

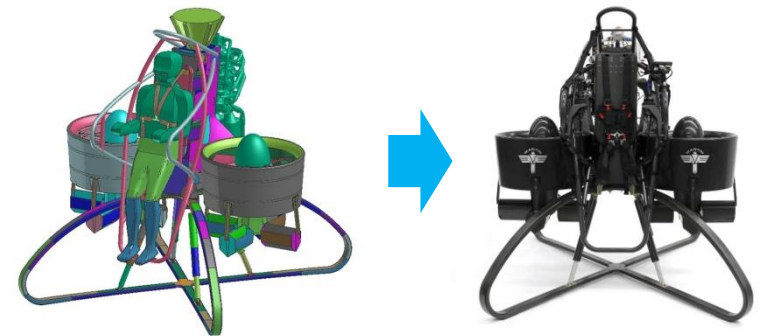
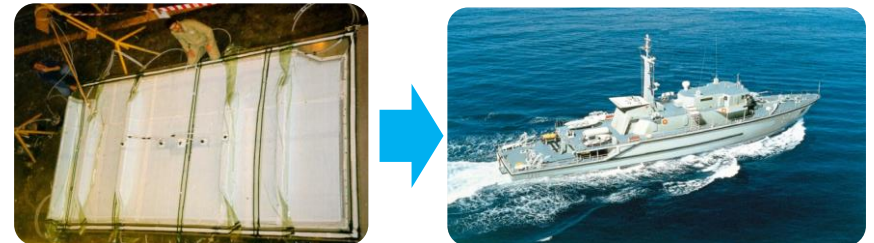
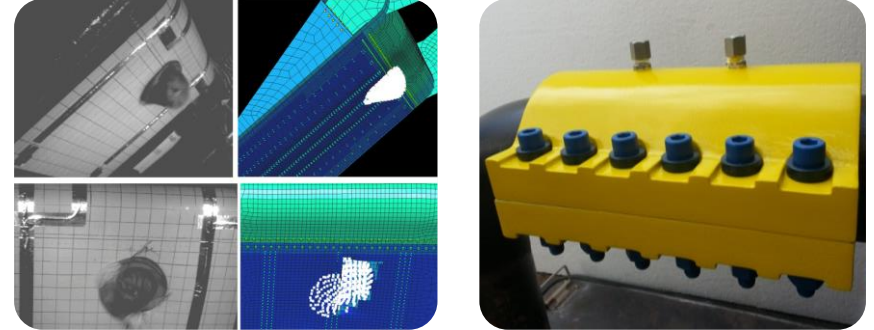
A photograph showing a red composite structure, likely a part of an offshore wind turbine, suspended in clear blue water. The structure is cylindrical and has several cables or ropes attached to its bottom. The background shows the seabed and some other structures in the distance.

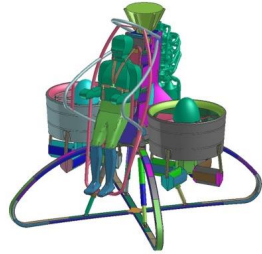
Composites Australia Conference 2022

Composites in Emerging Renewable Energy Applications

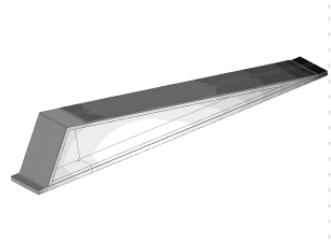
Andre Duarte
Advanced Composite Structures Australia

- ACS Australia has developed capability over **30 years involving design and manufacture of composites**, having been spun out from the highly successful CRC for Advanced Composite Structures, which was established in 1991.
- **Delivered composites technology solutions to industry:**
 - Bird strike analysis and certification for Boeing Aerostructures Australia 787 program
 - Repair technologies of oil & gas pipelines for Petronas
 - Low cost manufacturing processes to Australian defence
 - Design, analysis, testing and pre-production of VTOL aircraft for Martin Jetpack.

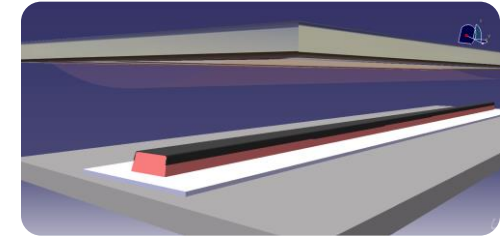




1. Structural Design and Analysis



2. Tooling Design and Manufacture



3. Process Improvement



9. Technology Transfer and Training



4. Product Development



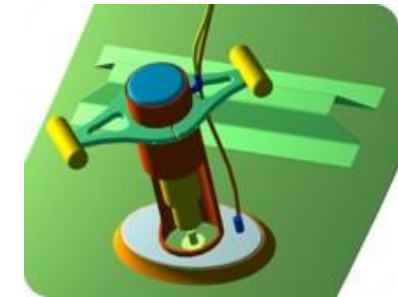
8. Manufacturing and Assembly



7. Full Scale Testing



6. Prototype Manufacture



5. Manufacturing Simulation

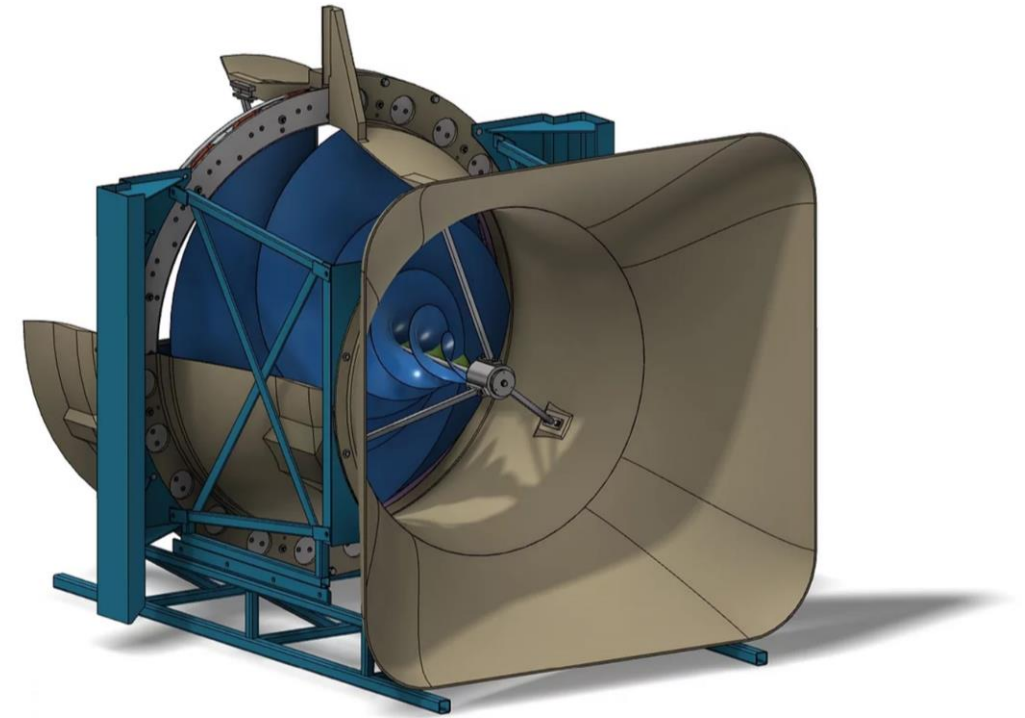
Partners and Affiliates



Hydro-Kinetic Energy Conversion Generator

Kinetic NRG has developed a micro hydro-kinetic energy conversion (HEC) generator.

This innovative device is capable of providing constant base load electrical power generation from fast flowing waterways including rivers and irrigation channels.



Source: Kinetic NRG

The HEC generator measures 1.5 metres in diameter with an output of up to 30 kilowatts (kW) from water flows of 2.0 metres per second.

Using a novel spiral-shaped turbine blade combined with the nacelle, it is able to produce power in smaller waterways that are not suited to traditional hydro-electric power generators.

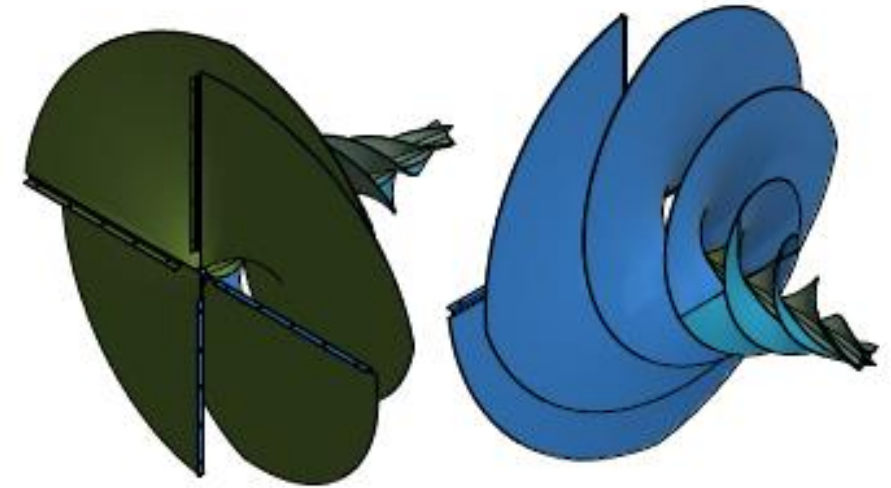


Source: Kinetic NRG

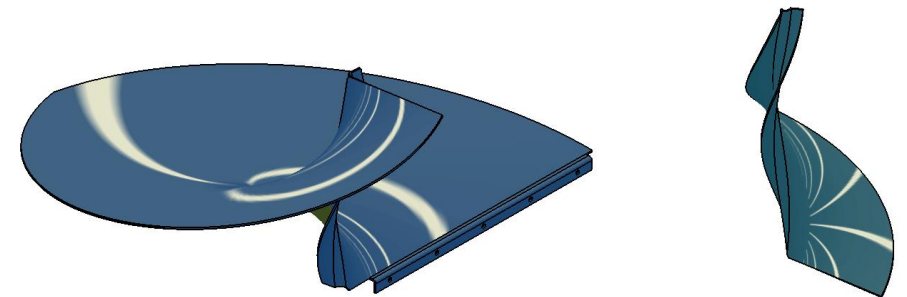
The original design of the turbine blade was based on a metallic construction, which had a number of challenges, including being difficult to manufacture and high cost.

Converting to a composite construction provided a viable solution, and also resulted in a reduced mass.

Designing the tooling for the blade's four subcomponents was a challenging aspect of the design.



Source: Kinetic NRG



Source: ACS Australia

Materials:

Non-crimp fabric glass reinforcement

Epoxy resin

Manufacturing Process:

Wet layup of sub-components

Bonded Assembly



Source: ACS Australia

Wave Energy Converter

Global aquaculture is moving operations further offshore, presenting a challenge to access clean renewable and reliable offshore energy.

One focus of the *Blue Economy CRC* is offshore energy production and synergies with offshore food production.



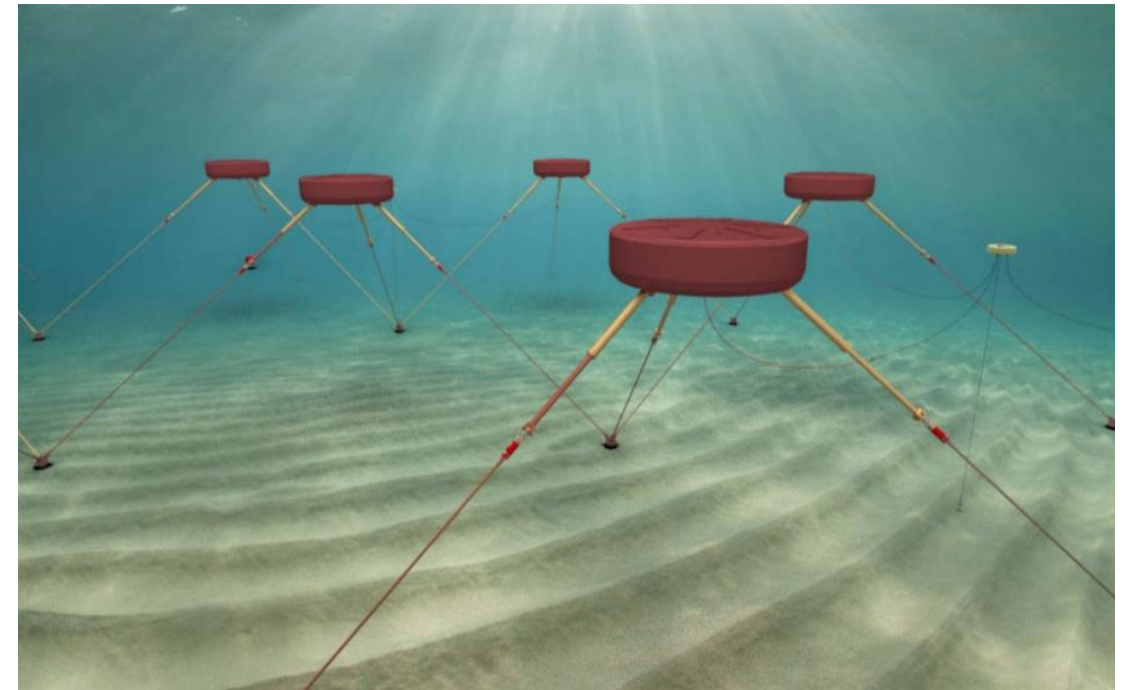
Source: 'Shutterstock / /Leo W. Kowal

Carnegie Clean Energy (CCE) based in WA, is developing the CETO 6 wave energy converter

- A large buoy is suspended in the water column, moving with waves and currents
- The motion of the buoy is converted into electricity through a Power Take-Off (PTO) unit attached to each mooring line.

BE CRC Project MoTWEC

- Carnegie Clean Energy, ACS Australia, University of Queensland and Ocean Energy Group
- Cooperating to develop and demonstrate a key component of the systems, the **Mooring Tensioner**.

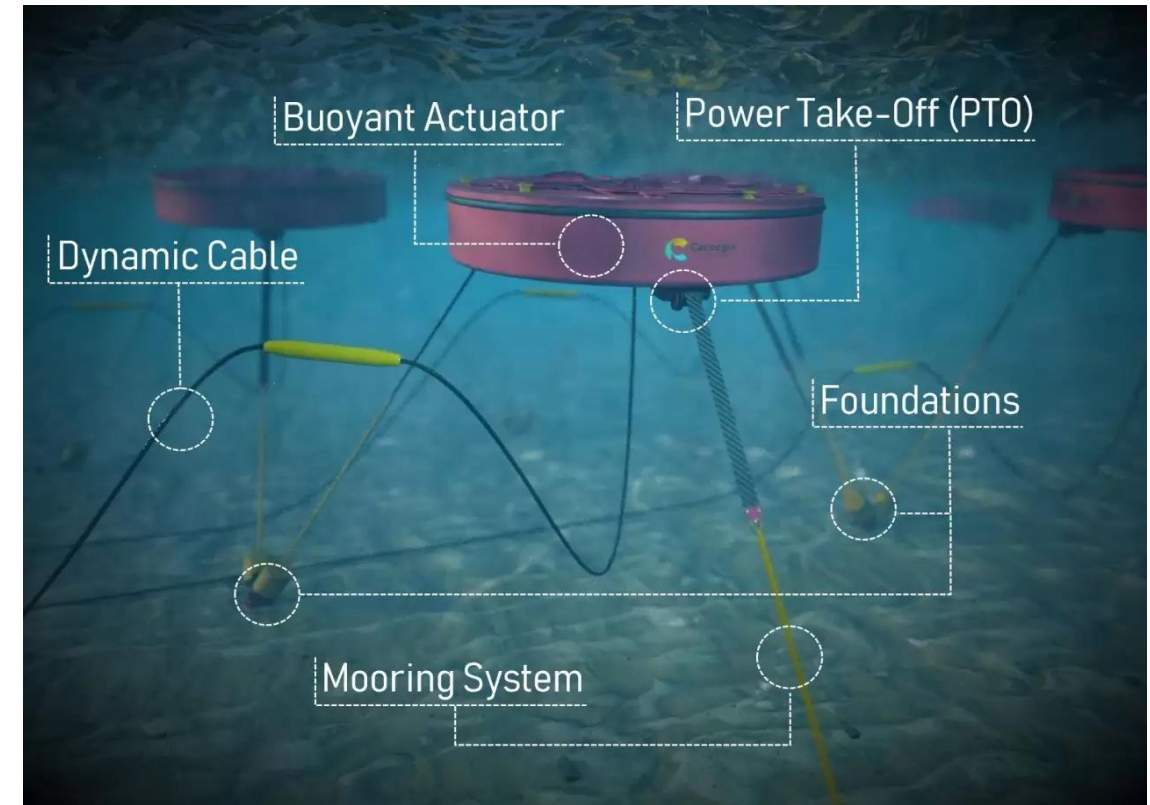


Source: Carnegie Clean Energy

The mechanical tensioner is a torsional spring within the PTO

- stores and releases energy, and ensures that the mooring lines never go slack

The spring is key to the efficient and cost-effective conversion of wave energy into electrical energy



Source: Carnegie Clean Energy

Tensioner Design Challenges

Size and space envelope

- Space for the tensioner is limited
- Needs to be easily manufactured, transported and installed

Torque and pretension requirements

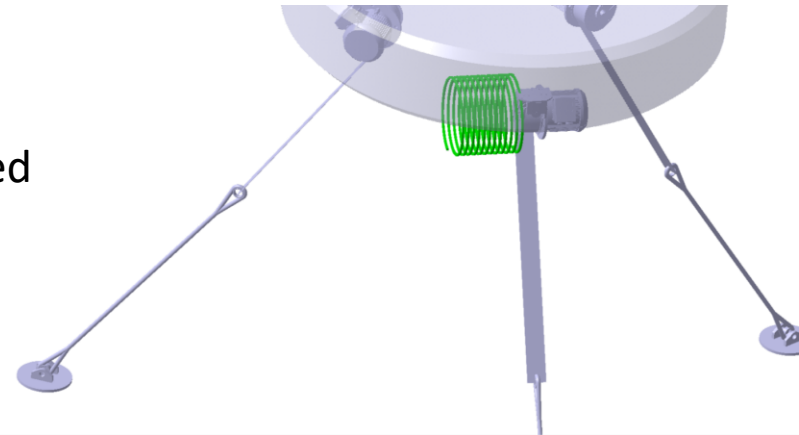
- Needs to sustain a very high torque
- Needs to sustain large rotation
- Large pretension

Life and durability requirements

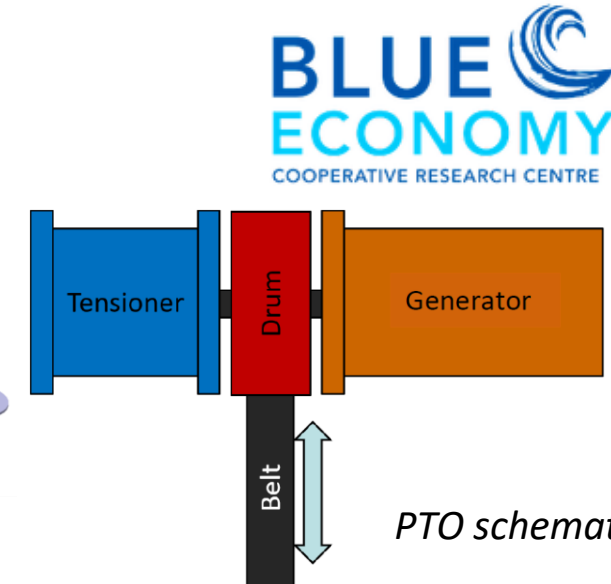
- 20+ years in a seawater environment

Cost

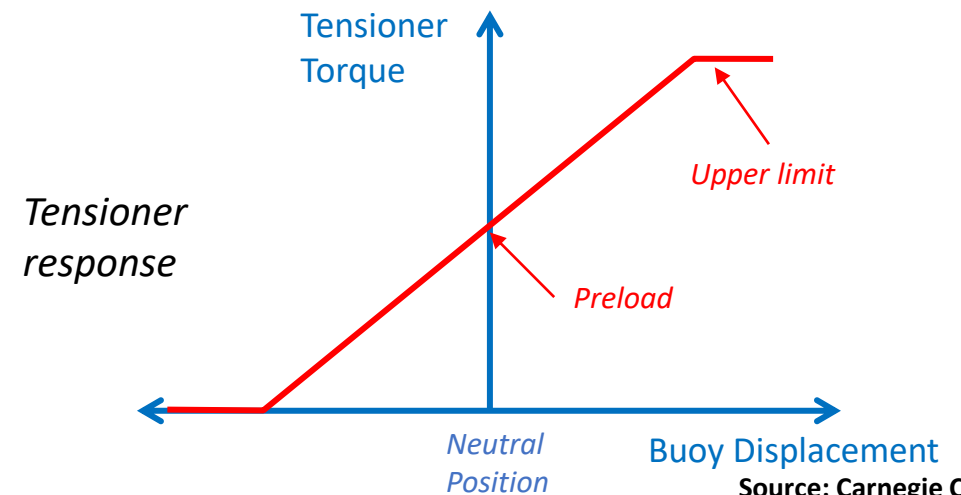
- Tensioner cost directly impacts levelized cost of energy (LCOE)



PTO with tensioner



PTO schematic



The torsion spring needs to sustain approximately one full rotation

Helical torsion springs

- Become unstable under high rotations
- Coils come into contact reducing efficiency

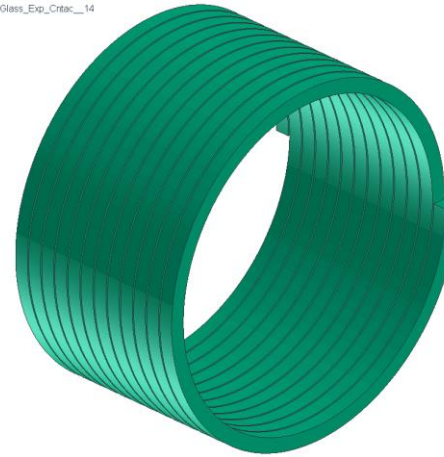
Spiral springs

- Come into contact under high rotations reducing efficiency

A novel tensioner spring configuration has been developed

- Provisional Patent has been filed

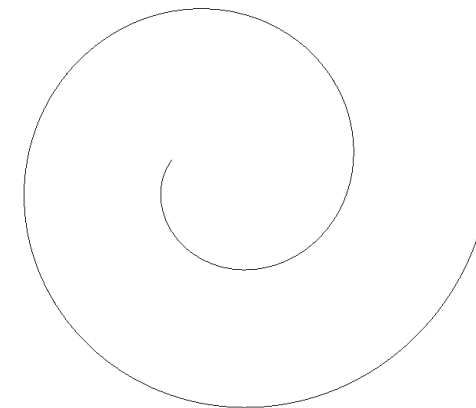
TS_V04_D1000mm_M42_M42_N12_S20Glass_Exp_Crtac_14



Helical spring instability under large rotations



1 / 0.00000



Spiral spring contact under large rotations



Tensioner spring element

The tensioner development has been supported by testing and evaluation

- Coupon testing program for static properties with and without environmental conditioning
- Coupon testing program for fatigue performance, including submerged in seawater
- Element testing program for critical features

A 1/5th scale PTO is under development for performance and durability testing

- Test uses two tensioners pre-tensioned against each other
- Spring elements manufactured (~1 m diameter)
- Testing to 2 lifetimes, monitoring performance changes

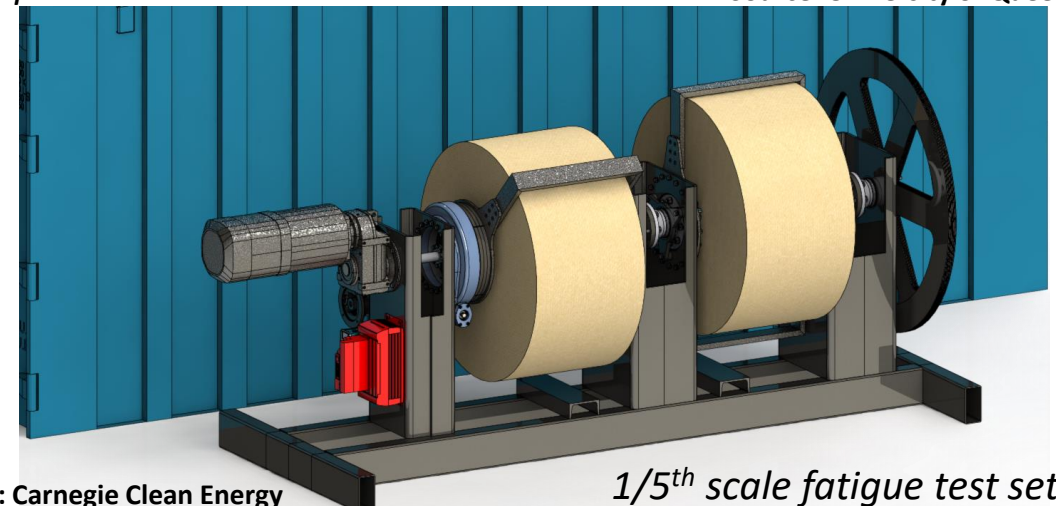


*Coupon fatigue testing
5 specimens in series*



End-fitting element bending test

Source: University of Queensland



Source: Carnegie Clean Energy

1/5th scale fatigue test setup

MoorPower™

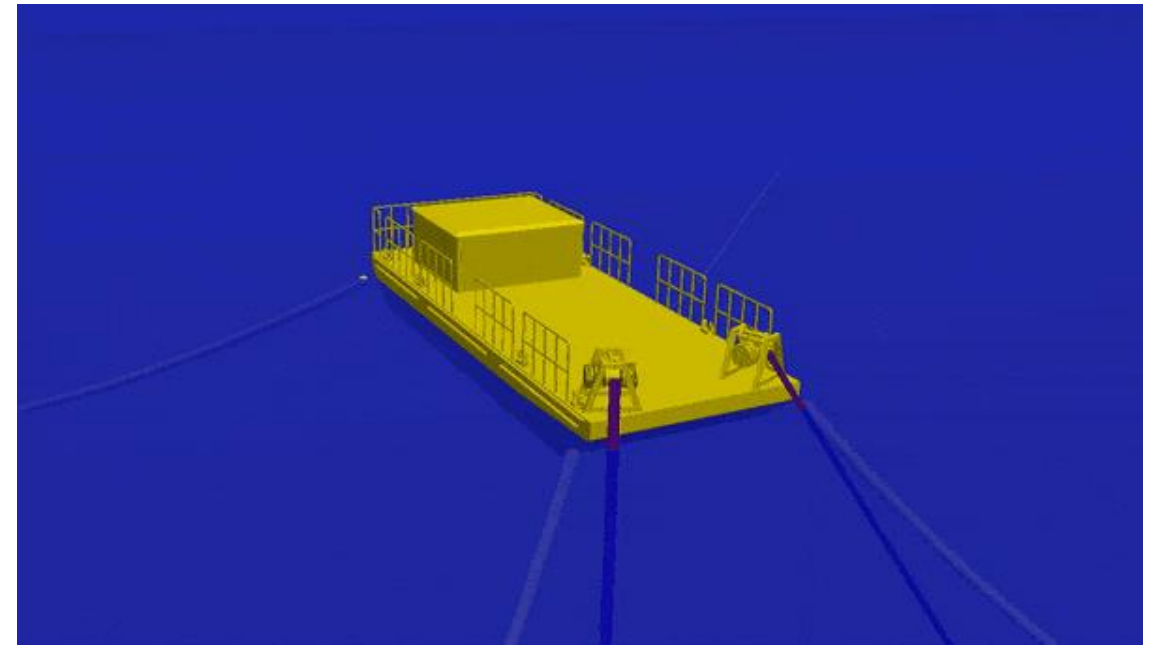
Scaled Demonstrator project

The MoorPower™ project aims to reduce the reliance of moored barges on fossil fuels for energy.

MoorPower™ is similar in concept to Carnegie's 'CETO' technology, but in this case energy is harvested from the wave-induced movement of a moored barge rather than a submerged buoy.

The movement of the barge drives a power take-off (PTO) system™ that converts the wave motion into electrical energy

- Used to supply clean energy to power fish farm fish feeding systems, lighting and air supply



Source: Blue Economy CRC

The \$3.4 million MoorPower™ Scaled Demonstrator Project was officially launched in October 2021 and runs over two years.

The project is funded with support from the Blue Economy CRC and in collaboration with partners Carnegie Clean Energy, Huon Aquaculture, Tassal Group, DNV, University of Tasmania, Climate KIC, Australian Ocean Energy Group, AMC Search, University of Queensland and ACS Australia.

Carnegie Clean Energy will operate the MoorPower™ technology demonstrator at their research facility in North Fremantle, Western Australia.



Source: Carnegie Clean Energy

The project is currently in the preliminary design phase.

ACS Australia is responsible for the tensioner design and prototype manufacture.

Spring concepts have been developed and prototyping of composite components is underway.



Source: ACS Australia

ACS Australia:

- Develops unique composite solutions for a wide variety of markets, including renewable energy.
- Provides real value to our customers by designing and manufacturing composite products with a competitive advantage.
- Works together with partners in the industry to grow an Australian and export market.



THANK YOU!

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