



Obtaining Greater Average Power Output from Wave Energy Converters:

An Introduction by:
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Typical Current Investment



- Considerable financial and intellectual investment has taken place in wave energy capture systems.
- Despite this energy costs are far higher than existing alternatives even with substantial carbon taxes. Why?
- To date most effort has gone into the wave energy converting devices and not into the most effective way to operate them.

Improving WEC Returns



What is required is to get the biggest possible return on the investment made already.

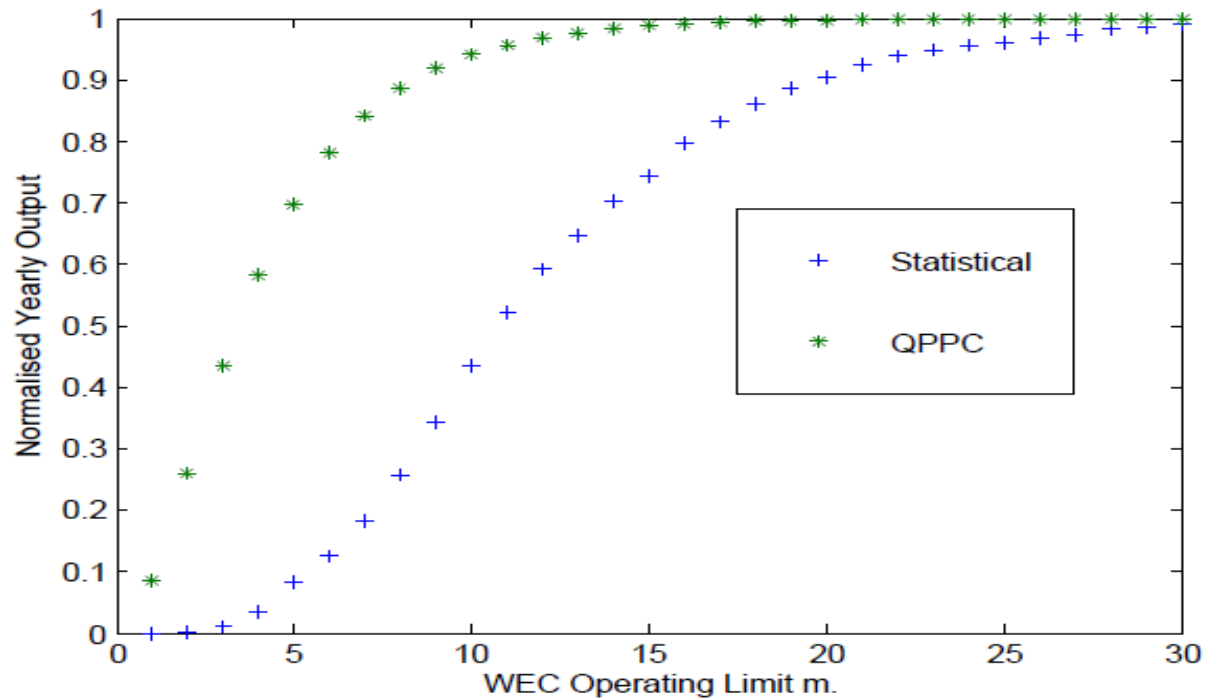
Achieving this goal is the main driver for the PRIMaRE work on Device Operations

An Example of PRIMaRE's WEC Operation Research



Wave Predictive Based WEC Control

Gain in Annualised Power Available Using Wave Predictive Control



Typical Wave Energy Converter “WEC” that benefits from Wave Predictive Control



OPT Power Buoy

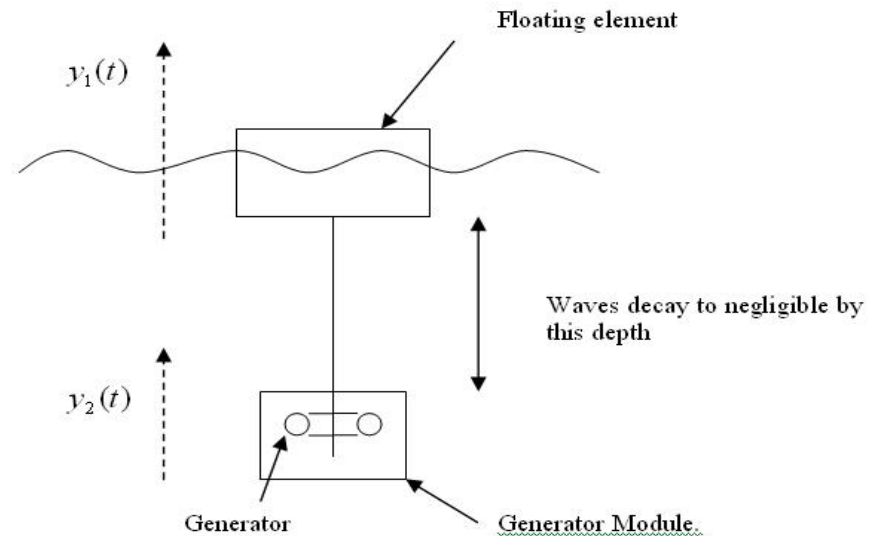


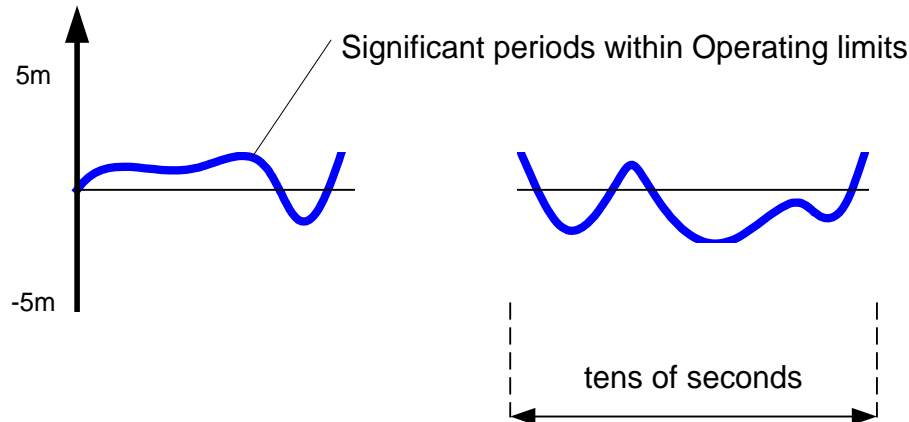
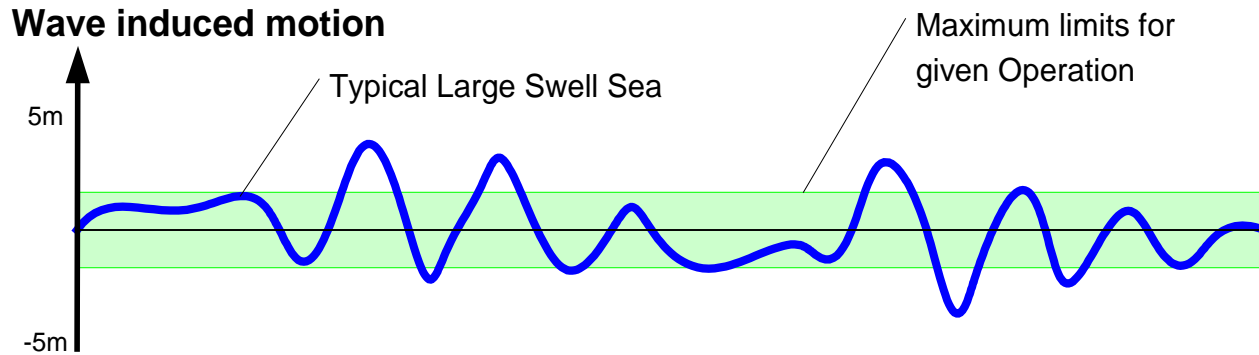
Figure 2. Isotropic WEC

Simple Model of WEC

Quiescent Period Operation

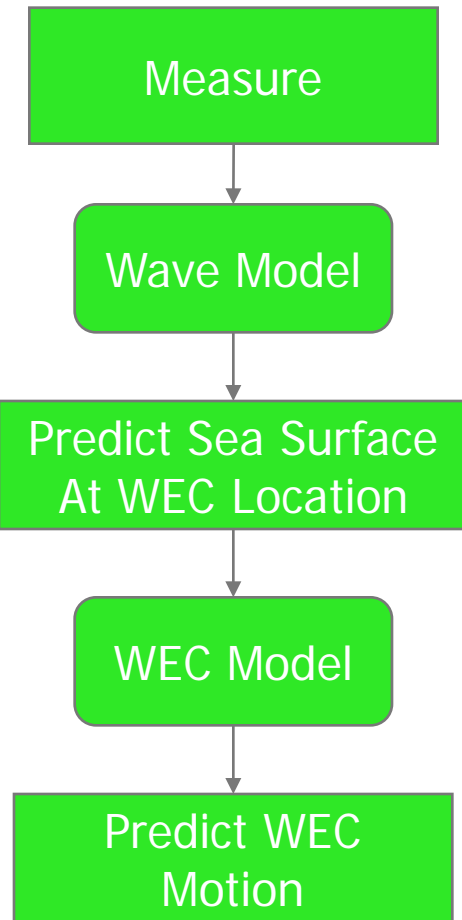
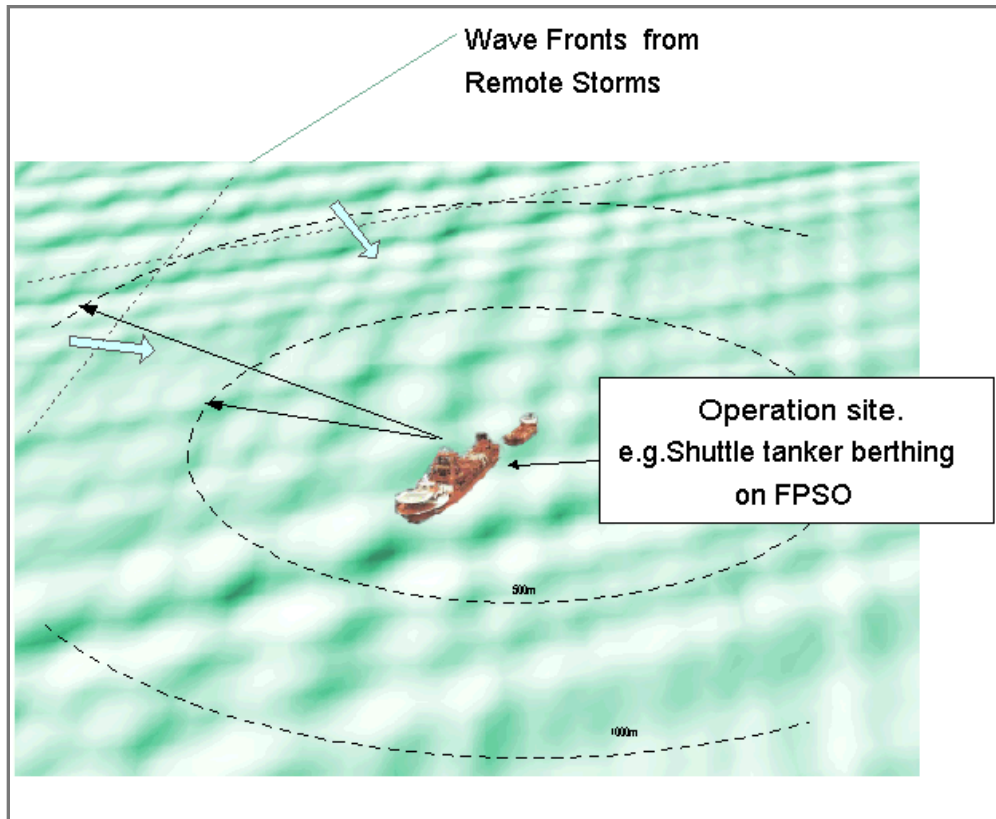


Wave induced motion



Prediction Method	Outcome
Classical Sea State (Statistical Data)	<u>Never</u> Execute Operation
Deterministic Look Ahead Prediction for tens of seconds	<u>Often</u> Execute Operation in safe prediction window

Elements Needed for a Wave Energy Converter Motion Estimator



So What's Happening?



- A Full Scale EU funded Demonstrator Project is being deployed off Portugal based upon the OPT Power Buoy. Kick off this November!
- PRIMaRE is installing a world leading phase coherent wave sensor array at the Wave Hub site funded by SWRDA. Installation Starts Next week!

South West Wave Buoy Array

Directional wave sensor buoy array

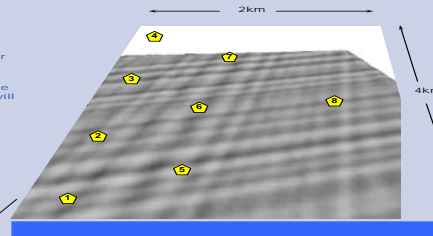
The wave sensor array being installed by PRIMaRE under SWRDA support is a world class marine instrumentation facility. Its intention is:

1. To provide fundamental research data for use in the fields of marine renewable energy and associated environmental impact work, plus fundamental oceanographic studies.
2. To provide data for use by the WEC operators in Wave Hub for the purposes of planning and operating WECs.

The array consists of 8 directional wave buoys spanning the 4km by 2km area of sea defining the Wave Hub. These buoys will be able to deliver synchronized live and continuous data streams that will allow PRIMaRE to explore new deterministic and statistical descriptions of a spatially local sea wave system.

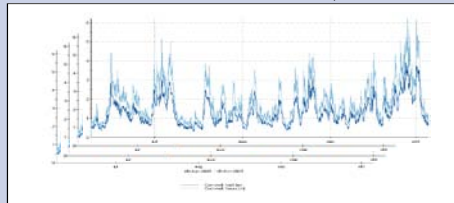
Specific tasks:

- To characterise the spatial variation of sea state measures across the area.
- To provide more local sea state measures for each WEC berth
- To measure 'down wave' from the WECs to evaluate wave energy depletion.
- To facilitate phase coherent, time series measurement, across the field, allowing deterministic sea wave direction calculation, and deterministic sea wave prediction.



An example of the deployment pattern for the array of 8 directional sea wave buoys.

The actual locations for each buoy will take in to account the requirements of both the Wave Hub infrastructure, the WEC berths and other PRIMaRE research facilities and programs.



Wave Data

The buoys can be configured to transmit ashore the standard statistical wave data (processed onboard) and, if requested, a time series of motion data (the 3 translation heave and the east and north displacements and GPS position data). The buoys will be initially configured to sample data at 2Hz, 2048 samples, for approximately 20 mins every hour, however the motion data set length and the data set repetition rate are selectable within the buoys' sustainable power budget. Data sets (motion or standard) will be time stamped and synchronously sampled across the buoy array. These data sets are transmitted at the end of sample window.

In a further mode true real time, raw sensor data, can be transmitted, live and continuously, from all of the buoys. This will be direct output from accelerometers, rate gyros, compass sensor and GPS receiver. This feature will allow deterministic and statistical descriptions of the local sea wave system to be feed, as a real time control input, to the WECs occupying the wave hub site.



Real Time Control Feed

The buoy array will also be an important part of the Wave Hub's infrastructure, capable of feeding wave information to the WEC devices. In one mode of operation the buoys will be able to deliver synchronized live and continuous data streams that will allow a local description of the sea surface to be computed in real time. This data can be provided as a live feed to the WEC devices to help optimize their energy capture.

Collaborative Research

The buoy array will constitute a world leading facility giving researchers in wave energy a unique opportunity to work with much richer and detailed data sets.

Whilst PRIMaRE's focus is on marine renewable energy, the wave buoy array and the data sets collected from the site will be available to the wider oceanographic community, for example, as a resource input in international research partnerships.



Furro OCEANOR SEAWATCH MINI II buoy

6 axis motion sensors
(3 translational and 3 rotational)

Magnetic heading

GPS receiver

Power: A combination of lead acid and lithium batteries, Solar panel support.

Mass: 320kg
Diameter: 1.25m

Telemetry:

- Time multiplexed transmission from each buoy on a single UHF channel
- Receiver Antenna at the National Coastwatch Institution's St Ives Station
- Broadband connection for direct internet access
- Watch keeping position transmission to Argos satellite

Support from the South West regional Development Agency and the European Union is gratefully acknowledged

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Conclusions & Sales Pitch

- PRIMaRE has a very real appreciation of the need to reduce installed capacity costs in the wave energy sector.
- PRIMaRE has pioneered world leading new science to achieve this.
- PRIMaRE is actively involved in implementing the technology in real commercial contexts.
- WE DO MORE THAN JUST GOOD SCIENCE

