Series "Ushering in a New Era of Carbon Neutrality" (4)

Ocean Energy Technology Development -Will Japan catch up with Europe?-

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Overview of ocean energy and its challenging issues

Ocean energy plays an important part in the "blue economy" which aims to help economic growth and improve social quality as well as to ensure the conservation of marine resources. While ocean energy technology is currently in the phases of research, development and demonstration, it is expected to contribute to decarbonization in the long-term. There are different ocean energy technologies in power generation to utilize the following resources: (i) tidal stream (the tidal currents caused by the ebb and flow of the ocean's tides); (ii) tidal barrage (the tidal range which is the actual height difference between high and low tide); (iii) ocean currents (large circulations of the ocean currents initiated by an interplay of wind, temperature and salinity); (iv) wave energy; (v) ocean thermal gradient (the temperature difference between the warm ocean surface and the cold deep-sea water).

Tidal stream shows a periodic movement caused by the interaction of gravitational forces of the sun and the moon, which indicates that it will be a predictable and stable energy source. Tidal stream technology uses the tidal currents to generate power mainly through an underwater turbine and is close to commercialization.

Similar to hydropower, tidal barrage that makes use of the tidal range is a technology that stores water in an enclosed tidal basin with high tide and releases it in low tide to generate power through a turbine. This technology has been in operation for years. Tidal barrage makes up 98% of the global installed capacity of 535MW across ocean energy technologies. However, new developments have been limited due to the difficulty to find suitable locations where it is possible to construct a dam and the tidal range is more than five meters.

Ocean currents can be a stable and large-scale energy source as the currents are less fluctuated in velocity and direction. Similar technologies that are deployed for tidal streams could be applied to ocean currents. Still, it is challenging to develop ocean current power generation systems because high volumes of ocean currents are generally found several kilometers away from shore in much deeper waters.

Harnessing energy contained in ocean waves, wave energy has more resource potential than tidal streams with short-term predictability. While wave energy technology is yet to be

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This paper is an authorized reprint of the original paper published in the May 4, 2021 issue of *Financial Affairs (Kinzai Weekly)*.

commercialized, various technologies have been pursued.

Ocean thermal energy conversion (OTEC) requires a temperature difference of about 20 degrees. OTEC is advantageous in providing stable power around the clock, and is hence expected to work as a baseload power source. In addition, OTEC can be coupled with other technologies such as seawater reverse osmosis (SWRO) and seawater air conditioning (SWAC).

Although research and development on ocean energy have been conducted for a long time, several barriers have hindered large-scale deployment of ocean energy technologies. First of all, further technology development is necessary to improve power generation efficiency and take other critical aspects into account, e.g., improving durability against the harsh offshore environment and reducing impacts on marine ecology. Infrastructure development and operation and maintenance also necessitate complicated work under the sea. Moreover, it is difficult for ocean energy projects to receive financing due to the risks inherent in immature technologies. Investors may find uncertainty in ocean energy technologies because most of them are at the early stage of development and convergence in technology has not been observed. Last but not least, inadequate regulatory framework and lack of support from governments are raised as concerns.

On the other hand, ocean energy is expected to bring about substantial benefits. For example, as ocean energy is a predictable and stable power source, it can be combined with variable renewable energy such as solar and wind energy to develop an efficient hybrid power generation system. Decarbonization could also be accelerated if ocean energy were to supply electricity for the blue economy like aquaculture. In addition, it is possible that ocean energy would replace with petroleum products on remote islands such as the Small Island Developing States (SIDS) which are dependent on diesel currently if it became cost-competitive.

Ocean energy technology development in the major countries

Europe has been at the forefront of technology development in ocean energy.

Among others, Scotland has provided its policy support for ocean energy since the 2000s, and promoted technology development mainly in the European Marine Energy Centre which is a demonstration and test site in the Orkney Islands. The MeyGen project is an operating tidal power generation facility connected to the power grid and is planned to expand the capacity from 6MW at present.

The European Union (EU) puts a priority on clean energy including ocean energy as a technology that contributes to economic growth. In the EU Strategy on Offshore Renewable Energy published in November 2020, the target of ocean energy development is set at least 1GW by 2030 and 40GW by 2050 although offshore wind energy is the majority of offshore renewables. Ocean energy will be supported under Horizon Europe, the key funding program for research and innovation in the timeframe 2021-2027.

Ocean energy technology has received attention in North America as well.

The United States has actively pursued technology development generally through grant programs for research and development and several national marine renewable energy centers. In February 2021, the National Renewable Energy Laboratory reported that the total marine energy technical resource in 50 states would be 2,300TWh per year, which is equivalent to about 57% of the electricity generated in the United States in 2019.

Canada focuses on tidal energy development. The province of Nova Scotia has implemented a feed-in tariff (FIT) scheme for tidal energy even in the testing phase. In November 2020, the Canadian government announced funding of CAD 28.5 million to support the installation of the 9MW floating tidal energy system.

In the Asian region, China shows rapid progress in ocean energy development. China's filed patents related to ocean energy have increased steadily since 2005 and outnumbered other countries in recent years. In 2020, China added 500kW power generation capacity for tidal and wave energy, respectively.

Demonstration projects in Japan – policy support expected for commercialization

Japan's 5th Strategic Energy Plan published in July 2018 addressed the promotion of research and development to assist in reducing cost and improving efficiency for ocean energy along with other renewable energies. Then, demonstration sites were selected in eight sea areas of six prefectures as one of the measures to encourage ocean energy technology development with a view to achieving commercialization [Table].

In July 2019, IHI, a comprehensive heavy-industry manufacturer, and the New Energy and Industrial Technology Development Organization announced to conduct a demonstration test of the 100kW class subsea floating type ocean current power generation system off the coast of Kuchinoshima Island (Toshima Village, Kagoshima Prefecture) for more than a year. As a recent demonstration project, in January 2021, Kyuden Mirai Energy installed the 500kW tidal power generation system at about 40 meters depth off the Naruseto Strait of Goto City (Nagasaki Prefecture).

However, ocean energy is not included among the new energy sources eligible for policy support under the Act on the Promotion of New Energy Usage. There are many challenges in promoting the deployment of ocean energy. Japan needs to deal with not only technological and economic obstacles but also issues related to fishery rights and regulatory constraints.

Surrounded by the sea, Japan has no reason not to harness ocean energy. It is about time to strengthen the policy measures to support ocean energy development.

[Table] Offshore renewable energy demonstration sites in Japan

	Sea areas	Energy type
Iwate Prefecture	Off the coast of Kamaishi City	Wave energy, floating offshore wind power
Niigata Prefecture	Off the coast of Awashimaura Village	Ocean currents (tidal stream), wave energy, floating offshore wind power
Saga Prefecture	Off the coast of Kabeshima Island, Karatsu City	Tidal stream, floating offshore wind power
Nagasaki Prefecture	Off the coast of Hisakajima Island, Goto City	Tidal stream
	Off the coast of Kabashima Island, Goto City	Floating offshore wind power
	Off the coasts of Enoshima and Hirashima Islands, Saikai City	Tidal stream
Kagoshima Prefecture	Around Kuchinoshima and Nakanoshima Islands, Toshima Village	Ocean currents
Okinawa Prefecture	Kumejima Town	Ocean thermal energy conversion

Source: Cabinet Office, “The Selection of Offshore Renewable Energy Demonstration Sites,” June 29, 2017.

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