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Wave resource variability: Impacts on wave power supply over regional to international scales

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The intermittent, irregular and variable nature of the wave energy resource has implications for the supply of wave-generated electricity into the grid. Intermittency of renewable power may lead to frequency and voltage fluctuations in the transmission and distribution networks. A matching supply of electricity must be planned to meet the predicted demand, leading to a need for gas-fired and back-up generating plants to supplement intermittent supplies, and potentially limiting the integration of intermittent power into the grid. Issues relating to resource intermittency and their mitigation through the development of spatially separated sites have been widely researched in the wind industry, but have received little attention to date in the less mature wave industry.

This study analyses the wave resource over three different spatial scales to investigate the potential impacts of the temporal and spatial resource variability on the grid supply. The primary focus is the Southwest UK, a region already home to multiple existing and proposed wave energy test sites. Concurrent wave buoy data from six locations, supported by SWAN wave model hindcast data, are analysed to assess the correlation of the resource across the region and the variation in wave power with direction. Power matrices for theoretical nearshore and offshore devices are used to calculate the maximum step change in generated power across the region as the number of deployment sites is increased. The step change analysis is also applied across national and international spatial scales using output from the European Centre for Medium-range Weather Forecasting (ECMWF) ERA-Interim hindcast model.

It is found that the deployment of multiple wave energy sites, whether on a regional, national or international scale, results in both a reduction in step changes in power and reduced times of zero generation, leading to an overall smoothing of the wave-generated electrical power. This has implications for the planning and siting of future wave energy arrays when the industry reaches the point of large-scale deployment.