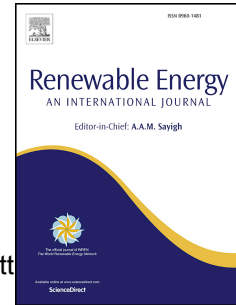


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The trade-off between tidal-turbine array yield and impact on flow: a multi-objective optimisation problem.

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Abstract

This paper introduces a new approach for investigating trade-offs between different societal objectives in the design of tidal-turbine arrays. This method is demonstrated through the trade-off between the yield of an array, and the extent to which that array alters the flow. This is posed as a multi-objective optimisation problem, and the problem is investigated using the array layout optimisation tool OpenTidalFarm. Motivated by environmental concerns, OpenTidalFarm is adapted to not only maximise array yield but also to minimise the effect of the array upon the hydrodynamics of the region, specifically the flow velocity. A linear scalarisation of the multi-objective optimisation problem is solved for a series of different weightings of the two conflicting objectives. Two idealised test scenarios are evaluated and in each case a set of Pareto solutions is found. These arrays are assessed for the power they generate and the severity of change they cause in the flow velocity. These analyses allow for the identification of trade-offs between these two objectives, while the methods proposed can similarly be applied to the two key societal objectives of energy production and conservation, thus providing information that could be valuable to stakeholders and policymakers when making decisions on array design.

Keywords:

marine renewable energy, tidal turbines, gradient-based optimization, multi-objective optimization, Pareto front, environmental impact

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