The Influence of Sea State Characteristics on Wave Energy Converter Performance

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Work stream 1:Array Planning

Introduction

- Prediction of the performance of Wave Energy Converters (WECs) requires an accurate characterisation of the incident wave climate at deployment sites.
- Predictions are based on the results of physical and numerical model tests that attempt to represent site conditions.
- Nonlinear energy conversion mechanisms introduce uncertainty in Annual Energy Production (AEP) estimation when modelling seas based on statistical parameters (H_{m0} & T_{01}) alone.
- The performance of certain WECs may vary depending on further spectral, temporal and/or directional characteristics.
- The effect that these characteristics have on WEC performance must be understood to confidently estimate AEP.

Aims

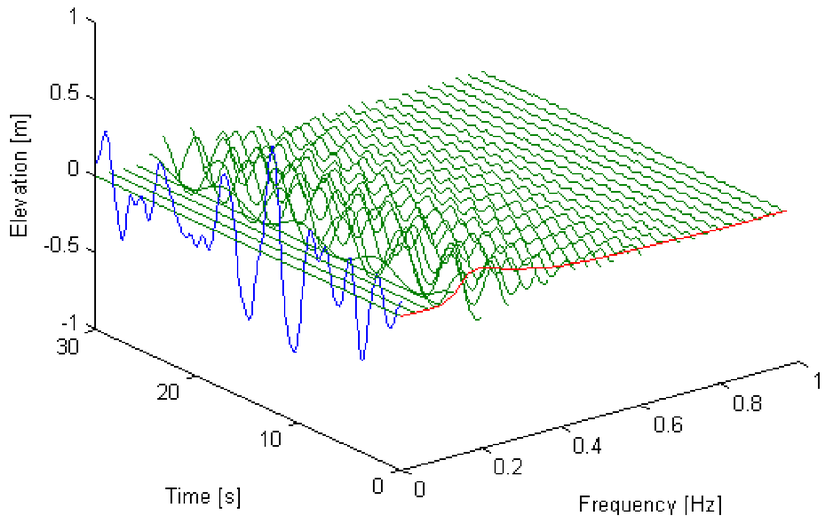
- Understand the influence of the spectral and directional distribution of wave energy on WEC performance.
- Relate the sensitivity of WEC performance to particular WEC characteristics.
- Develop a numerical model to estimate AEP of WEC arrays in fully directional spectral sea states.

Methodology

- Test models of various WECs in 16m wide coastal basin at QUB.
- Compare performance of models to both prototype and numerical data.

References

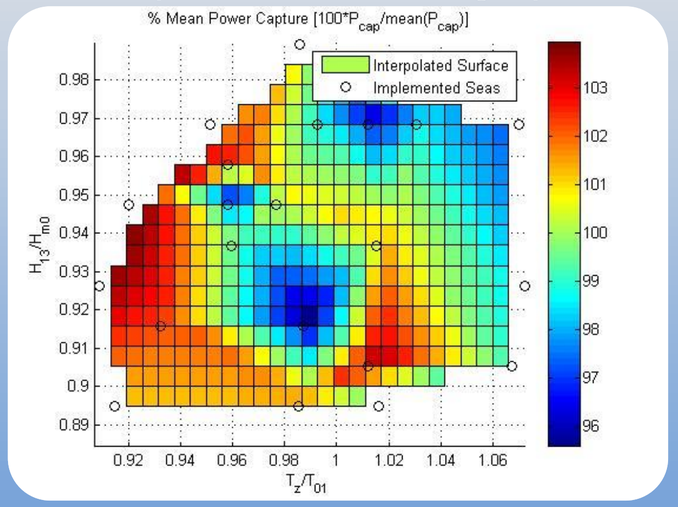
[1] D. Clabby, A. Henry, M. Folley, T.J.T. Whittaker, *The Effect of the Spectral Distribution of Wave Energy on the performance of a Bottom Hinged Flap Type Wave Energy Converter*, 31st Conference on Ocean, Offshore and Arctic Engineering, Rio de Janeiro, Brazil, 2012.



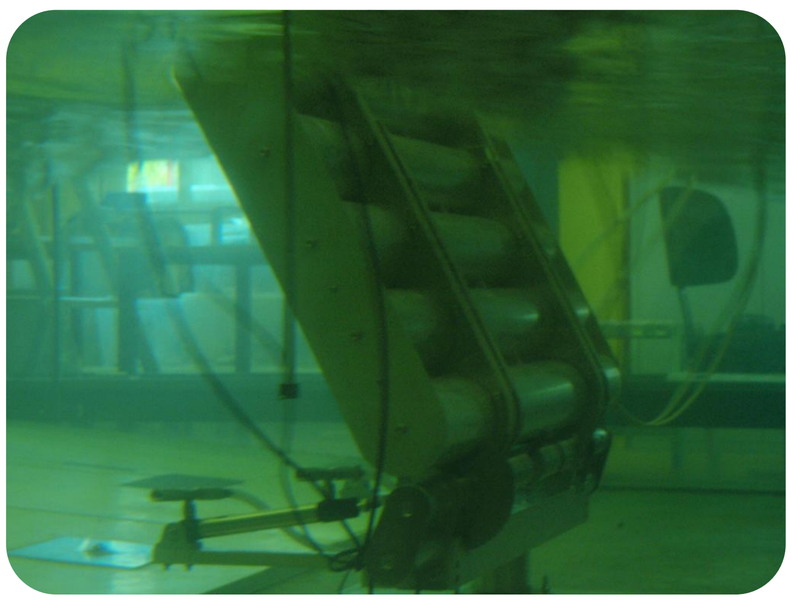
- Surface elevation time trace decomposed as summation of regular wave components.
- Amplitude of each regular component represented in the frequency domain by the amplitude spectrum.

Time Domain

(See blue line in above figure)

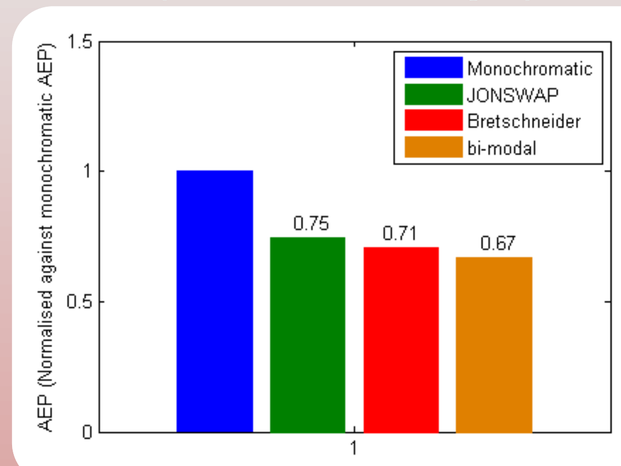


- Power captured by 20th scale Oyster model measured in a single sea state (H_{m0}=1.9m & T_{01}=7.3s, Bretschneider) implemented as 21 different time series.
- ±~4% variation in mean power capture.
- Reason for variation attributed to influence of nonlinear processes such as overtopping, viscous drag etc.

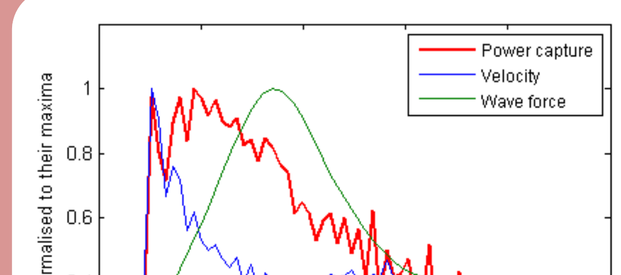


Frequency Domain

(See red line in above figure)



- AEP for Oyster model in 10 H_{m0} & T_{01} combinations generated in four ways:
  - Monochromatic
  - Bretschneider
  - JONSWAP
  - Bi-modal.



- Moderate sensitivity of performance to spectral shape due to wide banded spectral response.
- This is due to a combination of low frequency resonance (~0.05Hz) and higher frequency peak (~0.17Hz) in wave excitation force [1].