



MASTS PECRE final report :

Simon Waldman

Dates:	July / August 2016 (6 weeks duration). Report compiled 23 rd Sept 2016
Home institution:	Heriot-Watt University, Stromness, Orkney
Host:	Dr. Changhong Hu, Research Institute for Applied Mechanics, Kyushu University, Fukuoka, Japan
Project title:	Modelling the effects of tidal energy extraction from the Goto Islands, Japan

Background

The Goto islands, in south-west Japan, experience strong tidal currents through four parallel channels. Work is underway to set up a marine energy test centre there similar to, and advised by, EMEC in Scotland. Kyushu University had an existing hydrodynamic model of these islands using the FVCOM flow modelling software, but it simulated only the existing scenario and did not include energy extraction.

The TeraWatt and EcoWatt2050 projects, undertaken by a broad consortium of Scottish universities under the auspices of MASTS, developed techniques for studying the effects of tidal energy extraction from channels. Marine Scotland Science has recently developed code to represent tidal turbines in the FVCOM flow modelling software, which was made available for this project.

Work conducted

Kyushu University's FVCOM model was updated to use the latest version of the FVCOM code. Tidal turbines were added across three of the four channels. Scenarios from the conservative to the improbably ambitious were tested in each channel individually. Selected scenarios were tested in combinations of 2 or 3 channels together. Predictions were made of the effects of energy extraction in various scenarios, and estimates of available power arrived at.

Conclusions

The predicted level of interaction between the channels of the Goto Islands was less than that found in simulations of the Pentland Firth¹ or suggested by simple theoretical models of parallel channels². A hypothesis to account for this anomalous behaviour was developed, but has not yet been tested.

¹ *e.g.* S. Draper, T. A. A. Adcock, A. G. L. Borthwick, and G. T. Houlsby, "Estimate of the tidal stream power resource of the Pentland Firth," *Renewable Energy*, vol. 63, pp. 650–657, 2013.

² P. F. Cummins, "The extractable power from a split tidal channel: An equivalent circuit analysis," *Renewable Energy*, vol. 50, pp. 395–401, Feb. 2013.

Simulations show a strong vertical bypass effect above turbines in deep water. This observation strengthens the importance of using a three-dimensional model that can simulate this mechanism, and suggests that a more innovative distribution of rotor area may be beneficial.

Outputs

- Presentation to staff and postgrad research students at Kyushu University shortly prior to end of exchange.
- Presentation to joint group of Scottish & Japanese school pupils visiting Orkney.
- Planned presentation to Heriot-Watt staff and students, and local stakeholders including consultancies and EMEC.
- Oral presentation accepted for MASTS Annual Science Meeting 2016.
- Planned paper for International Journal of Marine Renewable Energy with Scottish & Japanese authors.

The exchange has resulted in improved links with the following Japanese researches and industrial groups:

- Prof. Changhong Hu & Dr. Soichi Yamaguchi of Kyushu University
- Prof. Yusaku Kyojuka of Nagasaki University
- Staff at the Nagasaki Marine Industry Cluster Promotion Association, who are involved in the development of the new test centre

Beyond the planned paper, it is hoped that further collaborations will follow from these connections.

Award size & expenditure

Total originally awarded:	£4,450
Flights:	£1,362.16
Living costs in Japan:	£2,346.35
Provisional total claimed:	£3,708.51