Sustainable Low-Carbon Hydrogen (Ammonia) Net-Zero Campus

Background

To achieve net-zero emissions by 2050, Taiwan's energy system must address four major challenges: (1) Intensifying competition for land use due to increased demand for green energy; (2) A higher proportion of green energy increasing the unreliability of the power system; (3) Immature international markets and technology for green hydrogen/ammonia that have high infrastructure investment costs.; and (4) Stricter international carbon management regulations driving a substantial increase in domestic demand for low-carbon resources. Thus, hydrogen energy will play a key role in Taiwan's efforts to achieve 2050 targets.

By diversifying the methods for producing low-carbon hydrogen domestically, it is possible to ensure an adequate supply of low-carbon energy while balancing sustainable development and the lifespan of existing energy infrastructure. This will help mitigate the competition for land use due to renewable energy development and contribute to the decarbonization of the energy system.

To this end, T-STONE has two major strategic goals:

(1) Establishing stable and reliable low-carbon energy to accelerate net-zero transition through domestic hydrogen/ammonia energy systems; and; (2) Creating a sustainable low-carbon hydrogen/ammonia industrial ecosystem while entering international supply chains by integrating technology and systems.

Global Outlook and Domestic Progress

Currently, various international regions—including Europe, Australia, and Japan—are promoting low-carbon hydrogen and ammonia demonstrations through the "hub" concept, with the Port of Rotterdam in the Netherlands serving as the leading benchmark.

By integrating North Sea offshore wind power with import terminals, the port plans to launch its hydrogen network operations in 2025. Supply is projected to reach 4.6 million tons by 2030 and expand to approximately 20 million tons by 2050. Similarly, Taiwan's "Hydrogen (including Ammonia) Supply Chain Decarbonization Flagship Action Plan" aims to utilize demonstration centers for technical validation to accelerate the deployment of key technologies.

Strategic Planning Frameworks

Strategy 1: Create Sustainable Low-Carbon Hydrogen / Ammonia Energy Technology Development Demonstration Hubs

Conduct real-world validation of key next generation hydrogen/ammonia technologies. Utilize the results to refine foresight technology research. Centered at Taichung Port and integrated with surrounding industries, the plan utilizes imported green ammonia as fuel, while leveraging ammonia-to-hydrogen conversion, green power, and marine energy as power sources for hydrogen production. The objective is to construct a comprehensive low-carbon hydrogen/ammonia supply-and-demand hub and accelerate the formation of the industrial ecosystem.

(a) Potential Southern Low-Carbon Hydrogen (Ammonia) Net-Zero Zone (Hub) — Kaohsiung Port

As Taiwan's premier maritime gateway, Kaohsiung Port is surrounded by a high density of low-carbon energy stakeholders, including both producers and consumers such as CPDC (China Petrochemical Development Corporation), Taipower, CPC Corporation, China Steel (CSC), the Linhai Industrial Park, and various Technology Industrial Parks.

By positioning Kaohsiung Port as a critical strategic node for low-carbon hydrogen and ammonia, this initiative aims to integrate the abundant energy resources of Southern Taiwan. This strategy will promote the localized production and application of low-carbon hydrogen and ammonia, catalyze the development of surrounding industrial clusters, and significantly bolster the global competitiveness of Kaohsiung's green energy industry.

(b) Potential Central Taiwan Low-Carbon Hydrogen (Ammonia) Net-Zero Zone (Hub) — Taichung Port

To implement this strategy, T-STONE plans to establish the "Taichung Port Low-Carbon Hydrogen (Ammonia) Net-Zero Campus" and the "Low-Carbon Hydrogen (Ammonia) Net-Zero Zone." The preliminary concept is to integrate low-carbon energy industrial resources in the Taichung area to build domestic industrial track records and provide the necessary R&D resources for industry, academia, and research sectors, thereby shaping Taiwan's low-carbon energy industrial ecosystem.

To this end, the master plan is divided into two major sections, as illustrated in Figure 1:

- Low-Carbon Hydrogen (Ammonia) Net-Zero Campus
- Low-Carbon Hydrogen (Ammonia) Net-Zero Zone

Taichung Port serves as a critical gateway for energy imports and exports, surrounded by a diverse array of low-carbon energy supply and demand stakeholders, including CPC Corporation, Taipower, Taiwan Fertilizer Co. (TFC), and Dragon Steel.

To ensure energy resilience, Taiwan must establish multiple hydrogen and ammonia parks beyond the initiatives in Southern Taiwan (or Xingda Port). Central Taiwan is uniquely positioned to host the nation's second major energy hub. By integrating the region's low-carbon energy resources, this hub will enhance industrial output value, create new job opportunities, and accelerate the transition toward a robust hydrogen economy.

The planning of shared port facilities focuses on establishing critical infrastructure, including hydrogen refueling stations, hydrogen pipelines, and offshore wind O&M (Operation and Maintenance) and component manufacturing bases. Additionally, the plan involves developing bunkering vessels and O&M equipment for LNG and ammonia. Key components include:(1) Hydrogen Energy Infrastructure: Construction of hydrogen storage and distribution facilities within the port area.(2)Clean Fuel Bunkering: Development of vessels and facilities for bunkering clean fuels (such as ammonia and LNG).(3)Offshore Wind Support: Establishment of testing and R&D equipment required for offshore wind O&M ports.

Ultimately, these elements will be integrated into advanced applications, such as CCUS (Carbon Capture, Utilization, and Storage) and Green Marine Data Centers.

Strategy 2: Establish Initial Market Mechanisms for Sustainable Low-Carbon Hydrogen / Ammonia Energy

The complexity of the hydrogen/ammonia energy supply chain comes from areas such as production, midstream distribution and storage, and end-use applications. Thus, it is essential to overcome existing limitations to promote market development. Currently, hydrogen/ammonia energy technology and value chains are still being developed. Thus, many relevant regulations are still narrow in scope. Therefore, the government must support the establishment of mechanisms in the early stages of implementation. In addition, the government must facilitate the creation of an industrial ecosystem that accounts for technology, industry, and the market by designing and implementing a technology sandbox mechanism while establishing standards for low-carbon hydrogen/ammonia certification and safety regulations for hydrogen/ammonia equipment.

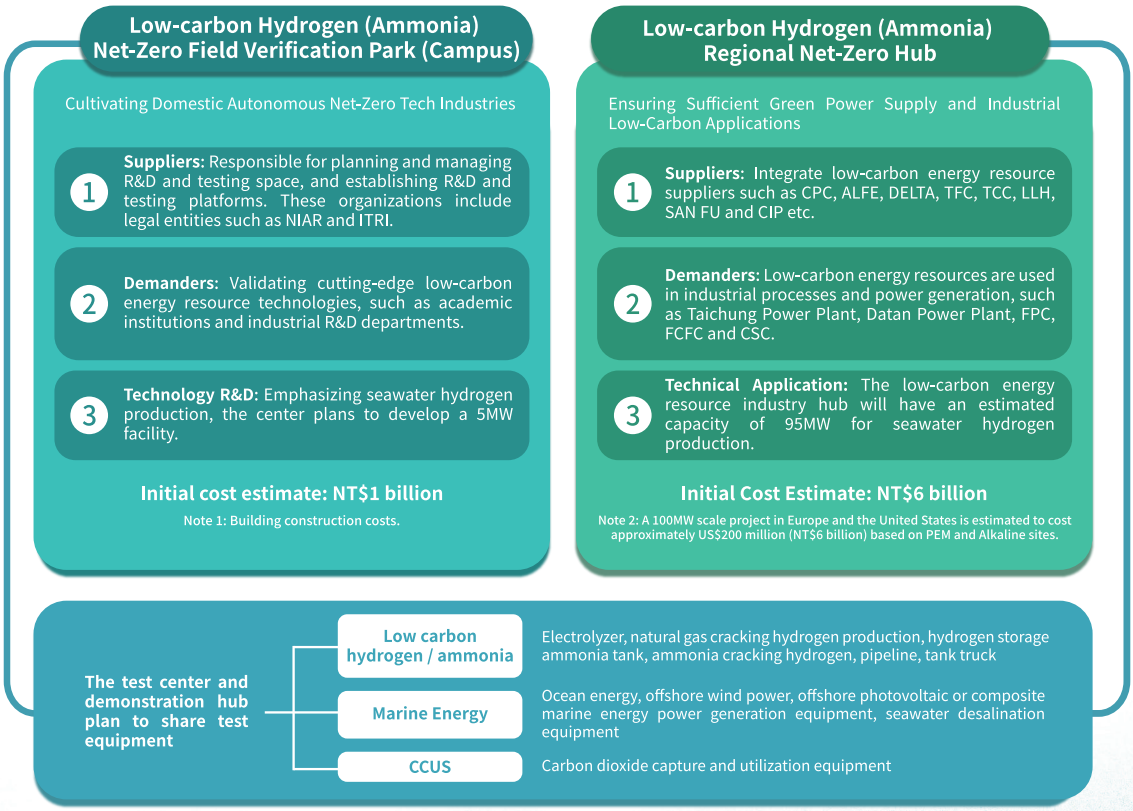

Figure 1 Taichung Port Low-Carbon Hydrogen (Ammonia) Net-Zero Campus and Low-Carbon Hydrogen (Ammonia) Net-Zero Zone

Source:T-STONE(2025)

Potential Benefits

The Low-Carbon Hydrogen (Ammonia) Net-Zero Campus is designed to build a cross-domain collaboration platform by integrating R&D expertise with industrial clusters and leveraging hybrid marine renewable energy resources (such as offshore wind and solar PV).

The campus is strategically located on an 8.5-hectare hydrogen production site within Taichung Port for real-world validation and commercial demonstration, as illustrated in Figure 2. By establishing a comprehensive value chain—encompassing production, storage, transport, conversion, and application—the campus will verify the technical feasibility and economic viability of these solutions in operational environments.

These efforts are intended to pave the way for large-scale commercialization and industrialization. In subsequent phases, the net-zero proving grounds will expand into surrounding industrial and power generation zones. This expansion will achieve a diversified green energy supply and establish the region as a pivotal hub for industrial decarbonization.

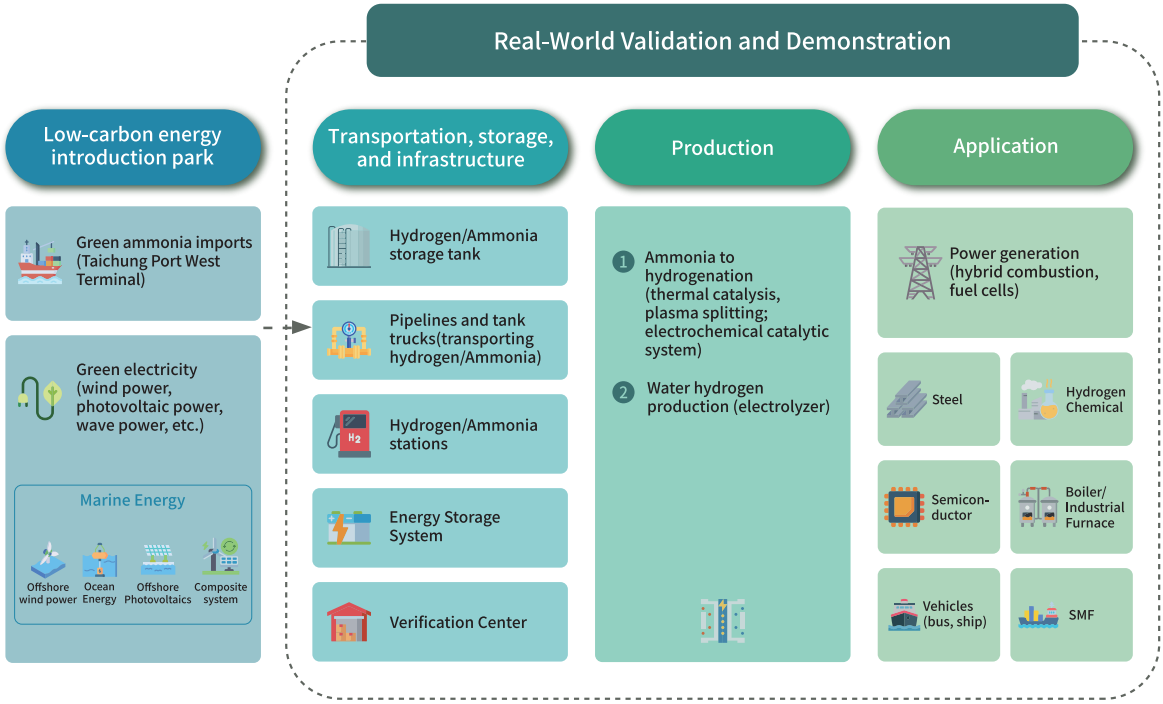

Figure 2 Schematic Diagram of the Sustainable Low-Carbon Hydrogen (Ammonia) Net-Zero Campus

Source:T-STONE(2025)