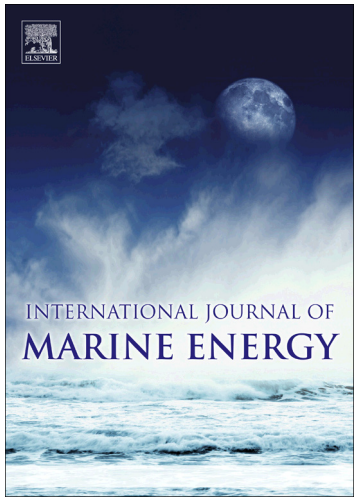
Accepted Manuscript



A surrogate-model assisted approach for optimising the size of tidal turbine arrays

D.M. Culley, S.W. Funke, S.C. Kramer, M.D. Piggott

PII: S2214-1669(17)30046-2
DOI: http://dx.doi.org/10.1016/j.ijome.2017.05.001
Reference: IJOME 150

To appear in:

Received Date: 22 March 2016
Accepted Date: 24 May 2017

Please cite this article as: D.M. Culley, S.W. Funke, S.C. Kramer, M.D. Piggott, A surrogate-model assisted approach for optimising the size of tidal turbine arrays, (2017), doi: http://dx.doi.org/10.1016/j.ijome.2017.05.001

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

A surrogate-model assisted approach for optimising the size of tidal turbine arrays

D.M. Culley [a*], S.W. Funke [b], S.C. Kramer [a] & M.D. Piggott [a,c]

[a] *Applied Modelling and Computation Group, Department of Earth Science and Engineering, Imperial College London, London, UK*

[b] *Center for Biomedical Computing, Simula Research Laboratory, Oslo, Norway*

[c] *Grantham Institute, Imperial College London, London, UK*

[*] *Corresponding author, dmc13@imperial.ac.uk*

Abstract

The new and costly nature of tidal stream energy extraction technologies can lead to narrow margins of success for a project. The design process is thus a delicate balancing act – to maximise the energy energy extracted, while minimising cost and risk. Scenario specific factors, such as site characteristics, technological constraints and practical engineering considerations greatly impact upon both the appropriate number of turbines to include within a tidal current turbine array (array size), and the individual locations of those turbines (turbine micro-siting). Both have been shown to significantly impact upon the energy yield and profitability of an array.

The micro-siting arrangement for a given number of turbines can significantly influence the power extraction of a tidal farm. Until the layout has been optimised (a process which may incorporate turbine parameters, local bathymetry and a host of other practical, physical, legal, financial or environmental constraints) an accurate forecast of the yield of that array cannot be determined. This process can be thought of as 'tuning' an array to the proposed site to maximise desirable outcomes and mitigate undesirable effects.

The influence of micro-siting on the farm performance means that determining the optimal array size needs to be coupled to the micro-siting process. In particular, the micro-siting needs to be repeated for any new trial array size in order to be able to compare the performance of the different farm sizes. Considering the large number of design variables in the micro-siting problem (which includes at least the positions of each turbine) it becomes clear that algorithmic optimisation is a key tool to rigorously determine the optimal array size and layout.

This paper proposes a nested optimisation approach for solving the array size and layout problem. The core of this approach consists of two nested optimisation procedures. The 'outer' optimisation determines the array size. At each 'outer' iteration the power extracted by N turbines is found via a separate optimisation of their micro-siting on the proposed site. The 'inner' optimisation is treated as a computationally expensive black-box solver, mapping array size to power (and additionally returning the optimal micro-siting design). This forms the basis of a practical approach to the

Download English Version:

https://daneshyari.com/en/article/5473540

Download Persian Version:

https://daneshyari.com/article/5473540

Daneshyari.com