Design Principles

November 2022

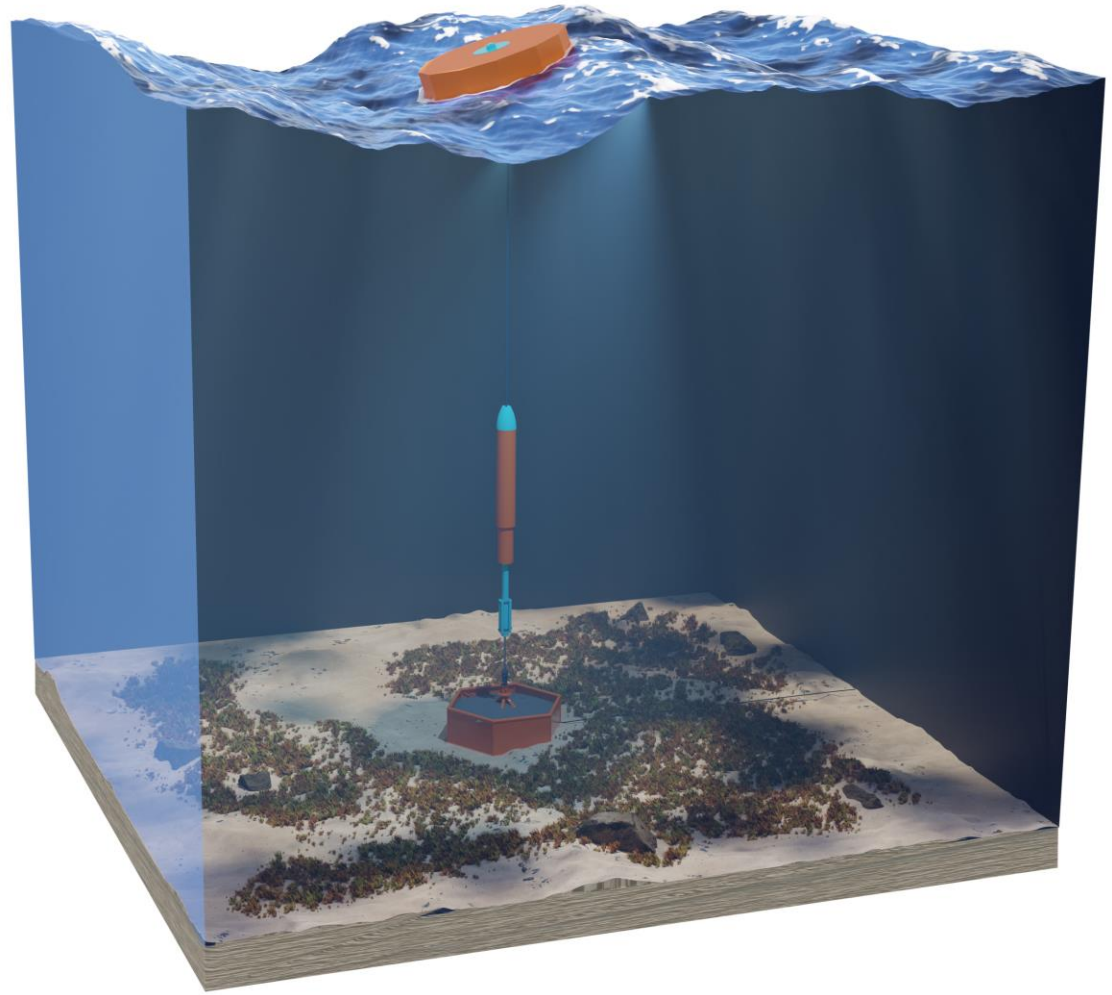
Introduction

Ocean Harvesting Technologies AB is a Swedish company that develops novel technology to transform ocean waves into clean, reliable and cost-efficient electricity.

InfinityWEC is a wave energy converter with an **advanced power take-off system**, which tunes to every individual wave to efficiently extract energy in all sea states. An innovative **end-stop function** ensures survival and reliable power production even in the harshest wave conditions.

The **buoy is made with high strength concrete**, with similar weight as a conventional steel hull, but at a quarter of the cost, a third of the CO_2 footprint and one tenth of the manufacturing time.

The excellent power production and reliability, combined with a **modular design**, where all critical parts are easily manufactured, transported, installed and maintained, make InfinityWEC a highly competitive solution for the future global energy market.



InfinityWEC Solution

Power Take-Off

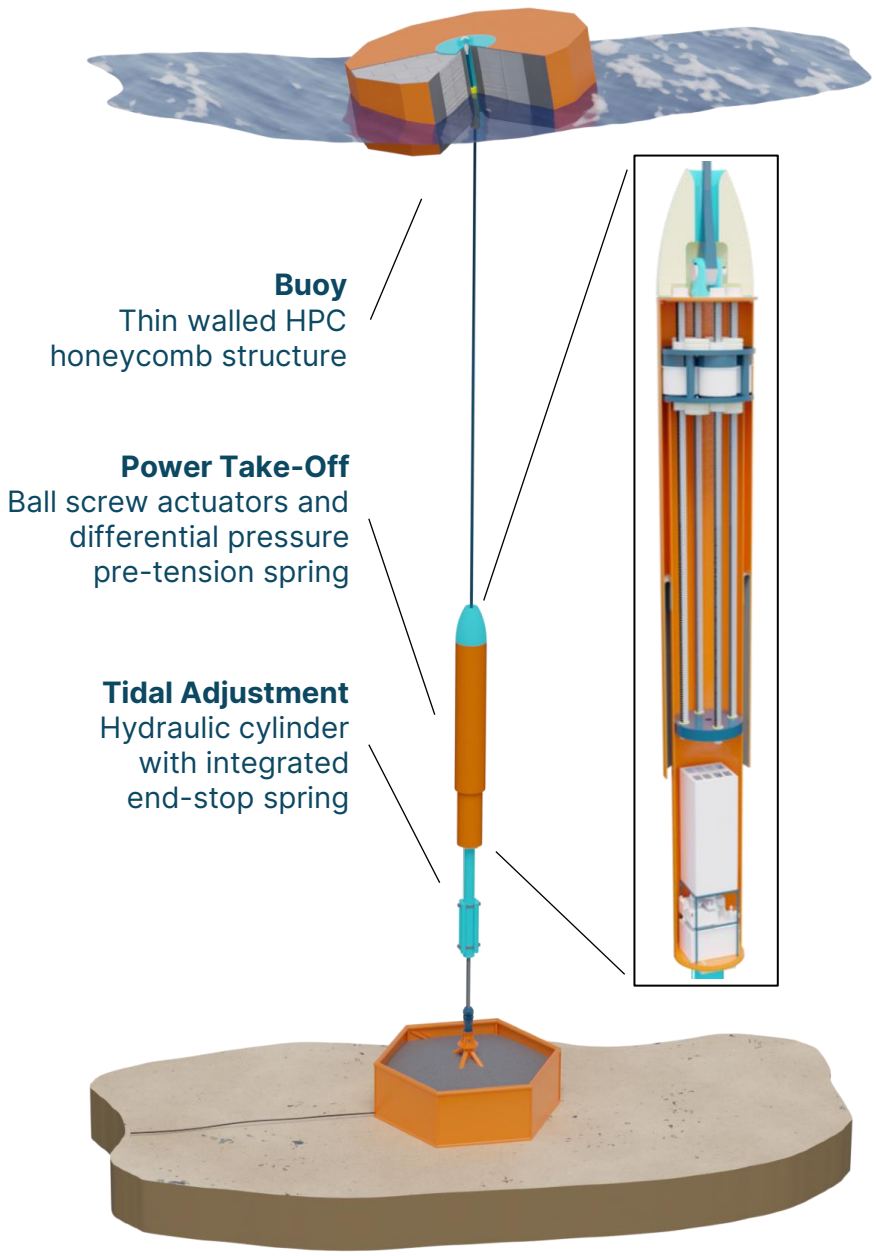
- **Instant force control** provided with high efficiency by combining:
  - Constant force by a differential pressure pre-tension system. The PTO hull is split in two halves being pushed together by the surrounding water pressure.
  - Bi-directional controllable force by ball screw actuators with frameless torque motors around rotating ball nuts.
- **Survival** ensured with an end-stop spring, reducing the maximum end stop force by half when holding the buoy submerged through the crest of large waves

Buoy

- Honeycomb structure made of high-performance concrete (HPC), giving a robust body with about the same weight as a conventional steel hull, at a quarter of the cost, a third of the carbon footprint and a tenth of the manufacturing time

Efficient Manufacturing and Logistics

- PTO designed for factory volume production, fits in standard container size, allowing efficient transport
- Buoy made on site in rapid moulding process with large portion of raw materials sourced locally



InfinityWEC Design Principles

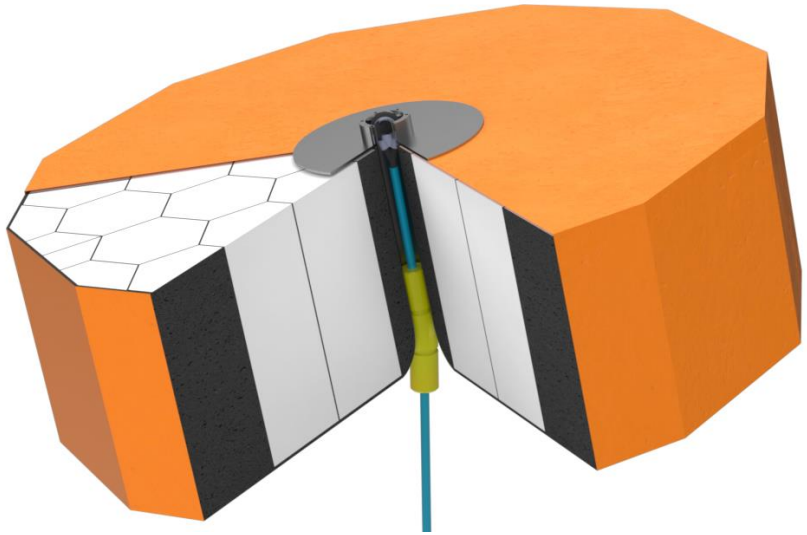
1. InfinityWEC is a **point absorber** type of wave energy converter because:
   - It has the highest hydrodynamic efficiency leading to smaller size per energy output compared to other types wave energy converters
   - It is suitable for large scale wave farms built as modular clusters of InfinityWEC units
   - It is suitable for installation depths between 50 – 200 meter, making it possible to deploy wave farms at many locations with strong wave resources

2. InfinityWEC has been designed as a direct-drive system with **instant force control** functionality because:
   - It is critical to match the buoy motion to the highly varying wave motion, using a force applied by the power take-off on the buoy (phase control)
   - Maximum power capture is achieved when the buoy oscillates in resonance with the waves, but this state typically causes high losses from circulating power flows due to the amplified motion
   - Maximum power output is achieved near the resonant state, with power capture reduced to balance the circulating power flows and its losses
   - Optimizing the force control for every individual wave increases annual energy production substantially compared to sea state tuned control
   - Reinforcement learning (AI) can be used, further increasing the annual energy production

3. InfinityWECs Power Take-Off (PTO) uses **ball screw actuators** combined with a **pre-tension spring force** because:
   - It is a highly efficient way to achieve instant force control
   - Ball screws is the simplest way to convert high linear force and slow motion into high speed and low torque input to the motor/generator
   - The differential pressure spring is efficient, reliable and low cost way to provide pre-tension, cutting the force in the ball screws in half and reducing the circulating power flows through the ball screws and motors/generators
   - It enables power production in both up and down motions and ensures station keeping of the buoy also in standby mode

InfinityWEC Design Principles

4. InfinityWEC has a **wide concrete buoy** because:
   - It can absorb more energy due to the increased area of the buoy on the water surface, compared to a narrower buoy with the same net buoyancy (volume and mass)
   - It reduces the need for resonance, thereby reducing the circulating power flows through the power take-off and the associated losses
   - It reduces the stroke length and maximum speed of the power take-off, reducing cost and making it possible to use heavy-duty ball screw actuators
   - Power capture is less sensitive to higher weight of the buoy, making it ideal for very cost-efficient on-site manufacturing with high strength concrete
   - Concrete is a very robust and corrosion resistant material, offering over 50-year lifetime with low maintenance



5. InfinityWEC has its **PTO separated from the buoy** because:
   - The mooring line between the buoy and the PTO minimizes the bending loads on the heave and level cylinders extending from the PTO
   - It makes the PTO system vertically fixed in normal heave motion, with a minimum of mass moving with the buoy
   - It allows for adjustment of the size and shape of the PTO module, enabling cost-efficient production, transport, installation and maintenance
   - It simplifies the structure of the concrete buoy, which can be manufactured on site from locally sourced materials
   - Separated PTOs allow for multiple PTOs to be attached to one buoy, efficiently scaling power output