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Temporal variability in the electricity generated from a tidal-stream turbine

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Balancing electricity demand with the variability of renewable energy sources is a challenge to future electricity network design and management. The electricity produced by a tidal-stream turbine will vary with time, with much research focusing on astronomical tidal constituent interactions that result in variability between tidal cycles (e.g. the spring-neap cycle). The influence of fine-scale variability to electricity quality in wind turbines (i.e. wind gustiness) is an established research topic, however very little research has investigated fine-scale variability to tidal-stream electricity generated. Tidal power is directly proportional to the cube of tidal current. Fine-scale temporal fluctuations to tidal current speed (turbulence) is known to be high at tidal energy sites, with tidal-turbine blades having little momentum (compared to the relatively much larger offshore wind turbines). Therefore, the spectrum of power from a tidal-stream turbine needs to be investigated. A unique dataset of hub-height tidal velocity and grid-connected shore-side power from an 18m diameter 1.2MW turbine (deployed at 59.14°N & 2.81°W), and recorded at sub-second scale frequency, has been obtained for two tidal cycles; 26 October 2014 and 26 Nov 2014. Fine-scale variability in the measured power output from the turbine was found, and this variability was correlated to waves, turbine-support structure interaction (blade passing the support structure) and to fine-scale variability in flow speed (turbulence). The effect of temporal variability on resource estimation, and a method for synthetic fine-scale tidal power variability, will be presented that will allow the quality of electricity from large-scale development of tidal power plants to be assessed.