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The value of tidal-stream energy resource to off-grid communities

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Tidal-stream energy research has often focused on the applicability of the resource to large electricity distribution networks, or reducing costs so it can compete with other renewables (such as offshore wind). Here we explore how tidal electricity may be worth the additional cost, as the quality and predictability of the electricity could be advantageous – especially to remote “off-grid” communities and industry.

The regular motion from astronomical forces allows the tide to be predicted far into the future, and therefore idealised scenarios of phasing tidal electricity supply to demand can be explored. A normalised tidal-stream turbine power curve, developed from published data on 15 devices, was developed. Tidal harmonics of a region, based on ocean model output, were used in conjunction with this normalised tidal-stream power curve, and predictions of yield and the timing of electricity supply were made. Such analysis allows the type and number of turbines needed for a specific community requirement, as well as a resource-led tidal turbine optimisation for a region. For example, with a simple M2 tide (12.42hour period) of 2m/s peak flow, which represents mean flow conditions, a rated turbine speed of 1.8m/s gives the highest yield-density of all likely turbine configurations (i.e. calculated from power density and so ignores turbine diameter), and with a 41% Capacity Factor. Furthermore, as tidal current and power predictions can be made, we explore the battery size needed for a given electricity demand timeseries (e.g. baseload, or offshore aquaculture). Our analysis finds tidal-stream energy could be much more useful than other forms of renewable energy to off-grid communities due to the predictability and persistence of the electricity supply. Moreover, our standardised power curve method will facilitate technical tidal energy resource assessment for any region.