DEGREES OF POWER

THE VAST POTENTIAL OF OCEAN THERMAL ENERGY CONVERSION

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THE temperature difference between the ocean's surface waters and those of its depths is remarkable. Near the equator, where surface water temperatures reach their peak, the change can be as high as 25 degrees centigrade.

Ocean thermal energy conversion (OTEC) uses this temperature difference to produce energy. Research and development into OTEC as a producer of clean renewable energy like solar and wind power has been progressing in countries worldwide. In Japan, Saga University is at the center of such work. And in Okinawa Prefecture, the world's first operational field testing has begun on the island of Kumejima.

OTEC's general mechanism is a loop process. It begins with producing vapor using warm surface seawater that powers a turbine to generate energy, and then cooling the vapor with cold seawater to change it back into liquid. Powering a turbine in this way is similar to thermal and nuclear power generation. Instead of using water, however, which boils at 100°C, substances such as ammonia—which has a low boiling point of around -33°C and vaporizes at low temperatures—are being used as working fluids.

OTEC's primary advantages are that it can generate power stably 24 hours a day, is not affected by weather conditions, and the potential energy derived from the process increases according to the temperature difference between surface and deep sea waters. In Japan, Okinawa Prefecture and the surrounding area, the Amami Islands in Kagoshima Prefecture, Minami-izu and the Ogasawara Islands are the most suitable locations.

In the seas around Kumejima where the field tests are being conducted, shallow water temperatures are nearly 30°C in the summer, and over 20°C in winter. The waters at depths of a thousand meters fall to approximately 4°C, and can generate a stable supply of energy year-round. Energy outputs are currently in the 50-kilowatt range, but in a few years facilities now in the planning stages will generate one to two megawatts as the technology develops further.

"Japan's land area is small, ranking sixty-second globally, but its oceanic expanse—including its exclusive economic zone—is large, ranking sixth," says Professor Yasuyuki Ikegami of Saga University's Institute of Ocean Energy. "And Japan is a world leader in many of the

The world's first operational OTEC field-testing facility, at Kumejima

The OTEC plant in Kumejima

fields indispensable to ocean thermal energy conversion, such as shipbuilding technologies and heat exchangers for converting liquids to vapor, all of which serve as the basis of seawater pumping processes."

After the oil crisis era, Japan and Western countries avidly pursued OTEC research and development. As crude oil prices plummeted in the 1990s, however, those other nations halted their research. As crude oil prices soared from around 2008, the world again began to investigate OTEC's potential. The U.S. is constructing a 10-megawatt-class plant, and Europe, South Korea and China are also plowing resources into development. Japan is the only country that has continued its studies without interruption since the first boom period. As a result of this continuous research, now entering the second-stage boom period, Japan boasts more patents for ocean thermal energy conversion technology than any other nation.

Seawater pumped from the deep can be used not just for generating electricity but also as a source of sea mineral water, and to cool buildings. It is also possible to recover precious lithium from the sea's depths. Moreover, the ocean possesses other great potential, such as for producing drinking water and hydrogen from shallow seawater. In Kumejima there is a booming industry developing that takes advantage of the multiple potentials of the ocean that is already worth two billion yen per year.

The issue is the expensive initial costs of building OTEC facilities. A 1000-kilowatt power plant will cost approximately five to ten billion yen, while a 100-megawatt plant would cost ten times that amount. However, when it comes to utilization rates, OTEC can reportedly surpass other renewable energy sources in cost benefits within a few years.

In July 2014, 52 foundations and organizations—including Saga University, Kumejima, Okinawa Prefecture, the University of the Ryukyus and Tokyo University—joined forces to establish the Global Ocean Resource and Energy Association as a big first step toward implementation. As an island nation, Japan seeks to be a driving force and global leader in making OTEC a viable energy-producing process.