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A review of wave energy estimates for nearshore shelf waters off Australia

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ABSTRACT

Australia is recognized as one of the most promising region in the world to harvest wave energy. In order to harness such energy it is required to perform an assessment of the available resources as a pre-requisite to accurately select and characterize sustained nearshore optimum sites of wave energy concentration called 'hot-spots'. Such regions typically offer greater economic potential for sitting wave energy conversion facilities since potential trade-offs between benefits of harvested wave energy and costs of bringing energy ashore are more profitable. This article is a review of wave energy predictions performed for nearshore shelf waters off Australia. Publicly available estimates of wave energy resource are reported from the literature, providing important descriptions of nearshore wave energy resources along Australia's margin. The states of Tasmania, Victoria, Western Australia and South Australia are endowed with relatively high levels of annual average wave power, in excess of approximately 30 kW m^{-1} along most of the exposed coasts. Coastal and nearshore wave energy resources are found significant and fairly sustained throughout the year for most of southern Australian states, with the highest mean wave energy power observed during spring and winter. These predictions mostly derived from numerical wave models revealed averaged discrepancies of approximately 20–30% when compared to wave-rider buoy records. The level of accuracy of wave hindcast data

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used as boundary conditions (model input) and its suitability to describe Australia's wave climate are found to be major reasons for that disparity. The densely populated coasts of New South Wales and Queensland are also found to be potential sites for wave energy harvesting, however, they have not yet been assessed for wave energy resources in nearshore shelf waters using a high spatial resolution wave transformation model. Lastly, using currently available WECs and Australian resource data the levelised cost of electricity (LCOE) of wave energy in the Australian southern coast has been calculated to be as low as ~100 $/MWh and the capacity factor as high as ~54%.

Contents

1. Introduction

The extensive coastline of Australia's southern half is relatively well exposed to the powerful storms from the Southern Ocean and to the prevailing westerly winds contains a notable fraction of the global wave energy resources [1]. Australia's potential market for harvesting wave energy using wave energy converters (WECs) is very promising and can definitely provide a sustainable alternative for electricity generation. However, wave energy varies substantially according to local features and weather systems of each region. Therefore, it is not uniformly distributed within nearshore regions along the coast as seen in Fig. 1. In order to identify and characterize the most suitable sites for wave energy harvesting and also to select the most appropriate WEC for each region, it is required to accurately assess priority nearshore wave energy resources (e.g. [2,3]).

Former investigations have assessed Australia's potential wave energy at several geographical and temporal scales using waverider buoy records (e.g. [4–7]) and or wave models (e.g. [8–11]) and the outcomes are suggestive of substantial wave energy resources. In order to attain appropriate measures of nearshore wave energy resource for determining the productivity of WECs, it is required to take into account the attenuation of the wave energy across the continental shelf [13,14]. Therefore, the usage of gross offshore wave energy estimates, as an indicator of the available wave energy resource in nearshore waters (i.e. where the WECs are typically positioned) is likely to be misleading. Significantly, until now no review of nearshore wave energy for Australia has been made. Amongst the available wave energy resource evaluations performed in Australia, research performed by [7–10] provides descriptions of the nearshore wave energy resource for water depths of $\leqslant$50 m. These assessments are of great value and represent most of the existing available information regarding Australia's nearshore resource. Nevertheless, further assessments of nearshore wave energy resource are required by the wave energy harnessing industry for tuning of existing wave energy converters and planning of