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Using Smoothed Particle Hydrodynamics in the development of a novel Vertical-Axis Turbine

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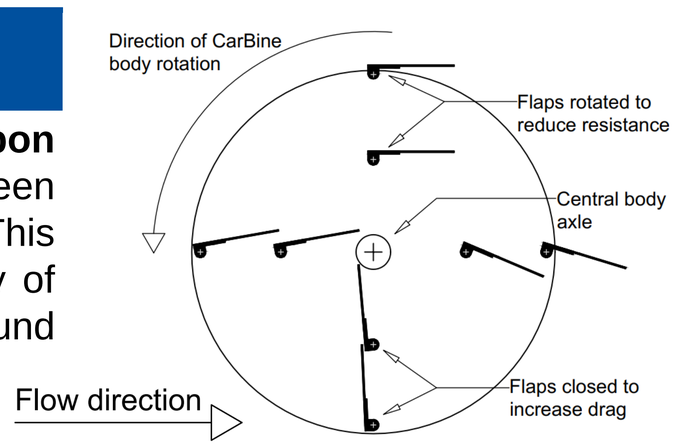
Motivation

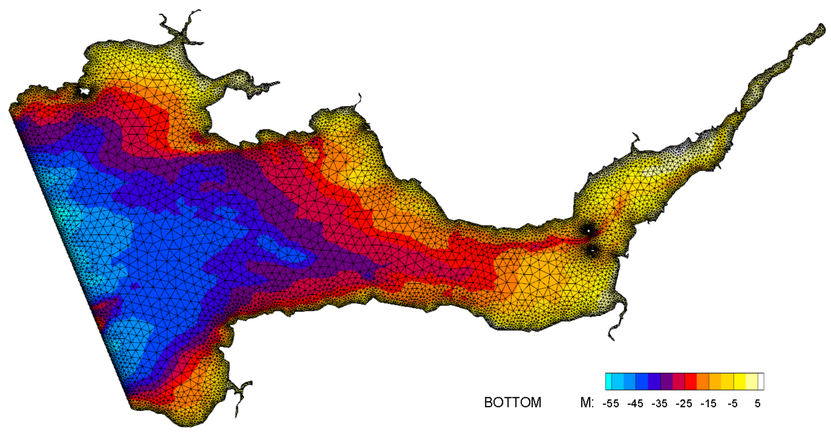
In response to global rises in demand for **low-carbon energy**, a **low-head vertical axis turbine** has been designed at Cardiff University, namely **CarBine** [1]. This work aims to optimise design and prove the viability of CarBine for use in low-head flows such as can be found in **tidal regions** and various **watercourses**.



Role of Smoothed Particle Hydrodynamics

Smoothed Particle Hydrodynamics (**SPH**) was identified as a method that would allow CarBine to be represented as **a set of connected, free bodies in the flow.** Fully capturing the movement of the body and the flaps allowing for a **realistic representation** of the flow conditions.

The open-source software **DualSPHysics** [2] was chosen due to the high speed of calculation available through the use of **GPU acceleration with CUDA**. The CarBine model is calibrated against flume results using an 2D depth averaged representation.

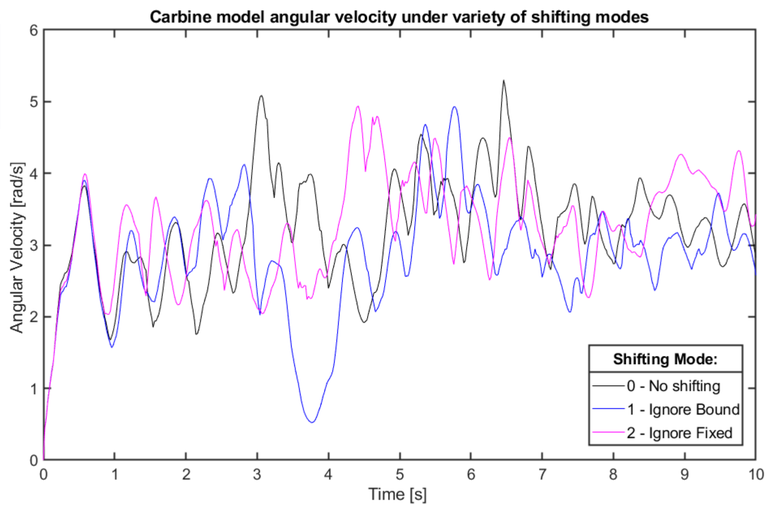


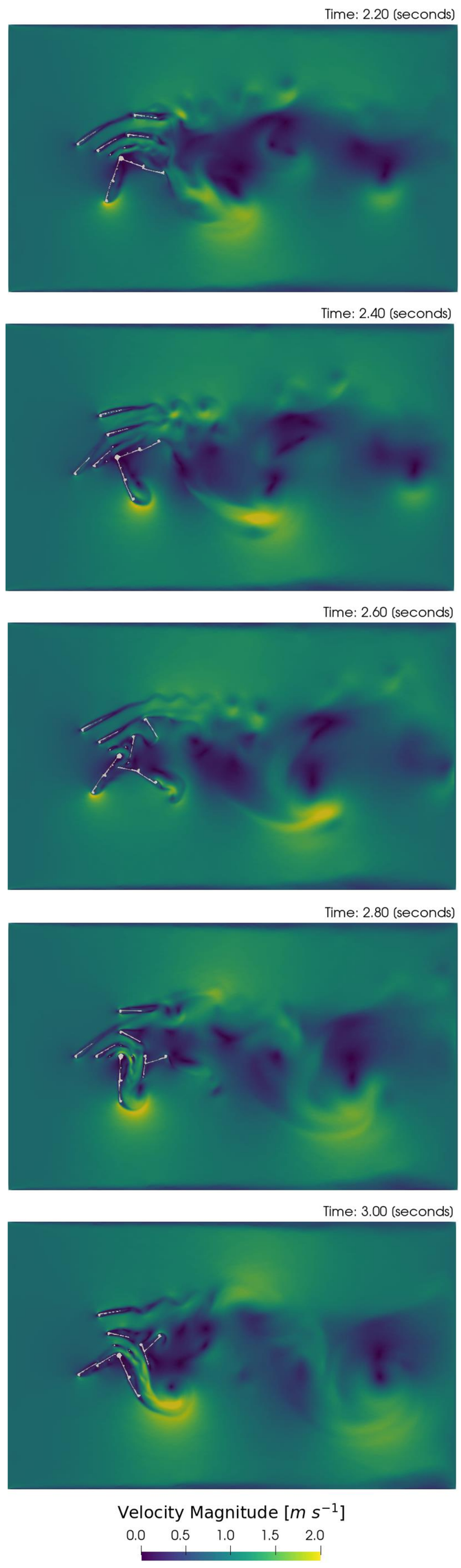
The Big Picture

- Fully calibrate CarBine model
  - Boundary conditions
  - Restraints
- Assess design adjustments
  - Number of arms
  - Configuration
- Link to regional scale model

Summary

- CarBine is a low-head vertical axis turbine
- SPH modelling is being carried out to:
  - Optimise design
  - Represent fluid conditions
  - Assess viability of SPH turbine modelling
- SPH could be a useful tool in this field
- We need renewable energy





References

[1] T. Harries, A. Kwan, J. Brammer, and R. Falconer, "Physical testing of performance characteristics of a novel drag-driven vertical axis tidal stream turbine; With comparisons to a conventional Savonius," *Int. J. Mar. Energy*, vol. 14, no. April, pp. 215–228, 2016.

[2] A. J. C. Crespo *et al.*, "DualSPHysics: Open-source parallel CFD solver based on Smoothed Particle Hydrodynamics (SPH)," *Comput. Phys. Commun.*, vol. 187, pp. 204–216, 2015.

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