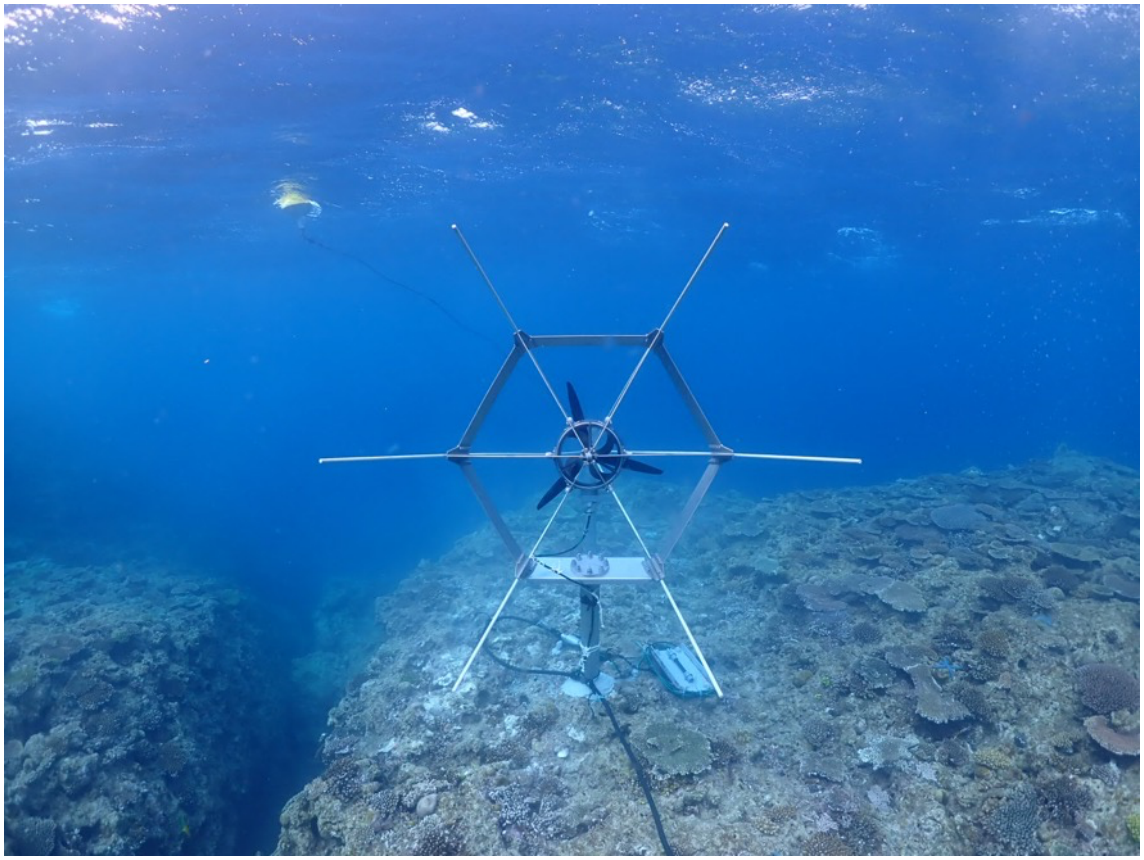
Archives from 2021to 2023

In 2021



First YAMAHA MOTOR + OIST Wave Energy Converter has been installed at 3 m deep drop-off in front of the OIST Marine Science Station in April 2022. This small size Wave Energy Converter is suitable for remote island countries to harness electricity from perpetual ocean waves.

New concept of wave energy device was proposed by Dr. Shintake in 2021 (September 30, 2021, US Provisional 2021-161724, Surface Ocean Wave Turbine) We have performed four times of ocean experiments on turbine, towing by boat at Maeda area. YAMAHA MOTOR CO.,LTD. jointed to our project, donated four HARMO (electric outboard motor) to OIST. We assembled one HARMO with three-blade turbine, and installed in seabed at 3 m deep, near drop-off in front of OIST Marine Science Station at Seragaki in April 2022.

OIST Wave Energy Project has been carrying out R&Ds to harness electricity from the moving water in the breaking wave zone since 2018, supported by Kokyo Tatemono Co. Ltd. in Tokyo, through their donation and contracted research.

However, what we learned from the project was that: the peak output-power driven by the breaking wave was fairly high, roughly 10 kW level for each 0.5 m diameter turbine/generator, while the average power, this is the most important parameter in renewable energy, was quite low, lower than 100 Watts unfortunately. We realized that there exists a fundamental problem: the breaking wave is chaotic phenomena, i.e., shape of the wave varies in time, also the breaking wave point moves back-and-forth. They are not predictable, thus probability of generating electricity was random and low after time averaged.

In order to overcome this problem, we decided to go deeper area, outside the wave breaking zone, where the moving water is smooth, like a sinuous motion of a pendulum oscillation, thus the output power becomes predictable. In the history of the wave energy development, no one had paid attention before in this area. OIST is the first place to utilize "Natural Oscillating Water Zone (OWZ)", which exists ubiquitously right near the wave breaking zone. New concept of wave energy device was proposed by Dr. Shintake in 2021 (September 30, 2021, US Provisional 2021-161724, Surface Ocean Wave Turbine)

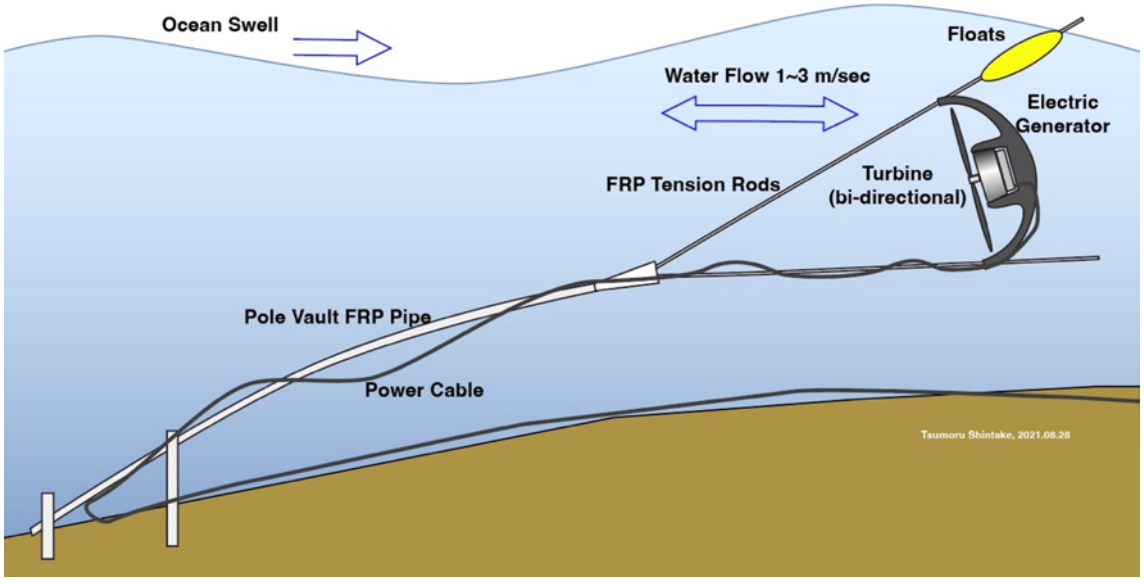


Figure 1. Submersible WEC located at OWZ: oscillating water zone

Through extensive studies via computer fluid simulations (CFDs), we confirmed existence of natural oscillating water zone near the breaking wave zone. We carefully analyzed wave

permeance around the beach of Seragaki Port, where we have OIST Marine Center. We identified the OWZ, roughly 100 m away from the sea barrier, where the average water depth is 3 m. The computer simulation predicted maximum 2 m/sec flow speed, when the seasonal swells arrive from NW direction in Winter (November to March), from which we expected to harness 1 kW electricity by using 0.6 m diameter turbine.

We conducted CFD analysis on the beach of Kandooma Island Maldives, and confirmed OWZ.

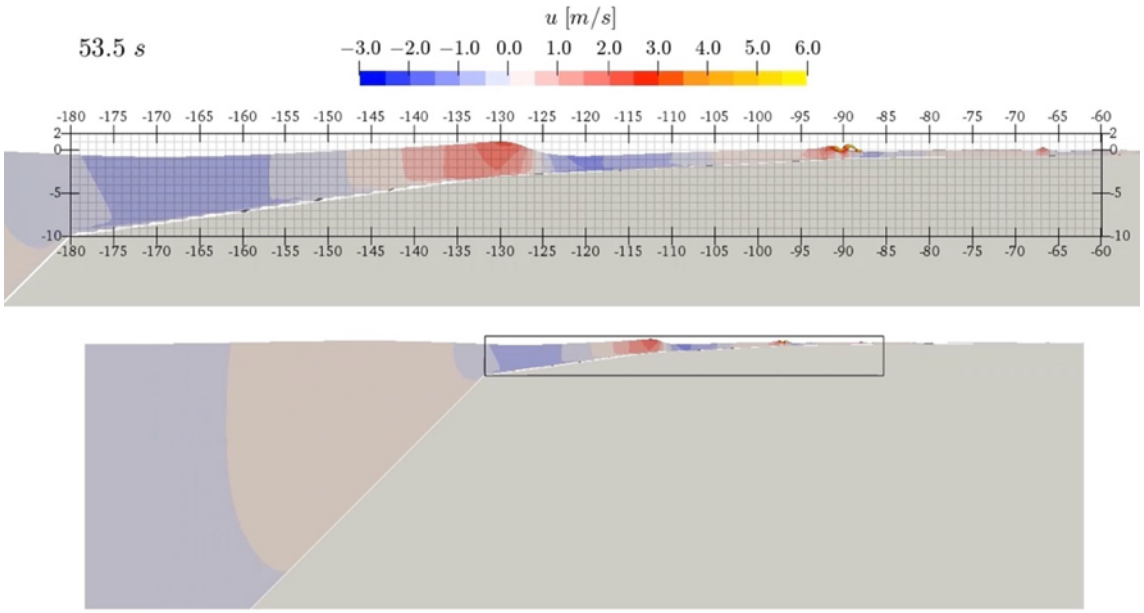


Figure 2. CFD simulation of the east side beach on Kandooma Maldives. Snapshot of the wave form, where the color indicates water flow speed. Wave height H = 1.2 m, T=10 sec.

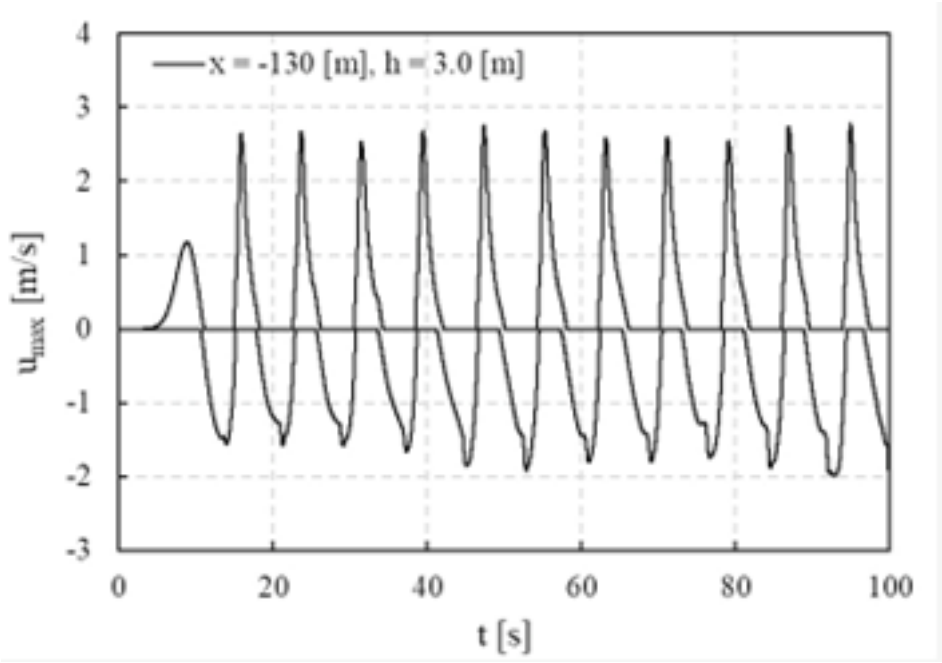
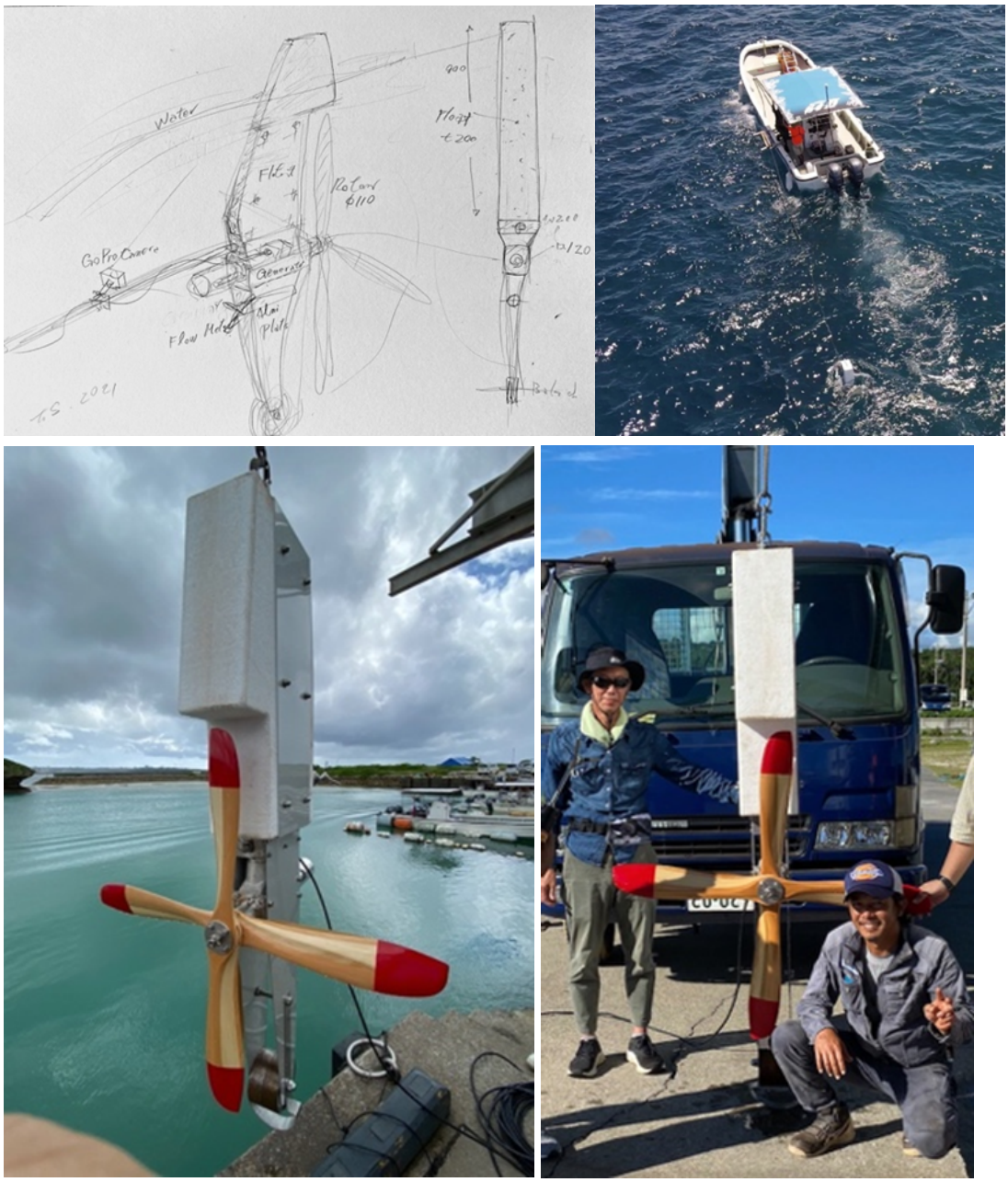


Figure 3. Temporal water flow speed in time at x=-130 m, depth of 3 m, outside of the breaking wave zone. The forward/backward flows indicate OWZ phenomena

We have performed four times of ocean experiments on turbine, towing by boat at Maeda area.



07/29/2021 08/16/2021

Figure 4. The first demonstration model using half-scale generator with propellers from the powered paragliders. The turbine is located behind of the float, and thus this design is "down wind" type, which causes the shadow problem on the turbine, i.e., lowering the speed of water.

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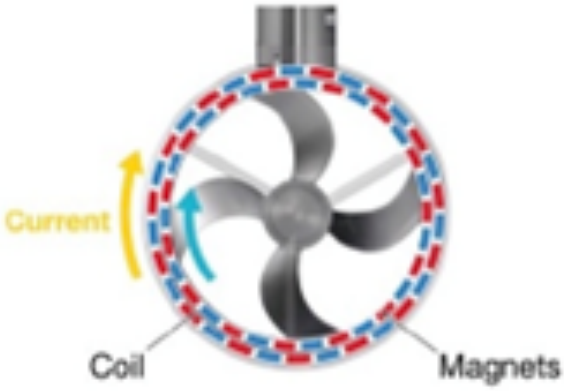

Figure 5. HARMO motor drive unit

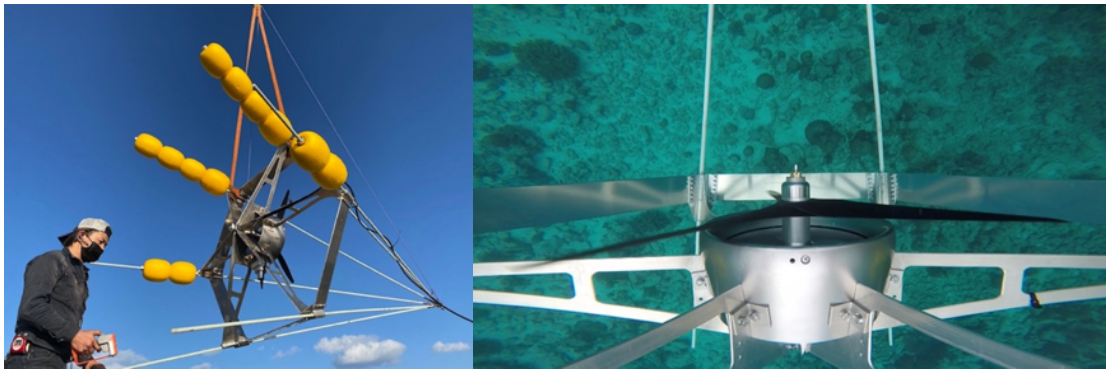

Figure 6. Submersible WEC using HARMO motor and three-blade turbine, which tested at Maeda port towing by motorboat.(02/17/2022)

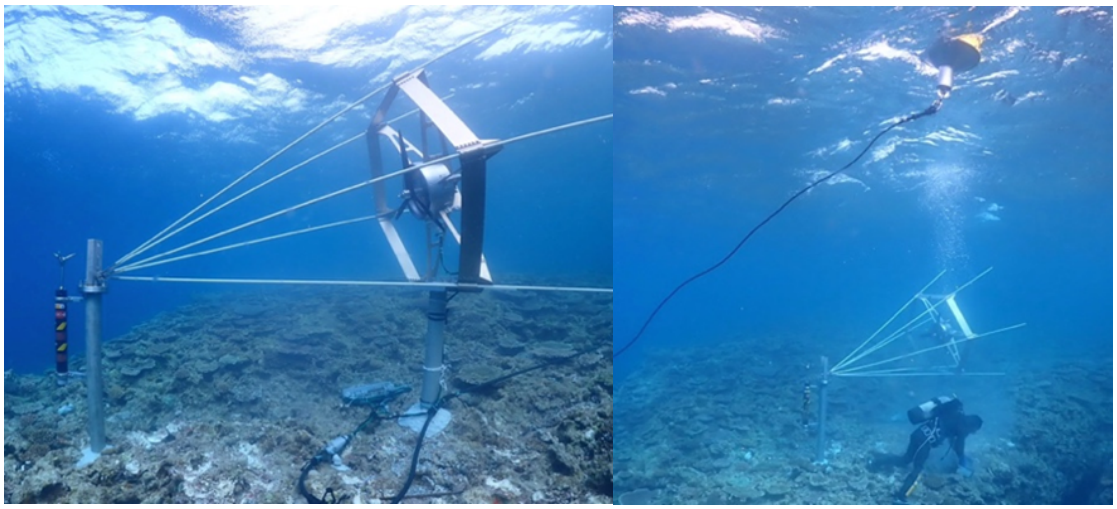

Figure 7. The first model of submersible WEC has been installed at the leaf-edge (3m deep) in front of the OIST Seragaki Marine Center. (04/09/2022). Hexagonal frame diameter is 1.2 m, and length of 2 m.

In 2022

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Seragaki Site

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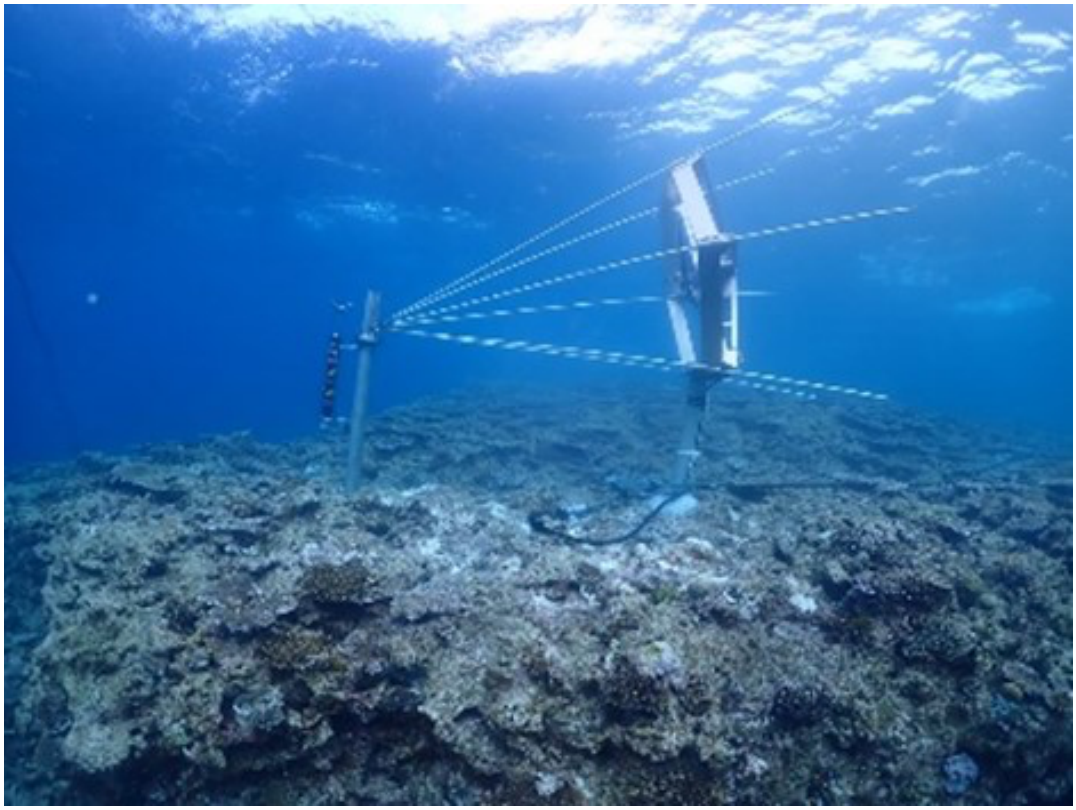
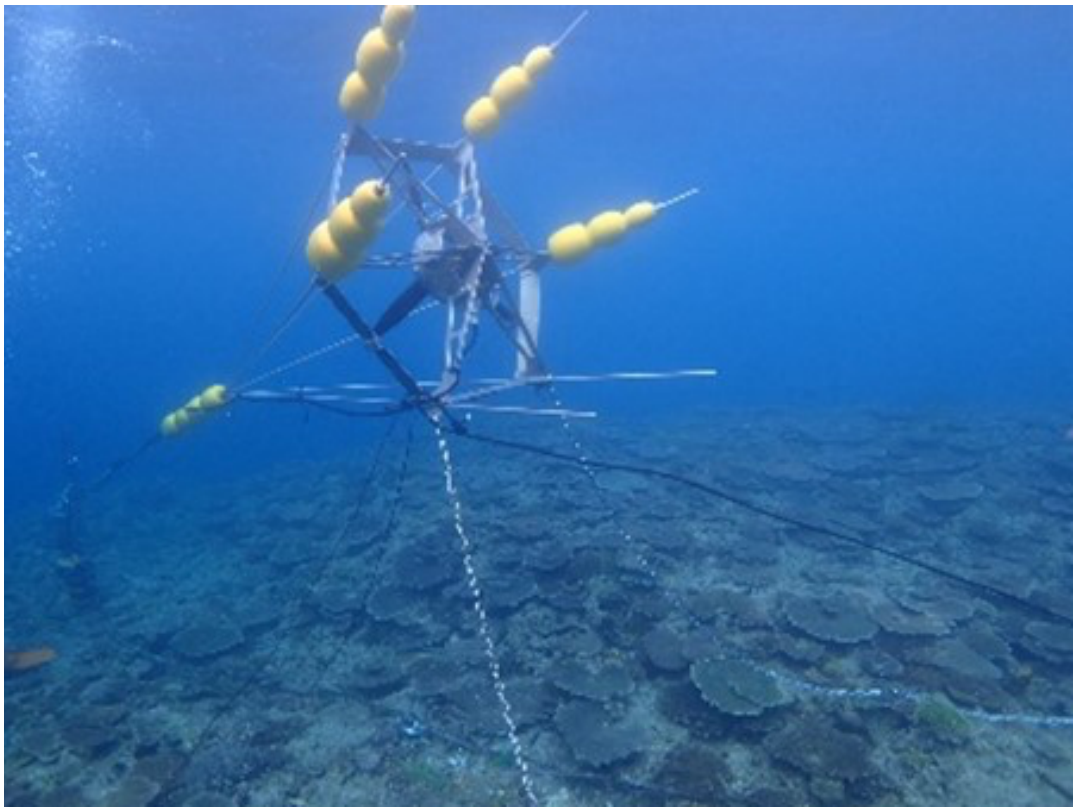


Ver.1

After installation in April, the turbine was updated in May (Ver.1) and data acquisition continued.



Ver.2

In September, Typhoon No. 11 caused rough sea conditions with wave heights exceeding 8M off Seragaki Fishing Port. It was a perfect opportunity for data acquisition, however, abnormal values were showed in the logger data. Waiting for sea conditions to improve, we examined the generator in the sea floor and found that the structure had been ripped away from the support trestle, and the cable had broken and fallen down. That seemed like significant damage but could be repaired and subsequently, the parts used in the holding section of the structure were replaced with aluminum parts to increase strength. After adjusting balance of the buoyancy structure, the generator was re-installed offshore of Seragaki Fishing Port. (Ver.2)

Ver.3

After the reinstallation was completed in November and about a month passed, the observation data from the generator was lost. We figured out the structure damage again. The solid aluminum parts had been bent like candy cane. Due to the above circumstances, the structure was carefully re-examined and modified to be as simple as possible (Ver.3) in March. We keep an eye on the structure condition and expect to receive efficient observation data during coming typhoon season.

Maldives

The Ducted WEC installation in Kandooma, Maldives had been suspended since 2021 and the generator and other equipment had remained on site. Consequently, the condition of those deteriorated significantly. Considering total cost to repair them and also reviewing the installation method, our decision was made to remove the generator and equipment once. In March 2023, the removal work was completed and Ducted WEC project was contractually terminated. When we develop advanced generator and find effective measure of installation, the project may recommence in Maldives.

For 2023 and beyond, please refer to the Annual Report.