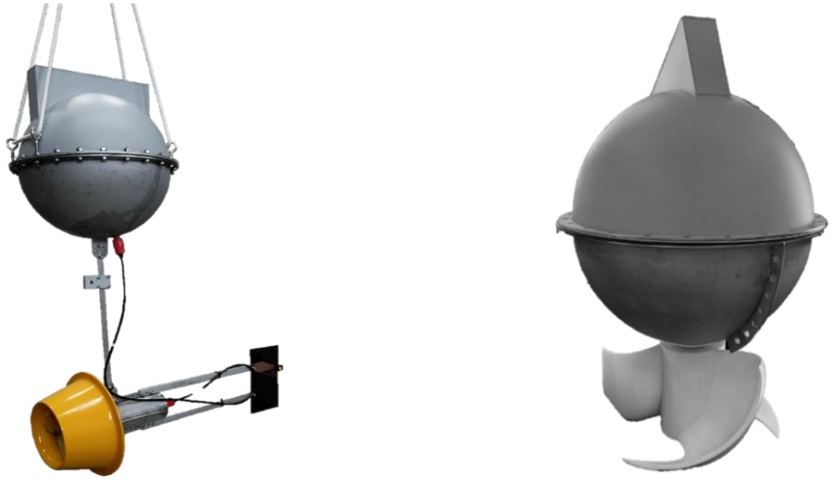
Press Information

Energy Harvesting Smart Buoy collects data of marine environment

Kyocera and Nagasaki University develop “Energy Harvesting Smart Buoy” to collect Ocean Data. The new innovation combines Nagasaki University's tidal current power generation technology with Kyocera’s IoT technology.

Kyoto/Neuss, 16. September 2021. Nagasaki University (President: Shigeru Kohno) and Kyocera Corporation (President: Hideo Tanimoto) announced their joint development of an Energy Harvesting Smart Buoy, which combines Nagasaki University's tidal current power generation technology with Kyocera's IoT technology to collect reliable ocean data. Prototype buoys can collect a wide range of data on the marine environment using self-generated energy. A pilot program gathered information from 21 sensors, monitoring everything from water temperature and humidity to current direction. Future development may include sensors for temperature-related salinity variation, chlorophyll turbidity, and temperature-related variations in dissolved oxygen concentrations, to name a few.



Energy Harvesting Smart Buoys
Left: SLTT (Small Lens-type Tidal Turbines),
Right: VTT (Vertical-axis Tidal Turbines）

1. Development Background

Marine pollution and climate change have become serious societal issues. To solve these issues and help create a more sustainable world, scientists need more reliable ways to monitor and visualize various sea conditions. However, maintaining a stable power supply is a big challenge for continuous data collection at sea. Therefore, Nagasaki University and Kyocera developed the "Energy Harvesting Smart Buoy," which generates its own electric power for continuous ocean data collection using a tidal-current power generation system in the buoy. The new Smart Buoy combines tidal-current power generation technology from Nagasaki University and IoT-related technology from Kyocera. In addition, Kyocera has future plans to monitor fisheries and aquaculture, conduct ocean surveys, and more.

2. Outline of the Prototypes

A buoy equipped with a tidal-current power generation system supplies power to the Kyocera GPS multi-unit and connected sensors.[1] The GPS multi-unit is a compact Kyocera IoT device, equipped with various sensors and antennas, compatible with GPS, GLONASS, and Michibiki[2] location tracking systems.

GPS multi-unit

Each prototype is equipped with two different tidal-current power generation systems:

- **SLTT (Small Lens-type Tidal Turbines)** - The buoy and power generation are separate, and a diffuser is installed around the turbine. In addition to protecting the turbine, the diffuser has the effect of increasing the flow of water for better power generation**.**

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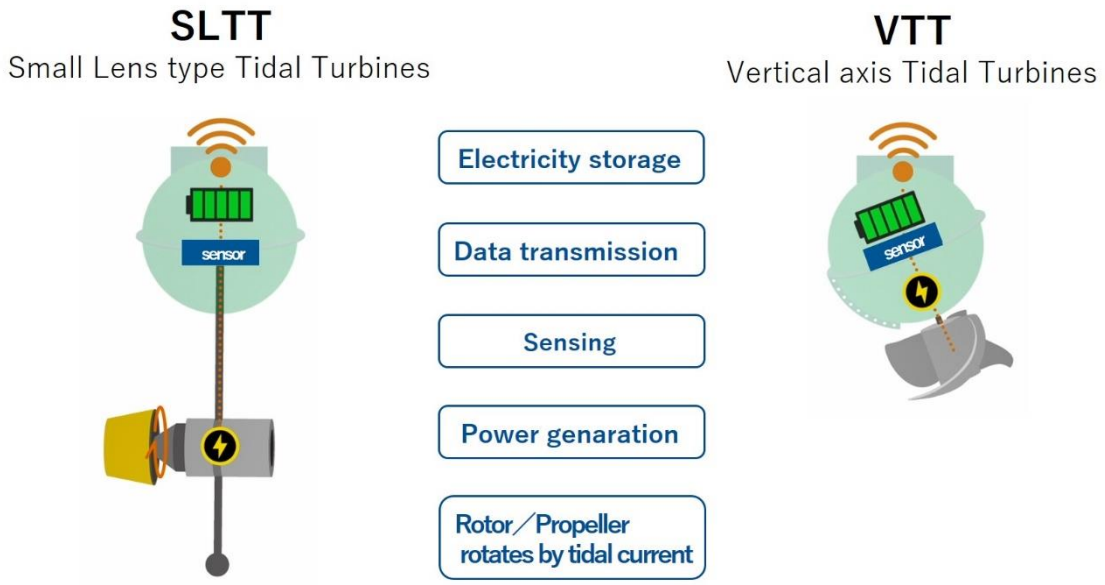
[1] Equipped with a general-purpose serial interface (RS-485), it can connect sensors according to application.

[2] GLONASS is a positioning system using Russian satellites. Michibiki is a Japanese satellite positioning system consisting mainly of quasi-zenith orbiting satellites.

- **VTT (Vertical-axis Tidal Turbines)** - The power generation element is directly connected to the buoy. Its AI-guided design incorporates a tilted axis to optimize turbine rotation amid heavy ocean swells and waves.



	SLTT	VTT
Size	Total ：Approx. 1800mm Buoy ：520mm ×500mm Generator ：400mm ×507mm	Total ：Approx. 910mm Buoy ：520mm×500mm Generator ：400mm×200mm
Weight	Approx. 32kg	Approx. 31kg
Battery	Tidal power generation + Secondary battery（54,000mA）	
External sensor	Current meter (Velocity, direction of flow, and water temperature)	
Internal sensor	Temperature and Humidity/Acceleration/Charging current/Battery voltage/Leakage detection	
Location information	GPS / GLONASS / Michibiki[2]	
Antenna	Built-in	
Communication method	LTE[3] Cat.M1（LTE-M）	
Compatible band	B1/B8/B19/B26	
SIM	nano SIM	

[3] LTE is a trademark of ETSI.

3. Role of Each Organization

Organization Name	Role
Nagasaki University	Turbine design optimized for tidal-current power generation
Kyocera	Development of various sensor controls, power control, buoy design, cloud applications, and mobile applications[4]

4. Pilot Test Results in Sea

Nagasaki University and Kyocera conducted a pilot test for nine days during spring tide to low tide in the tidal cycle. The test used 21 sensors to collect data which was then transmitted to the cloud, including acceleration, temperature, and humidity (using geomagnetic sensors inside the buoy), water temperature, flow velocity, current direction, battery current, and voltage (using an external electric current sensor). The average amounts of electricity generated and consumed during the experiment were:

Average power generation	16.3 Wh
Average power consumption	15.2 Wh
Sensing interval	5 Minutes
Data transmission interval	5 Minutes

Experimental results of SLTT

5. Future Initiatives

To promote ongoing ocean monitoring, the companies are planning to support a water temperature-salinity sensor (temperature, salinity, and electrical conductivity), chlorophyll turbidity sensor (chlorophyll, turbidity, and water temperature), DO sensor (dissolved oxygen and water temperature), and an underwater camera. Performance and operation will be improved, along with a reduction in size and weight, in commercial versions. Kyocera will also build an IoT platform to store collected data, and ongoing testing will be conducted mainly in Nagasaki Prefecture.

[4] PAL Co., Ltd., and Shinei Kogyo LLC., both of which are based in Nagasaki City, cooperated in the prototype manufacturing of the buoy.

For more information on Kyocera: www.kyocera.co.uk

About Kyocera

Headquartered in Kyoto, Japan, KYOCERA Corporation is one of the world's leading manufacturers of fine ceramic components for the technology industry. The strategically important divisions in the KYOCERA Group, which is comprised of 297 subsidiaries (as of March 31, 2021), are information and communications technologies, products which increase quality of life, and environmentally friendly products. The technology group is also one of the most experienced producers of smart energy systems worldwide, with more than 40 years of know-how in the industry. The company is ranked #549 on Forbes magazine's 2020 "Global 2000" listing of the world's largest publicly traded companies.

With a global workforce of over 78,000 employees, Kyocera posted sales revenue of approximately €11,74 billion in fiscal year 2020/2021. The products marketed by the company in Europe include printers, digital copying systems, semiconductor-, fine ceramic-, automotive- and electronic components as well as printing devices and ceramic kitchen products. The KYOCERA Group has two independent companies in the United Kingdom: KYOCERA Fineceramics Ltd. and KYOCERA Document Solutions Ltd.

The company also takes an active interest in cultural affairs. The Kyoto Prize, a prominent international award, is presented each year by the Inamori Foundation — established by Kyocera founder Dr. Kazuo Inamori — to individuals worldwide who have contributed significantly to the scientific, cultural, and spiritual betterment of humankind (approximately €763,000* per prize category).

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