

Modelling the Operations and Maintenance Strategy of a Wave Energy Array



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Introduction

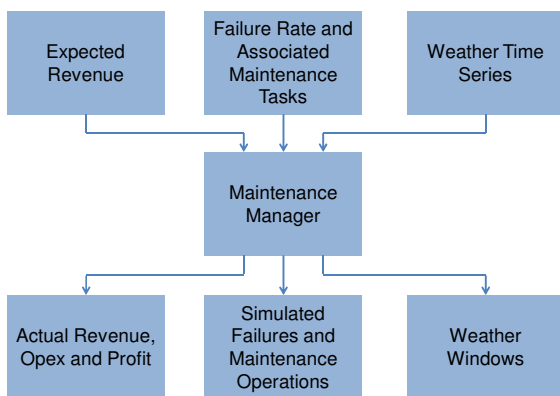
Wave energy is a young, growing industry with huge potential. Operations and maintenance (O&M) is a vital area of research in the push to make wave farms a commercial reality. The world's first commercial scale wave energy converter to generate electricity to a national grid was the Pelamis device. Between 2008 and 2014, two Pelamis P2 machines gained over 11,000 grid connected hours at the European Marine Energy Centre (EMEC) in Orkney. This vast knowledge and experience can be used to reduce the levelised cost of energy of future wave energy arrays.



One of the two Pelamis P2 machines currently based in Orkney

Modelling a Strategy

An O&M model was developed in 2007 as a means of informing design and budget decisions for the current generation of Pelamis devices (P2). It is now undergoing a significant upgrading phase as part of a Wave Energy Scotland-IDCORE collaboration. The model uses the Monte Carlo method, combined with failure rate data, to simulate the occurrence of faults during machine operation. This 'reactive' maintenance approach is accompanied by a 'proactive' routine service on each machine, resulting in a complete O&M strategy.



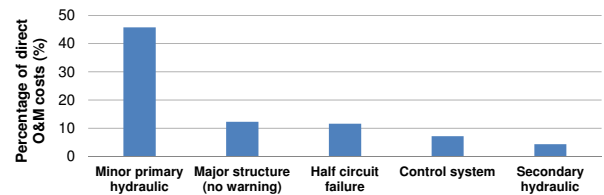
O&M model description

There are three key benefits of building an enhanced and realistic O&M model:

1. Obtain accurate operational costs and therefore predict Levelised Cost of Energy (LCoE)
2. Identify key failures to influence future design changes
3. Assess wave farm O&M strategies and considerations

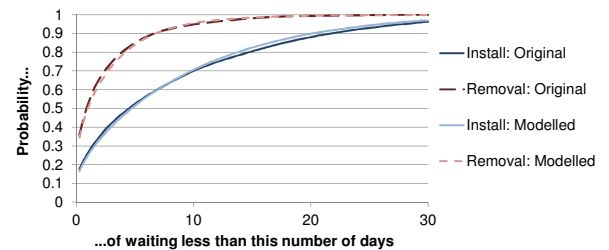
Reliability

A sensitivity analysis has identified key subsystems within the Pelamis P2 device that would contribute most to maintenance costs over the lifetime of a wave farm. This information can feed into the design of future wave energy technologies.



Percentage of O&M costs attributed to a certain failure category (only top 5 shown) for a 10 machine farm over a 20 year lifetime

Accessibility



Winter (Dec-Feb) weather window analysis. Comparison of original and modelled datasets for install and removal constraints

In addition to failure rate data, the other primary input to the O&M tool is weather information. A Markov-based weather model has been developed to generate a synthetic, yet realistic, time series containing significant wave height, wave energy period and wind speed. The modelled dataset can be used by the O&M tool to estimate power output and simulate realistic weather windows using the target limits for installation and removal operations. This enables site-specific analysis to be undertaken.

