



Impact of Tidal-Stream Turbines on the Generation of the Higher Tidal Harmonics

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The higher tidal harmonics result from the interaction of the astronomic tides with both themselves and each other through non-linear processes. In shallower waters such as those near the coast these non-linear processes become more significant and thus, so too do the higher tidal harmonics become more significant. The interaction of the tide with tidal-stream turbines (TSTs), through thrust and drag processes will be non-linear and as such will contribute to the generation of higher tidal harmonics, thus changing the nature of the tide downstream of the turbines. The change to the tide may potentially impact on the downstream energy resource (Robins et al. 2015) and sediment transport processes (Pingree & Griffiths 1979). This paper will present analytical results, which suggest that TSTs will impact on the generation of all higher harmonics but with odd overtides being impacted more than even overtides, the most important examples of which are the M6 and M4 tides respectively, which are the first odd and even overtides of the M2 tide. Change in phase and amplitude of the M6 tide by TSTs will distort the tide but will not cause an asymmetry between the flood and ebb of the tide. Change in the phase and amplitude of the M4 can not only distort the tide but also cause asymmetry. Hence any change to the M4 tide by the turbines is more significant, despite the magnitude of change to the M6 being greater. In order to gain a fuller understanding of the way in which TSTs change the tide downstream and the significance of any change for transport processes or energy resource, a numerical modelling study will be carried out, which will be presented in a future paper.

Robins, P.E., Neill, S.P., Lewis, M. & Ward, S.L., 2015. *Characterising the spatial and temporal variability of the tidal-stream energy resource over the northwest European shelf seas*. Applied Energy, **147**: 510–522.

Pingree, R.D. & Griffiths, D.K., 1979. *Sand transport paths around the British Isles resulting from M2 and M4 tidal interactions*. J. Mar. Biol. Ass. U.K., **59**: 497–513