simulates a WEC of arbitrary geometry subject to operational waves. It is developed in MATLAB/Simulink as a Simulink library and associated Matlab files. The WEC-Sim hydrodynamic solution has been verified through a code-to-code comparison. It has also undergone preliminary validation with experimental data, with further experimental validation planned in 2015.

The previous release of WEC-Sim had a simple linear damper power take-off (PTO) model. A collaborative effort between SNL and the Energy Systems group at Oregon State University (OSU) has resulted in the development of PTO-Sim, the WEC-Sim module responsible for accurately modeling a WEC’s PTO. The development of PTO-Sim makes WEC-Sim a wave-to-wire model. The WEC’s PTO system is easily created with drag and drop PTO-Sim library blocks. The PTO-Sim module consists of a Simulink library with PTO component library blocks that can be linked together to model different PTOs. Each of these library blocks is a Simulink model of common PTO components, such as electric generators, pistons, and accumulators.

PTO-Sim is capable of accurately modeling several power take-off configurations. In this paper two different applications of using PTO-Sim to model PTOs will be given. One example is of a hydraulic power take-off system, and one is of a linear direct drive power take-off system. Hydraulic power take-offs are one of the most popular power take-off systems used in wave energy devices. The main advantage of using a hydraulic system is the inherent energy storage capability. The hydraulic power take-off systems can be modeled as a passive system that automatically smoothes the flow across a hydraulic motor. It can also be modeled as a complex device that uses an active control system to track an optimal power absorption trajectory. The second PTO configuration is a direct drive power take-off. It is considered as a viable alternative to a hydraulic power take-off mainly because of its simplistic design and higher efficiency. These PTO-Sim models are fully coupled with the WEC-Sim hydrodynamic code, and together solve for the WEC’s hydrodynamic response and power performance.