Developing datasets of tidal and wave energy generation from renewable resource models

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Objective & Background

Wave, tidal stream and tidal range energy generation has the potential to play a significant role in the decarbonisation of energy in countries with suitable resource, such as Great Britain (GB). The practical resource is significant relative to demand estimates, and the temporal profile of these renewable resources is complementary to that of wind and solar power, so their deployment has the potential to improve power system flexibility and energy security, enhancing the collective value of the marine energy system. Suitable wave and tidal resources are, however, often located in remote areas far from load centres and existing power transmission networks. In order to support investment in these technologies, there is a need for reliable datasets of wave, tidal stream, and tidal range power output for incorporation into energy system models to better understand their effectiveness. The research presented here is developing such a set of datasets for the GB energy system.

Method

Existing renewable resource datasets for energy system modelling in GB include data for a whole region based on typical power conversion technologies. As wave and tidal resource is significantly more variable, this dataset focusses only on credible installation locations based on available literature [1, 2]. Furthermore, the design of energy converters for these resources hasn't converged, so power output data is based on selected nominal technologies (the Pelamis Wave Energy Converter or Orbital Marine O2 floating tidal turbine).

Different approaches were taken in sourcing wave and tidal resource data. As the former is weather dependent, 10 years of wave data was extracted from historical reanalysis data [3] to capture all typical weather states. In contrast, tidal range and stream resource is, predictable yet highly variable spatially, requiring targeted multi-scale modelling. This was accomplished through the Thetis coastal ocean regional models (e.g. [4-6]) to simulate tidal resource availability at specific future time points.

The resource data was transformed through power performance data to produce time series of capacity factors (power output as a ratio of rated power) at each credible installation location [7].

Principal Findings

Capacity factor time-series were calculated for 17 credible wave, 21 tidal stream and 7 tidal range sites. An extract from the output is illustrated in Figure 1, showing the complementarity of the power outputs. These datasets have been applied in an analysis of the future energy production of wave and tidal stream deployment in GB for 2025 to 2050 [7].

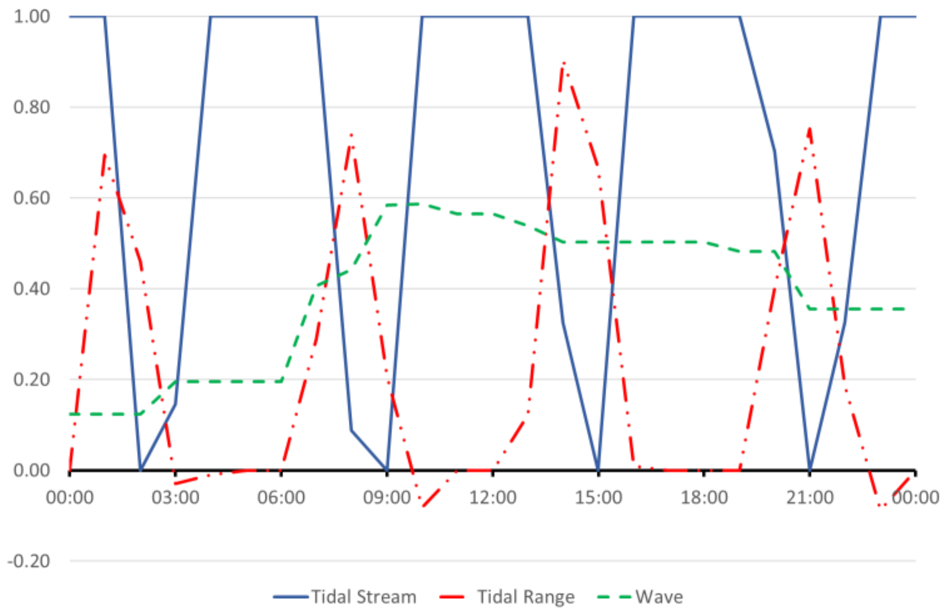

Figure 1 – Typical capacity factors for tidal stream (Sound of Islay), tidal range (Liverpool) and wave energy (West of Hebrides) on 21st March

Discussion

The datasets developed in this research enables the integration of detailed spatial and temporal wave and tidal data into GB energy system models. One limitation, however, is in reconciling the use of historical weather data for wave energy with the predictable future tidal resource for modelling future energy systems. Further work will consider the impacts of climate change on wave energy and ensure these datasets are better aligned.

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