

Accepted Manuscript

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PII: S2214-1669(17)30075-9
DOI: <https://doi.org/10.1016/j.ijome.2017.09.002>
Reference: IJOME 176

To appear in: *International Journal of Marine Energy*

Received Date: 17 March 2017
Revised Date: 6 September 2017
Accepted Date: 19 September 2017



Please cite this article as: S. Waldman, S. Yamaguchi, R. O'Hara Murray, D. Woolf, Tidal resource and interactions between multiple channels in the Goto Islands, Japan, *International Journal of Marine Energy* (2017), doi: <https://doi.org/10.1016/j.ijome.2017.09.002>

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Tidal resource and interactions between multiple channels in the Goto Islands, Japan

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Abstract

The Goto Islands in Nagasaki Prefecture, Japan, contain three parallel channels that are suitable for tidal energy development and are the planned location for a tidal energy test centre. Energy extraction is added to a 3D numerical hydrodynamic model of the region, using a sub-grid momentum sink approach, to predict the effects of tidal development.

The available resource with first-generation turbines is estimated at 50–107 MW peak output. Spreading turbine thrust across the whole cross-section to prevent bypass flow results in a 64% increase in peak power in one channel, highlighting the importance of 3D over 2D modelling.

The energy available for extraction in each strait appears to be independent of the level of extraction in other straits. This contrasts with theoretical and numerical studies of other multi-channel systems. The weak interactions found in this study can be traced to the hydraulic effects of energy extraction not extending to neighbouring channels due to their geometry.

Keywords: FVCOM, numerical modelling, Goto islands, tidal energy, split channels

1. Introduction

1.1. Background

In 2010 nuclear power provided 25% of Japan's electricity [1], making Japan the third-largest producer of nuclear energy in the world [2]. Following the tsunami of 2011 and the subsequent events at the Fukushima Daiichi nuclear power plant this figure dropped to less than 2% (in 2012) as the nation's reactors were taken off-line, and most of the shortfall was replaced by fossil fuels. Lacking substantial fossil resources of its own, by 2015 Japan had become one of the world's greatest importers of fossil fuels, and in addition to the environmental

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