International Experiences in Hydrogen Energy Development Provide Valuable Insights for Taiwan

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In late March 2022, the National Development Council of the Executive Yuan announced the "Taiwan 2050 Net Zero Emissions Pathway and Strategy Overview." In this plan, because of electricity as the primary source of greenhouse gas emissions, decarbonizing the power sector was identified as a crucial policy direction. This includes aiming for hydrogen power generation to account for 9 percent to 12 percent of the energy mix. According to the Industrial Technology Research Institute's "Taiwan 2050 Hydrogen Application Development Technology Blueprint," the estimated hydrogen demand in Taiwan in 2050 will be approximately 4.06 million metric tons (with 3.15 million metric tons for power generation). However, more than 40 percent (approximately 1.71 million metric tons) of this demand is expected to be domestically produced (including blue and green hydrogen), while nearly 60 percent (approximately 2.35 million metric tons) will need to be imported. Therefore, the sources and import costs of hydrogen will significantly impact future energy costs of Taiwan. However, due to the characteristics of hydrogen, which is in gaseous form at normal temperatures and has low density, substantial energy consumption is required for compression, liquefaction, transportation, storage, and other processes.

Due to the extremely low energy density of hydrogen gas, presenting hydrogen in different carriers to increase density is a common solution. Large-volume pipelines are the most convenient way to transport hydrogen, but they require large-scale investment and often necessitate new infrastructure. Hydrogen tankers can be used for small-scale transport, but they are costly. Ships can be used for long-distance transportation, but costs are similarly high.

Unless pipelines can be used, transporting hydrogen in its gaseous form should be avoided as much as possible, and ideally, production should occur at or near the point of use. Additionally, if hydrogen is to play a significant role in driving a clean economy, an effective and economically viable method of storage must be found. International research indicates that if hydrogen storage is required for over a year, it is suitable to store hydrogen in depleted natural gas reservoirs, salt caverns, rock cavities, or convert it into ammonia, with storage in salt caverns being the least expensive option. If the storage period is only a few days, options like liquid hydrogen or compressed containers may be chosen.

Taiwan's hydrogen demand in 2050 is estimated to be approximately 4.06 million metric tons, with nearly 60 percent of it relying on imports. Due to the low energy density of hydrogen, the choice between importing or producing green and blue hydrogen and determining the type of carrier for international transportation deeply influences the future costs of hydrogen energy, electricity generation, and electricity prices domestically. Particularly, production costs constitute a significant portion of the overall hydrogen energy costs. Assuming that domestically-produced green hydrogen is generated through renewable energy, efforts need to be made to reduce the costs of renewable energy generation, enhance the efficiency of electrolysis cells, and make good use of surplus green electricity for hydrogen production.

Moreover, concerning domestic transportation, when it comes to transporting large quantities of hydrogen, using pipelines is the most cost-effective way to transport hydrogen, while trucks can be utilized for lower capacity transport but at a higher cost. Additionally, due to the physical properties of hydrogen, the storage cost of hydrogen will always be higher than that of natural gas. Storing an equivalent amount of energy in hydrogen requires three to four times the space of natural gas, and hydrogen liquefaction requires more energy. In cases where geological storage is not feasible, ammonia is the cheapest option. Given that Taiwan lacks geological formations like salt caverns or rock cavities found abroad, new storage facilities need to be established, or consideration should be given to storing hydrogen in the form of ammonia or other alternatives. However, further evaluation is needed on the potential storage quantity, storage technologies and hardware equipment, costs, etc., to facilitate the development of hydrogen energy domestically.