Seasonal Variability Assessment of the M4 Wave Energy Converter Practical Power along the Western Australian Coast

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BACKGROUND

- The M4 is a line absorbed WEC composed of three cylindrical floats where the spacing between adjacent floats is about half a wavelength (Fig. 1).
- Designed and developed in the U.K. (Stanby et al., 2015; Eatock Taylor et al., 2016; Santo et al., 2016a; Santo et al., 2016b), the M4 WEC was recently subjected to a performance study in Albany, Western Australia (Santo et al., 2020).
- Characterized by a consistent long-period swell-dominated wave climate, Albany wave conditions were assessed to present relatively low seasonal variability.
- According to Stanby et al. (2015), to size the M4 device for optimal power output, the M4 resonant heave period $T_r$ should match the local long-term mean energy period $T_e$.

RESEARCH DIRECTIONS

- What is the seasonal variability of the M4 power output at Albany and along the western Australian coast when sizing the M4 WEC according to Stanby et al. (2015) sizing methodology?
- How does the size of the M4 influences the power output seasonal variability at Albany?

MATERIALS & METHODS

- The incident power was determined on a sea-state basis accounting for finite water depth ($P_{bw} = g \int S(f) \cdot c_g(f) df$, where $S(f)$ is the sea-state spectrum and $c_g(f)$ the associated group velocity).
- The power output was then obtained by incorporating the adequate Capture Width Ratio (CWR) extracted from the reference curve derived in Santo et al. (2016b) ($CWR = \frac{T_r}{T_e}$), where $P_{bw}$ is the absorbed power and $\lambda(T_e)$ is the wavelength associated with the energy period $T_e$.
- The M4 power output was derived on a monthly basis at Albany, as well as at Rottnest Island and Jurien Bay (located in Fig. 2).

The data sets used in this study were all recorded by wave buoys which main features are summarized in Table 1.

<table>
<thead>
<tr>
<th>Wave Buoy</th>
<th>Offshore Torbay (Albany)</th>
<th>Inshore Torbay (Albany)</th>
<th>Rottnest Island</th>
<th>Jurien Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitude (°)</td>
<td>117.722</td>
<td>117.710</td>
<td>115.408</td>
<td>114.914</td>
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<td>Latitude (°)</td>
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<td>Water depth (m)</td>
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<td>20</td>
<td>10</td>
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<tr>
<td>Record length (months)</td>
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<tr>
<td>Incomplete/missing monthly records</td>
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<td>6</td>
<td>5</td>
<td>3</td>
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</tbody>
</table>

Table 1: Wave buoy records characteristics.

RESULTS

- The wave conditions and power long-term means of the three locations of interest are reported in Table 2.
- The seasonal variability at Albany is depicted in Fig. 3 on a monthly basis.
- The influence of M4’s size on the power output seasonal variability is shown in Fig. 4, both with absolute values (a) and with values relative to the yearly mean (b). The related power output yearly averages are listed in Table 3.

CONCLUSIONS

- For similarly-sized M4 machines, the yearly power output (1 MW) is twice as high at Albany than at both Rottnest Island and Jurien Bay (500kW).
- Following the incident power trend, the M4 power output is higher during austral winter months. The minimal-to-maximal value factor is 1.6, which is relatively low when compared to U.K. wave conditions.
- The M4 sizing study reveals that the larger the M4 machine, the larger the power output but also, the larger the seasonal variability. The 126m-long machine (9s) seems to be an interesting compromise between maximal power output and minimal seasonal variability.

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REFERENCES