LUREG

Lancaster University

Research on Wave & Tidal Energy Generation Systems

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Renewable Energy Group
& Fluid Machinery Group

Overview

Wave & Tidal Energy Research

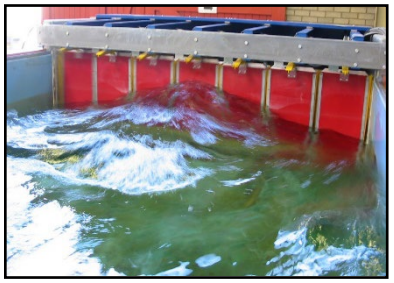
1. Introduction
2. Research to date
3. Next steps
4. Conclusions

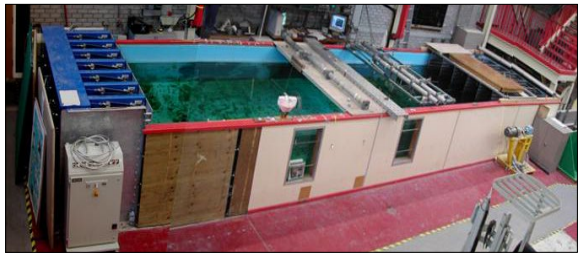
Energy - LUREG Research

- Research on Renewable Energy & Fluid Machinery
  - Generic & Applied
- Energy & Renewables
  - Computational & Experimental Modelling
  - Device Development & Power take off
  - Computational Fluid Dynamics & Control
  - Economics, Resource & Condition Monitoring
- Novel Topology Fluid Machinery & Turbines
  - Computational Fluid Dynamics, Turbine Design & Analysis
  - Direct Drive & In Line Turbines
  - Siphonic Low Head & Low Cost Turbine Research
  - Fluid Machinery reliability & Energy Efficiency
- Funded by EPSRC, Carbon Trust, EU, RDAs, Utilities and Industry

Lancaster University Engineering Building

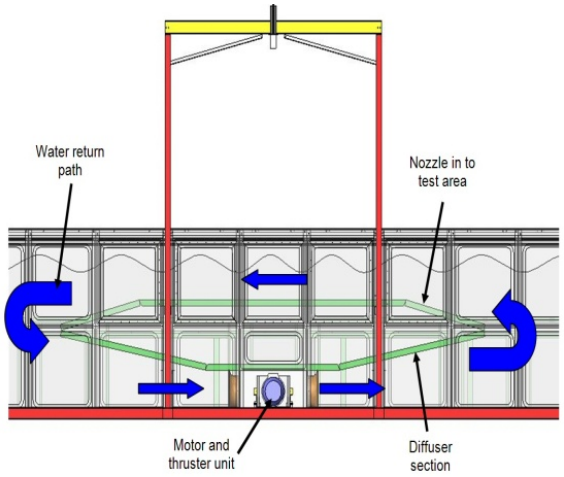
Ocean Energy Testing Facilities





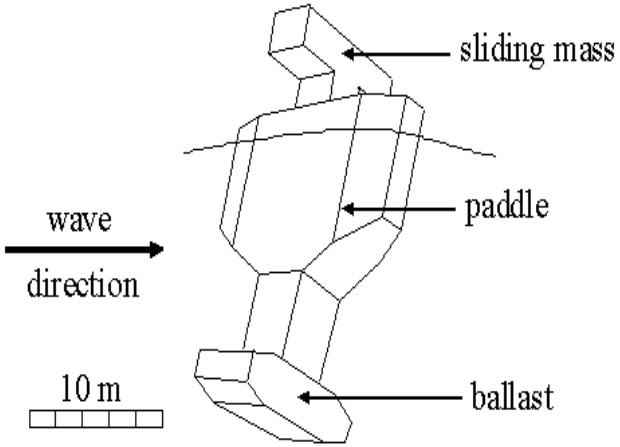
Wave Tank

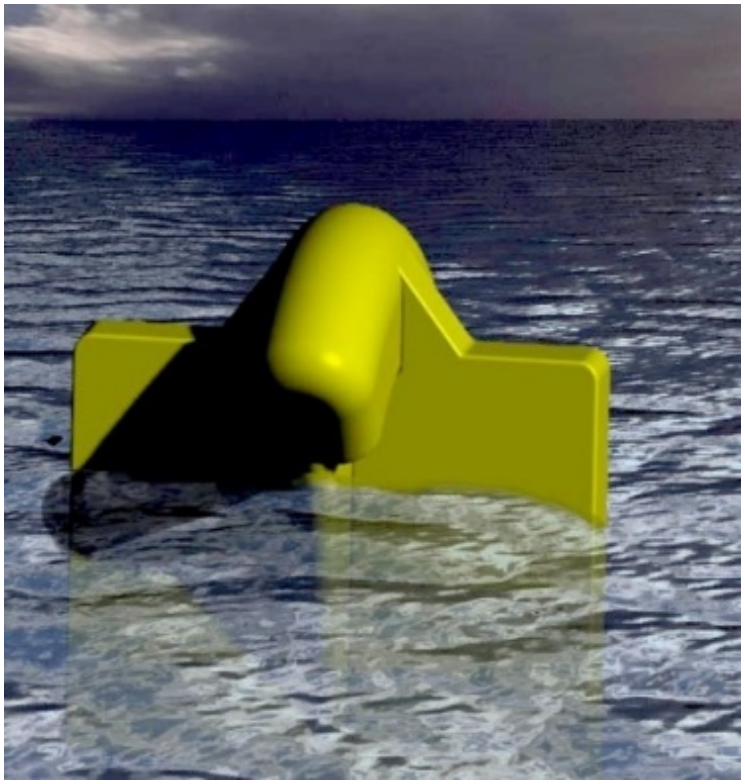
- 12.5 m x 2.5 m plan and 0.8 m deep
  - Approx. 100th scale deep water offshore environment
  - Low reflection beach
- Edinburgh designs paddles allow generation of:
  - Regular waves (both plane and angled)
  - Irregular waves (via input spectra)
  - Focused waves
  - Directionally spread wave-fields



PS Frog - EPSRC & Carbon Trust

Early PS Frog





PS Frog 5 - EPSRC

CRM PS Frog

Carbon Trust

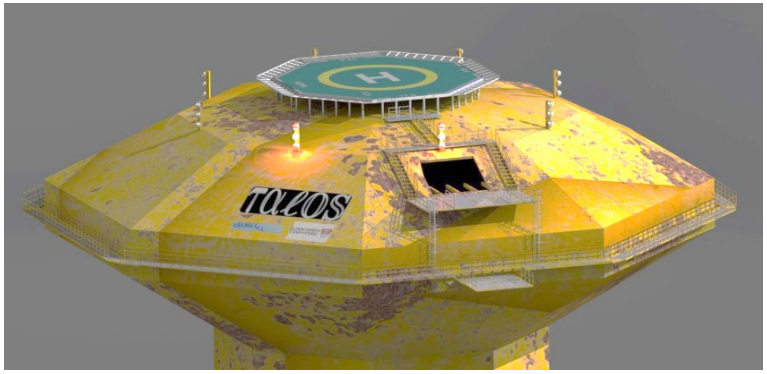
McCabe, A.P., Bradshaw, A., Meadowcroft, J.A.C. and Aggidis, G., 2006. Developments in the design of the PS Frog Mk 5 wave energy converter. *Renewable Energy*, *31*(2), pp.141-151.
Carbon Trust, Future Marine Energy (**2006**) **CT601**.
Widden, M.B., French, M.J. and Aggidis, G.A., 2008. Analysis of a pitching-and-surging wave-energy converter that reacts against an internal mass, when operating in regular sinusoidal waves. *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, *222*(3), pp.153-161.

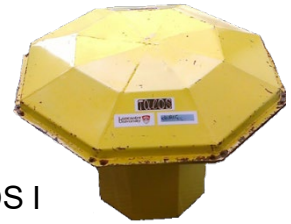
Lancaster WEC Research

waves2watts

Lancaster University Research on W2W Multi Oscillating Water Column Wave Energy Converter and Floating Breakwater.

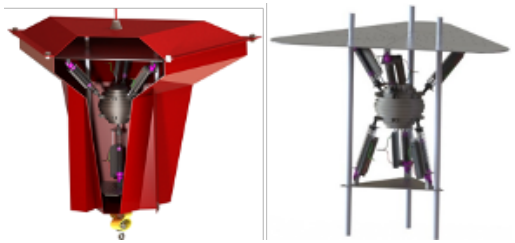
Doyle, S. and Aggidis, G.A., 2019. Development of multi-oscillating water columns as wave energy converters. *Renewable and Sustainable Energy Reviews*, *107*, pp.75-86.





TALOS I

TALOS III
Multi Axis
Wave Energy Converter System



TALOS II

Aggidis, G.A. and Taylor, C.J., 2017. Overview of wave energy converter devices and the development of a new multi-axis laboratory prototype. *IFAC-PapersOnLine*, *50*(1), pp.15651-15656.

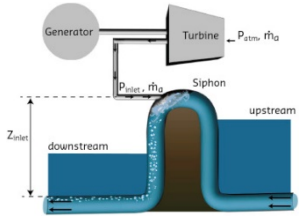
Novel Topology Turbines Testing Facilities

Waters, S. and Aggidis, G., 2016. Tidal range technologies and state of the art in review. *Renewable and Sustainable Energy Reviews*, *59*, pp.514-529.

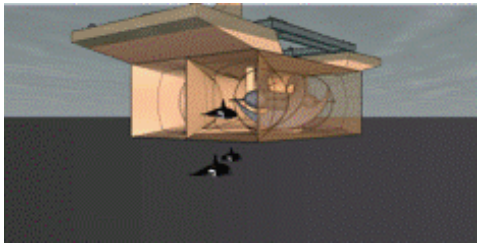
Waters, S. and Aggidis, G.A., 2015. Over 2000 years in review: Revival of the Archimedes screw from pump to turbine. *Renewable and Sustainable Energy Reviews*, *51*, pp.497-505.

Holland Estuaries

Lancaster University Research on Low Head Hydro and Archimedes Screw Turbines for Tidal Applications



Lancaster University Research on Environmentally Friendly Solutions using Tidal movements



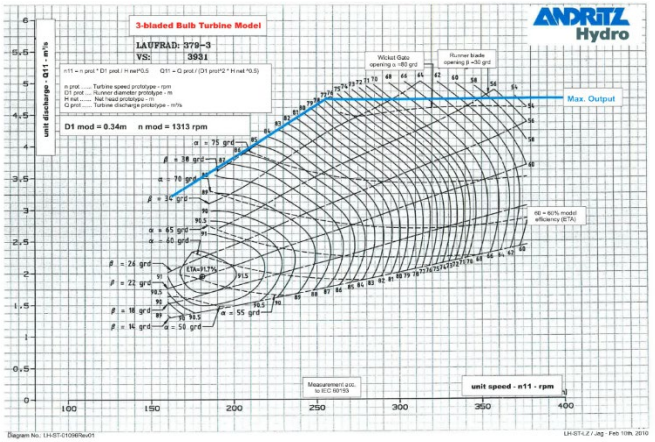
TIDAL BRIDGE

Indonesia

https://www.tidalbridge.com/

Widden, M.B., French, M.J. and Aggidis, G.A., 2004. Economic energy from low head water by conversion to air pressure. In *IMechE Conference Transactions* (Vol. 6, pp. 41-49).

Ocean Current and Range Research



Lancaster University Research with Infinities Global on Tidal Current and Hydrogen Storage Technology

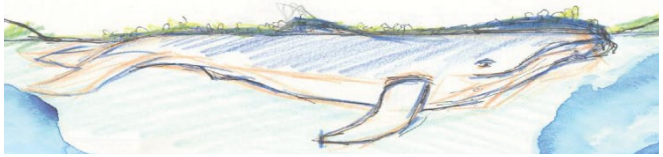
TIDETEC
Optimising two-way hydropower

Smart sea water storage to provide flexibility services to the energy network

Petley, S. and Aggidis, G., 2016. Swansea Bay tidal lagoon annual energy estimation. *Ocean Engineering*, *111*, pp.348-357.

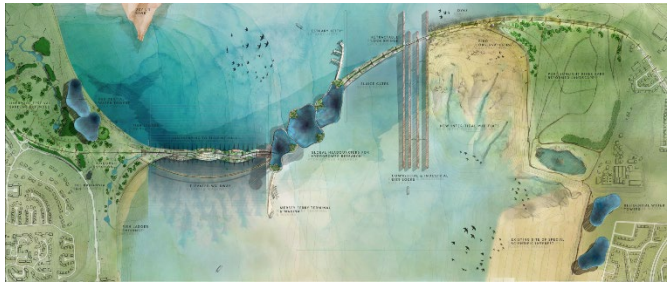
Multidisciplinary Research
Multi Functional Infrastructure

Opportunities for tidal range projects beyond energy generation: Using Mersey barrage as a case study.



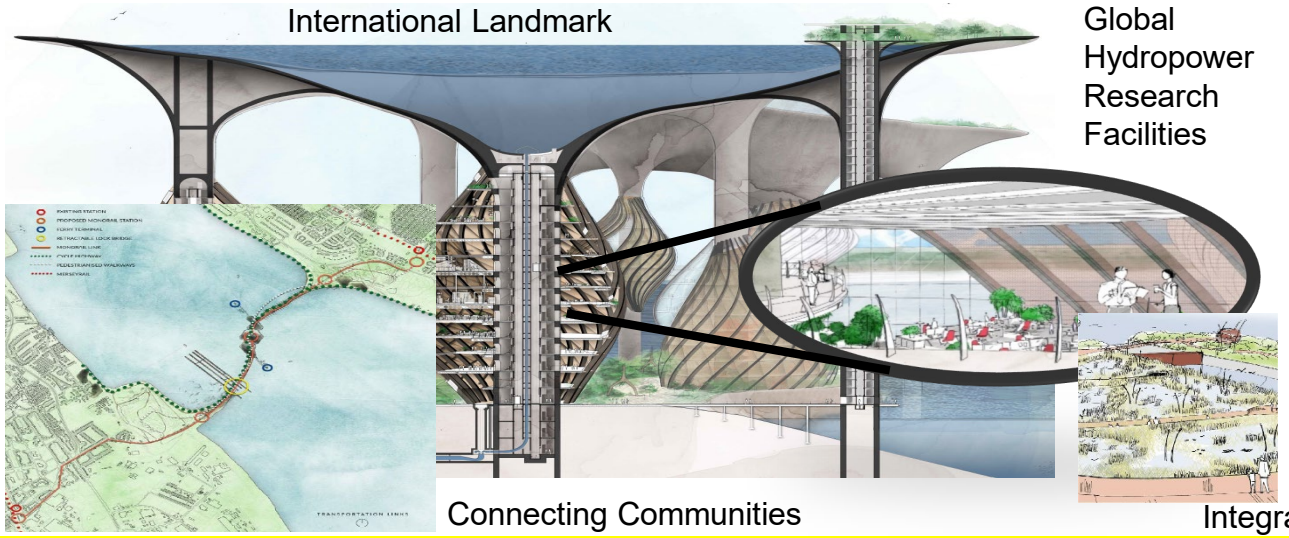
THE GREEN WHALE (2017)

Dr David Howard CEH
& Prof George Aggidis

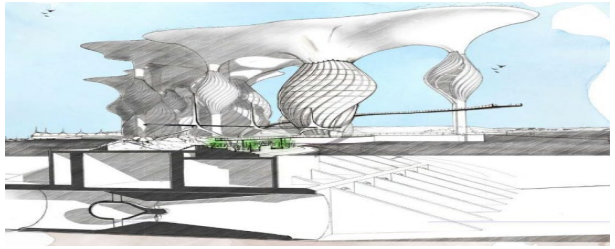


…This paper contributes in part to a fully holistic treatment of **tidal barrages**, recognising that apart from **energy generation,** other **environmental, societal and economic opportunities** arise and must be fully investigated for robust decision-making…

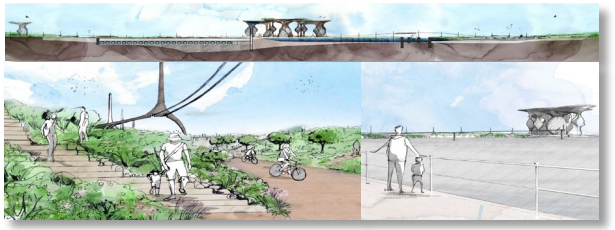
International Landmark



Global Hydropower Research Facilities



Connecting Communities



Integrating Wildlife

Petley, S., Starr, D., Parish, L., Underwood, Z. and Aggidis, G.A., 2019. Opportunities for tidal range projects beyond energy generation: Using Mersey barrage as a case study. *Frontiers of Architectural Research*, *8*(4), pp.620-633.

"Net Zero" by 2050

- The UK government have announced a climate emergency with targets to decarbonise by 2050.
- We need to reach "net zero" far sooner than 2050 – we're already seeing the catastrophic effects of climate breakdown both across the globe and here in the UK.
- We have just a short window of opportunity left to avoid irreversible damage.
- We need to live greener and more sustainable lives.
- We need to reduce UK dependence on imports of dirty fuels like coal, oil and gas.
- The UK should be powered by a home-grown renewables sector, providing jobs and clean energy at affordable prices for homes, heating, transport and industry.

New £1million Lancaster-led research to take us closer to harnessing the energy of waves

24 March 2021 09:00

The TALOS concept wave energy converter

A new research project will develop cutting-edge technologies that will advance efforts towards capturing the huge renewable power of the oceans.

Led by **Professor George Aggidis**, and involving researchers from Lancaster University's **Department of Engineering** and the Energy and Environment Institute, University of Hull, the £1million NHP-WEC (Novel High Performance Wave

> *"This research will advance our knowledge and understanding of these extreme marine environments where these machines will be deployed, as well as improve operators' ability to control the machines when changes in conditions are forecast to improve their ability to generate electricity, and increase their ability to survive."*
>
> Professor George Aggidis

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Thank you

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