Hybrid Offshore Renewable Energy

Background

In response to Taiwan's 2050 net-zero emissions target, the proportion of renewable energy in the country's power generation mix must reach 60-70%. However, individual renewable energy sources face challenges such as unstable power output and large space requirements for installation. Thus, the development of renewable energy must address two major challenges: the stability of power output and competition for limited space.The development of Hybrid Offshore Renewable Energy not only leverages complementary energy sources to enhance the baseload power output of offshore energy, but also reduces overall installation and generation costs while accelerating industrialization by sharing infrastructure. Improving the efficiency of marine space utilization will also provide a more stable zero-carbon power system by helping overcome Taiwan's limited land constraints.

It is currently a critical time for planning the location and application of floating offshore wind farms in Taiwan. Hybrid Offshore Renewable Energy development is also a significant trend given that international floating wind technology is still in its verification stage. Taiwan should seize the opportunity for industrial development in this field by accelerating the integration of offshore energy technologies—such as floating wind power, wave energy, marine current power, and offshore solar power. Such development will enhance the maturity of Taiwan's offshore energy technologies, develop the domestic industrial ecosystem, and shape the supply chain.

Global Outlook and Domestic Progress

Apart from fixed offshore wind power, which has become relatively mature, the progress of other offshore energy development in various countries remains mostly at the testing stage because of the higher cost of power generation along with the limited success of commercial operations in real marine environments. Currently, the international community is moving towards combined testing solutions of floating wind power with wave energy or offshore solar power. For example, a team consisting of 16 European energy companies and research groups, led by the Dutch Marine Energy Centre (DMEC), has launched a €45 million (approximately NT$1.49 billion) project to build a multi-source offshore renewable energy park.

Additionally, the European Scalable Offshore Renewable Energy Sources (EU-SCORES) project, with an investment of €34.8 million, aims to fully utilize marine space by combining floating wind turbines with wave energy, or floating wind turbines with floating solar power. This complementary approach is designed to achieve more stable but flexible power output. In addition, the project will also evaluate the feasibility of integrating green hydrogen production. EU-SCORES is primarily driving two impactful demonstration projects, both of which are being deployed in 2023-2024, with scaling up expected in 2025.

In response to the future demand for low-carbon electricity, Taiwan is actively promoting the development and installation of various renewable energy technologies. For instance, Taiwan is expanding

its offshore renewable energy into deeper waters while developing floating offshore wind turbines, floating solar power, and ocean energy. However, these technologies still require verification, scaling up, and the collection of relevant environmental data.

In terms of domestic investments in offshore energy related technology projects, various government ministries have gradually invested in the development of floating offshore wind power, floating solar power, shore-based/ point-absorbing wave energy, and Kuroshio Current power generation in recent years. However, technology readiness level (TRL) remains between 4 and 5, and comprehensive offshore energy technology strategies have yet to be implemented. There are also gaps in technology related to midstream maritime engineering (see Figure 1 for details).

Taiwan, whose industry has been gradually developing, already possesses the necessary conditions and foundations for developing offshore energy, which include the ability to conduct marine surveys and underwater engineering. Leveraging more mature or developing offshore wind farm sites and sharing infrastructure in nearshore shallow water areas can accelerate the process of industrializing offshore energy and solar power. In terms of scientific research, it is essential to conduct marine spatial planning to understand environmental conditions and evaluate the most suitable areas for development. Additionally, government agencies should minimize environmental, ecological, and social impacts by communicating with the public to address potential impacts.

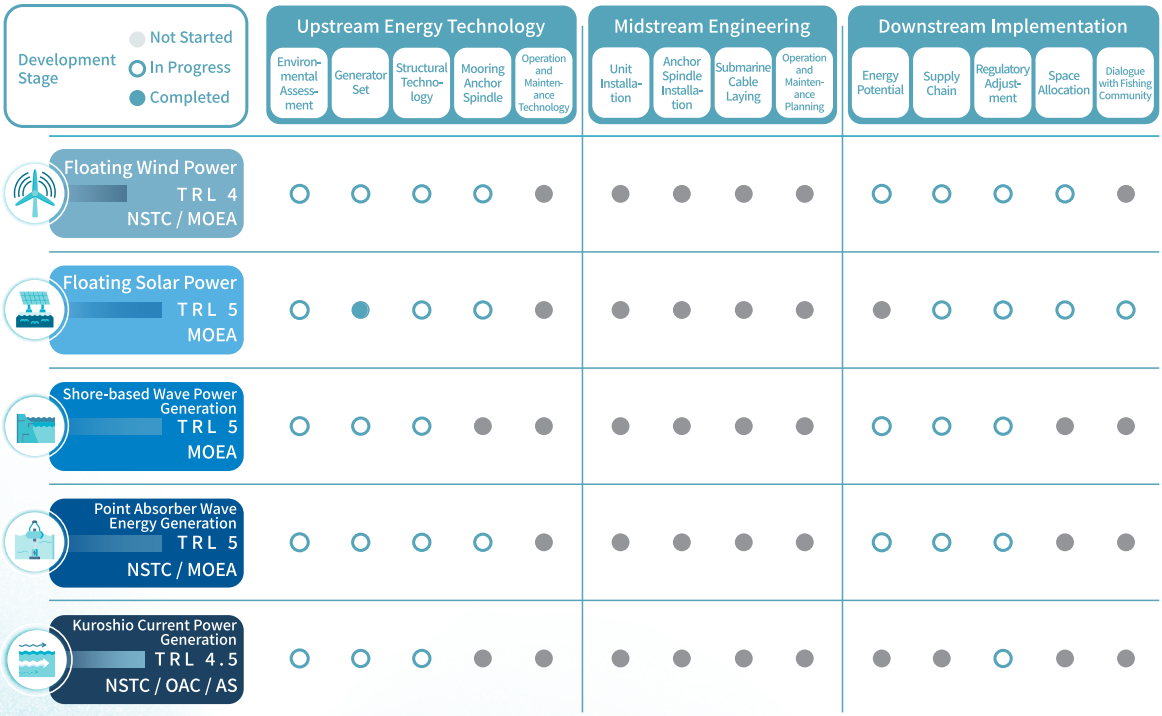

Figure 1 An Analysis of the Status of Scientific Research Investment for Hybrid Offshore Renewable Energy

Source: Taiwan Science and Technology Office for Net-zero Emission (T-STONE) (2024)

Strategic Planning Frameworks

In response to achieving net-zero by 2050, Taiwan should actively develop potential offshore renewable energy sources while balancing the competition for limited land with building an offshore energy supply chain. Thus, T-STONE has formulated a comprehensive hybrid offshore renewable energy technology strategy based on the concept of an Offshore Energy Technology Innovation Chain. The integration and promotion of the following seven strategies aim to enhance the maturity of offshore energy technologies and improve the efficiency of marine spatial utilization. This will achieve the core values of verification for innovation technology (research), formation of an offshore energy supply chain (industry), and construction of support systems (governance). The planning of a systematic carbon reduction pathway will assist Taiwan in moving toward its net-zero targets (see Figure 2). Brief descriptions of each strategy are as follows:

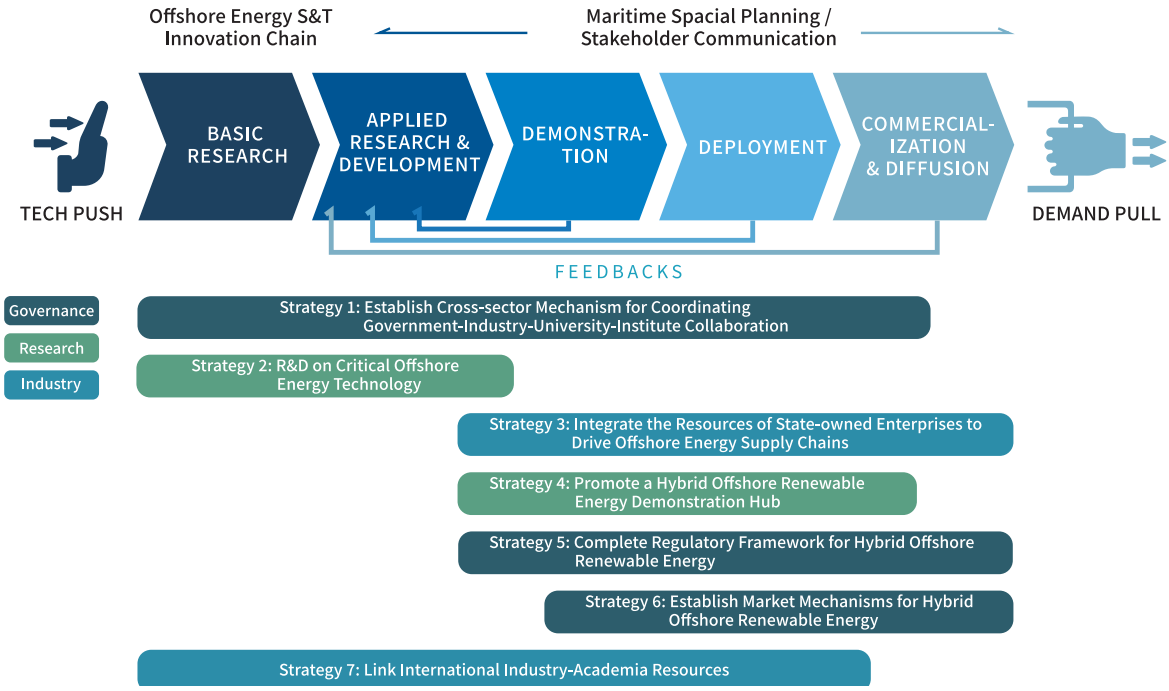

Figure 2 Comprehensive Strategies for Hybrid Offshore Renewable Energy Technology Based on Technology Innovation Chains

Source: Taiwan Science and Technology Office for Net-zero Emission (T-STONE) (2024)

Strategy 1: Invest in Geothermal Exploration and Frontier Engineering R&D

Through Government-Industry-University-Institute collaboration, establish a value chain that focuses on the core issues of "Overcoming Bottlenecks in Foresight Technologies," "Integrating Cross-Departmental Resources," "Entering Untapped Markets of Blue Ocean Industries," and "Activating Market Mechanisms". Strengthen public-private collaboration mechanisms and enhance communication with the public.

Strategy 2: R&D on Critical Offshore Energy Technology

Key technologies cover three main categories: Power Generation/Energy Conversion Technologies and System Design, Maritime Engineering and Power Transmission, as well as Infrastructure and Support Systems. Research and development goals include improving the efficiency, reliability, and stability of related equipment, conducting real-world validation through co-constructed/co installed power generation, enhancing operational and maintenance efficiency, and monitoring environmental and ecological impact.

Strategy 3: Integrate the Resources of State Owned Enterprises to Drive Offshore Energy Supply Chains

Integrate resources of state-owned enterprises (such as Taiwan Power Company and CPC Corporation). Enhance the technological maturity through real-world marine demonstrations. Drive diverse and comprehensive development of related supply chains by leveraging model cases to strengthen investor confidence among businesses and financial institutions.

Strategy 4: Promote a Hybrid Offshore Renewable Energy Demonstration Hub

Conduct testing of offshore power generation technologies and system integration assessments at existing state-owned offshore wind farm sites. These sites and services will also provide key technical standards verification, establish long-term environmental monitoring and marine data governance mechanisms, and introduce operational model planning concepts. This will gradually create an offshore energy industry ecosystem by ensuring the readiness of real-world deployment and commercial operation of relevant technology.

Strategy 5: Complete Regulatory Framework for Hybrid Offshore Renewable Energy

Several competent authorities, each with its own management purposes regarding the use or restrictions of marine areas, are responsible for regulations related to offshore energy. This may result in exclusivity in the utilization of marine areas and conflicts between the regulations of multiple agencies governing the same waters. Thus, it is imperative to establish comprehensive regulatory support to coordinate the use of marine areas.

Strategy 6: Establish Market Mechanisms for Hybrid Offshore Renewable Energy

Establish a commercial ecosystem and market mechanisms for investment and financing in the early stages of offshore energy development. In the medium and long term, focus on encouraging investments from domestic financial institutions while promoting state backed financial guarantees to strengthen the complete development of the local supply chain and market for hybrid offshore renewable energy.

Strategy 7: Link International Industry-Academia Resources

Help establish research exchange and collaboration opportunities with leading countries in technology by prioritizing the utilization of Taiwan's existing international cooperation and exchange platforms while connecting with potential manufacturers from domestic industry associations.

Expected Benefits

“Hybrid Offshore Renewable Energy” includes seven strategies across three main domains: Research, Industry, and Governance. Expected benefits include enhancing green electricity supply and improving grid stability by leveraging the complementary characteristics of offshore renewable energy—wind, solar, and wave—to increase capacity factor and power generation stability. In addition, sharing infrastructure can reduce costs and accelerate the commercialization of offshore energy technologies.

Building on its experience in wind farm development, maritime engineering, and floating platform technologies, Taiwan can seize opportunities to develop a supply chain while shaping an offshore energy industry ecosystem. Diversified applications will establish partnerships with diverse stakeholders by effectively utilizing marine areas while balancing the competition for limited space with marine conservation.

In line with the government's policies based on the concept of Integrated Resource Planning (IRP), such as the National Project of Hope and the initiation of the second energy transition, Taiwan will achieve net-zero goals by accelerating the development of hybrid offshore renewable energy in conjunction with floating offshore wind farms.

References

[1] CorPower Ocean (2022). The rise of hybrid marine energy parks: An interview with Dutch Marine Energy Centre (DMEC). https://corpowerocean.com/the-rise-of-hybrid-marine-energy-parks-an-interview-with-dutch-marine-energy-centre-dmec-project-coordinator-benjamin lehner/

[2] EU-SCORES (2023). EU-SCORES: European Scalable Offshore Renewable Energy Source. EU-SCORES website. Retrieved July 9, 2023, from https://euscores.eu

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