Ocean Wave Energy Resource Assessment-

hotspots, exceedance-persistence, and predictability

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James Edward Frazerhurst

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Figure A. (Title page). A breaking wave from the perspective of a surfer travelling inside (source: www.surfermag.com).

Abstract

Ocean wave energy conversion is evolving towards commercial viability. Succinct resource assessment is essential to the conversion of wave energy for grid supply electrical generation. The ability to differentiate potential wave energy locations by means of comprehensible evaluations is particularly useful to the commercial developers of wave energy power plants.

This report establishes an assessment of wave energy that provides an understanding of the resource in both spatial and temporal resolution. Three aspects of the wave resource are established; mapping of wave energy **hotspots** due to wave focusing, visualisation of the probability of wave energy **exceedance** and **persistence**, and calculation of the **predictability** of wave energy for a particular aspect of coast. These three assessments are explained with a review of the science surrounding the phenomena of wave creation and propagation, the development of wave energy converter devices, as well as visualisation and manipulation of wave resource assessments. The outputs of these assessment methodologies are comparable, uncomplicated, graphic representations of the resource.

Case studies for seven locations encircling New Zealand were investigated, in order to demonstrate the practicalities of the wave energy resource assessment methodology developed by this project.

This study modelled the transformation of several hundred combinations of wave height, period and direction from deep-water to shore. The different conditions were ranked in terms of probability of occurrence. Recombination of these iterations created hotspot maps. The locations examined in this study were then compared to other infrastructure for wave energy utilisation.

Historical wave data was processed to establish the probability of levels of wave energy being exceeded and persisting. This information establishes how often a potential wave energy plant might provide significant output and for how long this output might persist.

Collection of wave prediction data for aspects of New Zealand allowed the comparison of up to seven day forecasts with a "now forecast". Assessment was then

made of the predictability of the climatic conditions creating waves for a location. The ability to be able to provide accurate forecasts of potential wave energy plants is of significant interest to generation companies in New Zealand in order to manage a diverse generation portfolio.

Key finding of this investigation:

- Waves and wave energy have significant variation of spatial, and temporal scales.
- Waves can be predicted for an aspect of coastline dependant upon the predictability of the climatic conditions of the wave generation location.
- Wave energy resource assessment is often presented as a single figure of averaged kilowatts per meter wave front that fails to adequately incorporate the temporal, spatial, and predictive aspects of the resource.
- A methodology was compiled to create "hotspot" (areas of intensified wave energy) mapping of a location utilising a wave transformation model. These maps can then be used to access spatial relationships to other digital information (electricity grid nodal locations, marine protected areas, navigation requirements, etc).
- Processing of wave climate data utilising Matlab© script developed by ASR Ltd identified the probability of wave energy being exceeded and persisting for a given location.
- Forecasts of wave characteristics are published on the Internet. Calculation of error between a "now forecast" and the previous day's forecast for today (up to six days out), can give an assessment of the predictability of an aspect of a location provided the wave forecast model utilises significant climatic variables.
- Case studies of wave energy resource assessment (using the developed hotspot, exceedence persistence, and predictability methods) for seven locations encircling New Zealand, identified three classes of wave resource; exceptional (Southland), good (Otago, Taranaki, Auckland, Hokianga), and poor (Canterbury, Wellington).

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