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Tidal stream resource characterisation in progressive and standing wave systems

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Characterisations of the resource and its variability over various timescales are crucial for the development of the tidal stream energy industry. To date, no research has compared resource sensitivity in standing wave and progressive wave tidal systems. We hypothesise the influence on power, timing of electricity generation, and potential environmental impacts to be markedly different between these contrasting systems. Here, we compare the flow regimes of standing wave (when peak currents occur midway between high and low water) versus progressive wave (where peak currents occur at high and low water) systems and the associated variations in tidal power with applications to device deployment options (floating-platform turbines over bottom-mounted turbines). Using a validated 3D numerical model (ROMS) of a globally significant tidal energy shelf sea (Irish Sea), we show that progressive wave systems are characterised by velocity-asymmetry over a tidal cycle (i.e. stronger peak flows at high water than at low water), hence power-asymmetry. Such power asymmetry can become amplified with floating device technology, where an assumed turbine depth tracks the sea surface, in contrast to bottom-mounted technology, where the hub height is fixed at a certain position above the sea bed. We show that these effects are exacerbated in shallow waters and where tidal range is large, because vertical variations in stream flow are larger. We generally found that shallow, high-flow regions contained up to 2.5% more power density from bottom-mounted compared with floating turbines; however, in some cases floating technology generated more power – highlighting the requirement for detailed resource assessments to consider the vertical plane. Standing wave systems, where flow asymmetry is minimised, did not particularly favour either technology.