Wave Energy Converter: Energy Transmission

Imperial College London

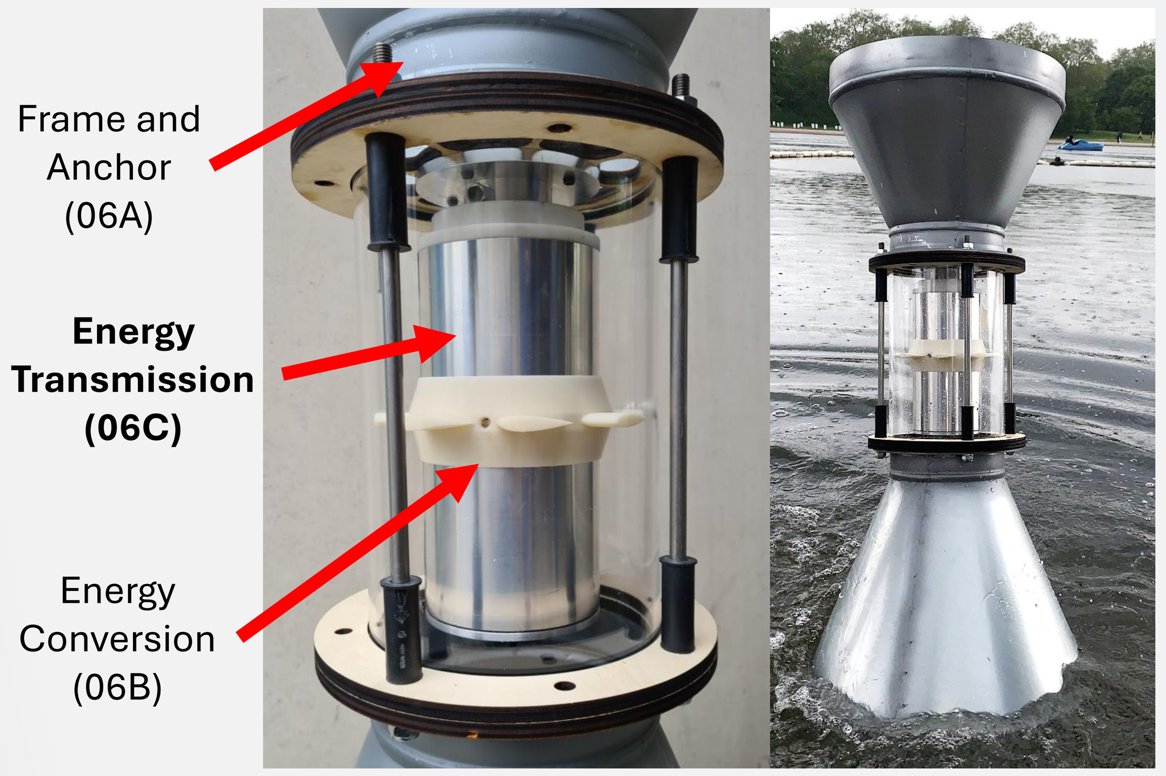
Group 06C: Max Yiye Cao, Giovanni Dos Reis Montefiori, Arnav Rai, Dharanee Sivananthan, Paul Bernheim

Supervisor: Prof Daniele Dini. Project Director: Dr Fred Marquis. Testing Technician: Pawel Orzlowski

Overview

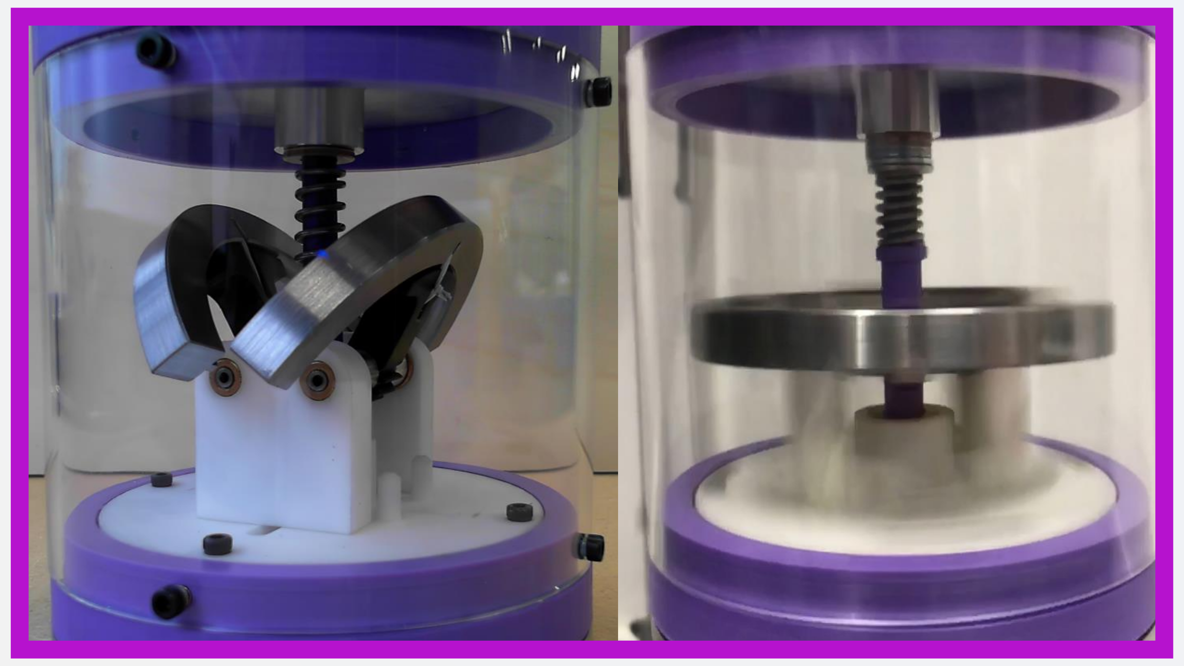
Energy transmission subassembly for a small-scale proof of concept oscillating water column wave energy converter prototype, consisting of frame, turbine, and transmission. In an elegant solution, the entire transmission is designed to be placed inside the hub of the turbine.

General Assembly Arrangement



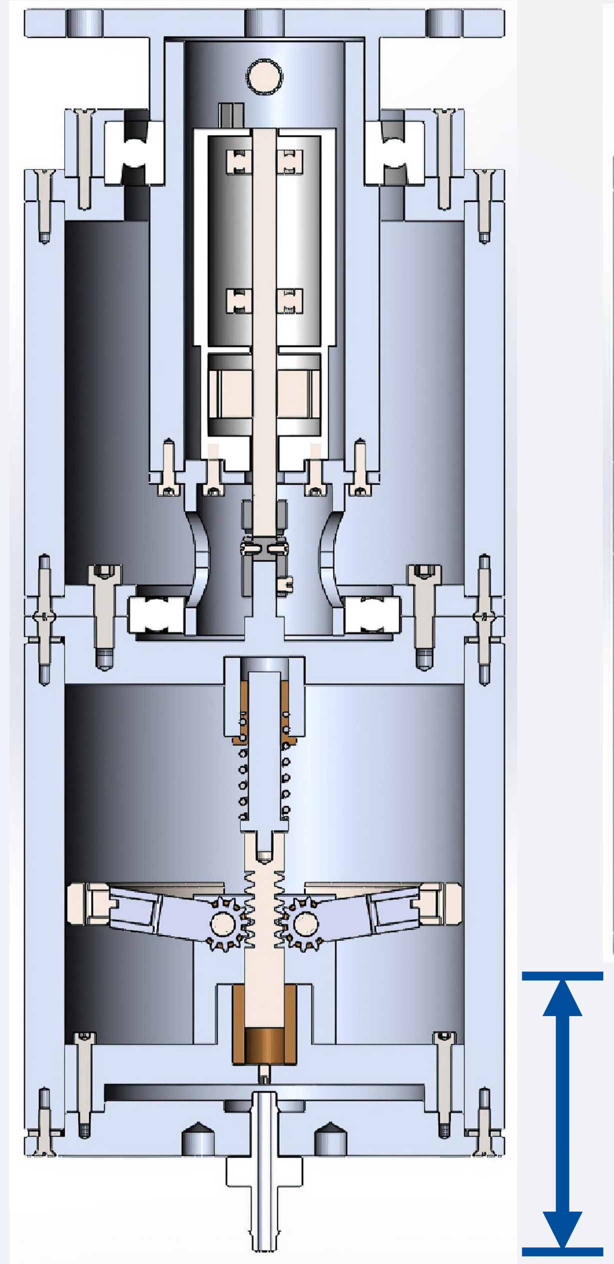
Transmission Assembly Objectives

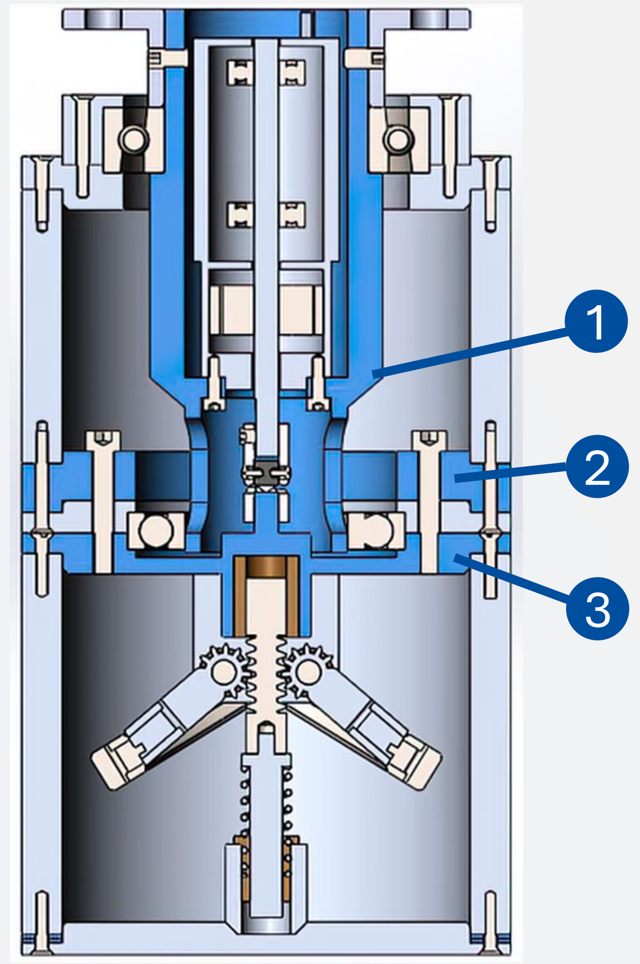
No.	Description	Addressed by
A	Transmit mechanical energy from Wells turbine to generator.	Hub subassembly.
B	Minimise frictional losses between the turbine and the generator.	Bearings between hub subassembly and frame mount subassembly.
C	Control the rotational speed of the turbine.	Flywheel subassembly.
D	Generate electrical energy to be conditioned.	DC motor/generator.
E	Structural interface to frame.	Frame mount subassembly.



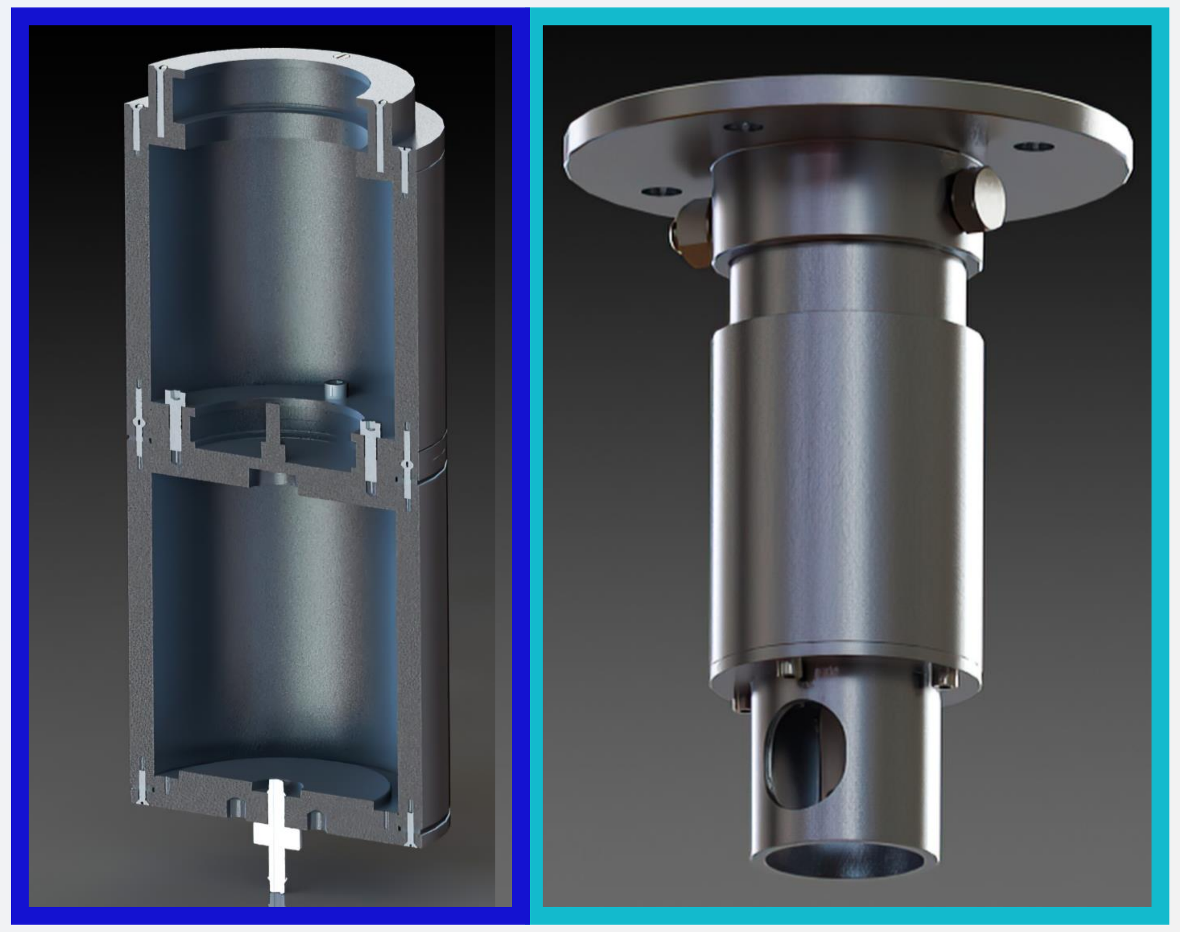
Variable Inertia Flywheel

The axial variable inertia flywheel is a novel, mechanical, short-term energy storage device offering superior performance to a conventional flywheel. The double arc mass arrangement connected to a central rack and spring mechanism is the result of three previous iterations built and tested during the project which assessed various mechanisms and mass geometries. The flywheel is rigidly connected to the rotating hub, with the flyarms extending outward with rotational speed - increasing the inertia of the system. The device functions as turbine speed control, where the choice of flyarm mechanism determines the characteristic curves of kinetic energy vs. speed. The images show the stationary uncalibrated flywheel (left), and the fully extended flymasses during operation (right).





The next iteration is 50 mm (20%) shorter, 61% stiffer (17.2 MNm^{-1}), 1.2 kg (23%) lighter, and contains 11% (77 total) fewer parts, including fasteners.



Hub

The turbine hub is made out of a series of concentric parts with stepped alignment features. The plates in the radial plane transfer torque, houses the bearings, and seal the vacuum compartment where the flywheel is housed.

Frame Mount

The frame mount forms the structural interface to the frame, houses the face mounted generator, and functions as a cantilevered shaft for the turbine hub.

Next Iteration

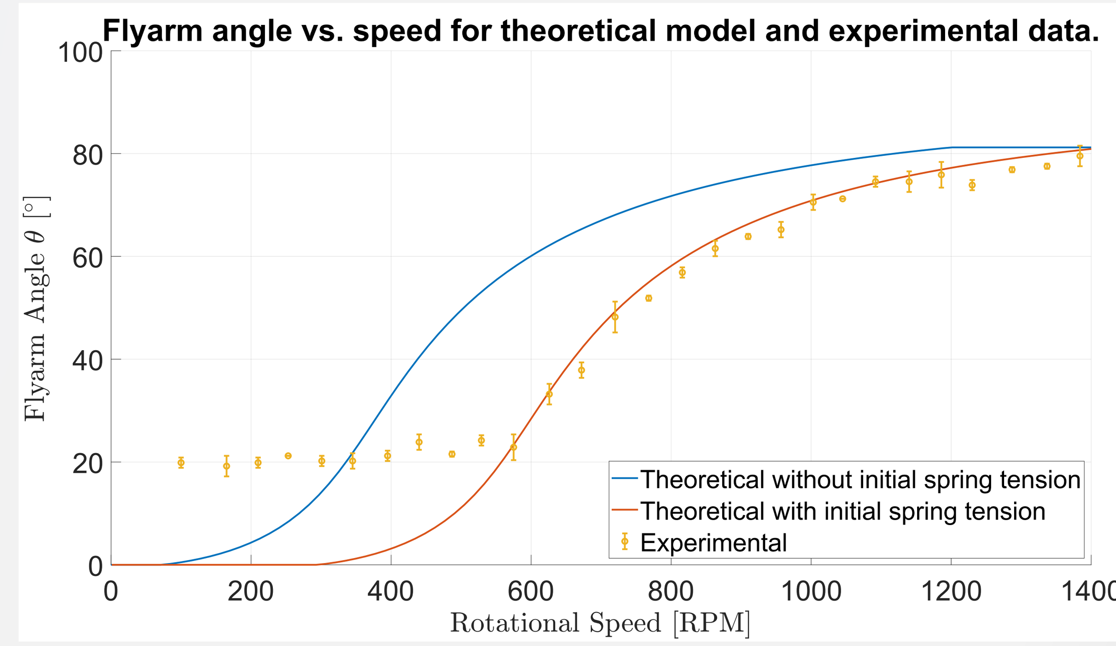
Testing verified the validity and quality of the design, and also identified key areas to be improved:

1. Increase the stiffness of the frame mount.
2. Remove the vacuum compartment.
3. Reduce manufacturing costs and complexity.

	New Part	Impact
1	Generator Mount	Increase shaft stiffness.
2	Blade Ring	Blade mounting mechanism.
3	Lower Centre Plate	Concentrate design complexity.

Testing Results

Ten separate experiments were conducted, which assessed various aspects of the design such as frictional torque, vibration behaviour, vacuum compartment effects, heat dissipation, and general assembly. The tests validated the theoretical models describing the system which may then be used to design and optimise at any scale in anticipation of a future full-scale iteration.



In the flywheel kinematics test (above) the experimental minimum angle is due to a physical design restriction. The bottom left figure shows the theoretical model for the vibration behaviour which agreed closely with experimental observations.