Report
by
Research Panel on Policy Recommendations for Expansion of Hydrogen Use

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Executive Summary: Policy Recommendations for Expansion of Hydrogen Use

Hydrogen is made from various resources including fossil fuels and renewable energy and has great supply potential globally. As for energy carriers for transporting hydrogen, numerous research and development and demonstration test projects have been implemented. In these projects, initiatives to improve transport efficiency and reduce costs will continuously be required to be enhanced. Regarding production of CO_2-free hydrogen from fossil fuels for massive supply, meanwhile, the important key will be the acceleration of initiatives to commercialize indispensable carbon capture and storage systems.

In order to expand hydrogen use, not only supply but also demand will have to be considered as a matter of course. To promote production and supply of hydrogen with enormous potential, hydrogen demand, which is now very limited, will have to be explored and expanded. Institutions to promote users' choice of CO_2-free hydrogen will have to be developed through the actualization of technological challenges and the environmental value of CO_2-free hydrogen. Following are recommendations for expanding hydrogen use on the supply and demand sides:

Toward building hydrogen supply chain

Given that hydrogen can be made from various resources, the use of power-to-gas technology for producing hydrogen from domestic renewable energy is also under consideration. However, it is reportedly difficult to secure a certain amount of hydrogen at low cost with the technology. Therefore, initiatives to import hydrogen from abroad are making progress toward massive, stable hydrogen supply. Given that there will be various hydrogen supply sources for Japan's imports, various options will have to be considered to develop a future path toward hydrogen imports.

Strategies by hydrogen supply source

Hydrogen use is significant for giving value to unused energy. While unused energy has not been effectively used because of its difficult transportation, such energy can be converted into hydrogen as a transportable, useful energy. At present, therefore, lignite (with CCS), associated gas (with CCS) and untapped renewable energy are seen as promising hydrogen sources. Their feasibility study and ongoing demonstration tests should be continued to materialize a CO_2-free hydrogen import chain reaching Japan.

From a long-term perspective beyond 2030, meanwhile, great constraints could be imposed on exports from countries producing fossil fuels in distribution at present in line with enhanced global CO_2 emission restrictions. Under such situation, using CCS for production and export of CO_2-free hydrogen from fossil fuels could become a new business model to effectively

utilize fossil fuel resources.

CO_2-free hydrogen using solar photovoltaics, wind, hydro and other renewables will also come into sight. However, the further reduction of renewable energy costs and the selection of favorable renewable energy locations will be required.

CCS commercialization

If fossil fuels that could allow massive hydrogen supply are used for producing hydrogen, CCS commercialization will be indispensable. In order to secure hydrogen's economic rationality, however, technological and institutional challenges involving CCS will have to be resolved.

To commercialize CCS, Japan will have to step up research and development efforts for cutting costs, develop systems for diffusing CCS, create a legal system for CCS development, grasp carbon storage potential and promote understanding about CCS. Particularly, a challenge that is as important as technological development for cutting costs is to unify different national standards and frameworks for establishing international CCS standards and an international CCS certification system. While overseas CCS projects as well as domestic CCS commercialization initiatives are expected to make progress, it is important to consider a mechanism to secure profit through standardization and technological development.

It is also significant to develop not only CCS but also CCU (carbon capture and utilization), with Japan positioned as the CCS research and demonstration base for overseas CCS and CCU expansion.

Resource diplomacy

If tough CO_2 emission restrictions lead to global constraints on oil and natural gas use, hydrogen production combined with CCS may become an economic lifeline for resource-rich countries.

Therefore, proposing a business model combining CCS and hydrogen production to resource-rich countries is worthy of consideration. As CCS commercialization alone is difficult at present, the expansion of enhanced oil recovery should be considered. Given Japan's excellent geological exploration and CO_2 monitoring technologies, Japan can cooperate with resource-rich countries in the EOR area. Over a long term, EOR cooperation could develop into a combination of CCS and hydrogen production.

Toward hydrogen demand expansion

The transport sector has taken the initiative in hydrogen consumption, with the power generation sector expected to consume massive hydrogen. It is necessary to consider creating hydrogen demand integrally and organically with hydrogen use in other sectors and inter-sectoral

collaboration taken into account. This will help mitigate burdens on a limited range of sectors.

Direction of sector-by-sector initiatives

Transport sector: There are many challenges for the penetration of fuel cell vehicles, including the rise of competitors such as electric and plug-in hybrid vehicles, and hydrogen refueling station development costs. As for FCVs, further efforts should be made to reduce costs and improve fuel efficiency. At the same time, ongoing hydrogen refueling station deregulation and technological development for cutting hydrogen station costs should be continuously enhanced.

If hydrogen refueling stations are used only for putting hydrogen into FCVs, these stations will be plagued with diseconomy resulting from low capacity utilization rates and hydrogen prices will fail to decrease. Then, a scheme to make hydrogen refueling stations energy supply bases for regionally distributed energy systems is conceivable. The scheme will have to be combined with initiatives to create regional hydrogen demand.

Another future challenge is to consider the penetration of FCVs for large long-range trucks for which FCVs are reportedly more suitable than EVs.

Buildings sector: To this end, hydrogen use in the buildings sector must be promoted. There are many challenges to tackle for the promotion, including the development of new infrastructure and terminal devices (pure hydrogen-using devices). However, a regionally distributed hydrogen town scheme can be conceived. It is conceivable to provide hydrogen towns with not only imported hydrogen but also hydrogen produced from regional renewable energy, sewer water and wastes. In regions where old infrastructure built in the 1960s is required to be renewed, infrastructure renewal opportunities could be used to introduce hydrogen infrastructure. In this respect, hydrogen refueling stations as regional hydrogen supply bases are worthy of consideration.

Mixing hydrogen into gas for city gas pipelines is dominantly viewed as inefficient on a cost-benefit basis. On the other hand, using pure hydrogen for medium- and low-pressure pipes is viewed as having no technological problem. However, technology verification and economic consideration for the whole of a network including high-pressure pipes and hydrogen-using devices are a challenge. Switching from city gas to hydrogen, though being one of the options to reduce carbon emissions in the city gas industry, should be prudently considered from a long-term viewpoint.

Industry sector: Meanwhile, the industry sector like the power generation sector is expected to consume massive hydrogen. If industrial facilities are concentrated in coastal zones, no large hydrogen pipelines may be required. Given these points, the industry sector can be expected to create hydrogen demand. However, there are industries that can use only natural gas or fuel oil. The applicability of hydrogen must be examined for each industry and each use. Detailed research is required into the applicability of hydrogen and hydrogen demand potential for each region and each industry. Research results will be useful for making a hydrogen supply plan. Particularly, industries located in coastal zones as well as the power generation sector will become massive hydrogen consumers and should be given priority for consideration.

Power generation sector: The power generation sector is expected to become the largest hydrogen consumer. As cheap and massive hydrogen supply is required for stable power supply, the sector's hydrogen demand is considered along with an imported hydrogen scheme. If massive hydrogen imports lead to lower hydrogen prices, it may have a spillover effect that may expand hydrogen demand in other sectors including transport.

As the basic direction of technological development for hydrogen power generation has been clarified, relevant challenges may apparently be resolved through the enhancement of technological development support. The power generation and industry sectors may use the same hydrogen combustion systems and could take advantage of technological development cooperation for cutting research and development costs.

Amid the progressing deregulation of the power market, however, potential hydrogen power generation entities cannot be identified due to uncertainties about stable hydrogen supply and costs. Given that hydrogen power generation will be used for CO_2-free regulated power supply, cost reduction measures should be considered along with a mechanism to give hydrogen power generation non-fossil value and the value of regulated power supply for stabilizing grids in line with the expansion of volatile renewable energy power generation, in order to encourage private sector business operators to choose hydrogen power generation.

Creating value of hydrogen use

In the above, we gave proposals for expanding hydrogen demand in each sector. At a time when hydrogen prices are high, hydrogen demand cannot be created or expanded despite the growing motivation to reduce CO_2 emissions. Who will choose hydrogen and what conditions will be required for the selection of hydrogen are still uncertain at present and should be considered in

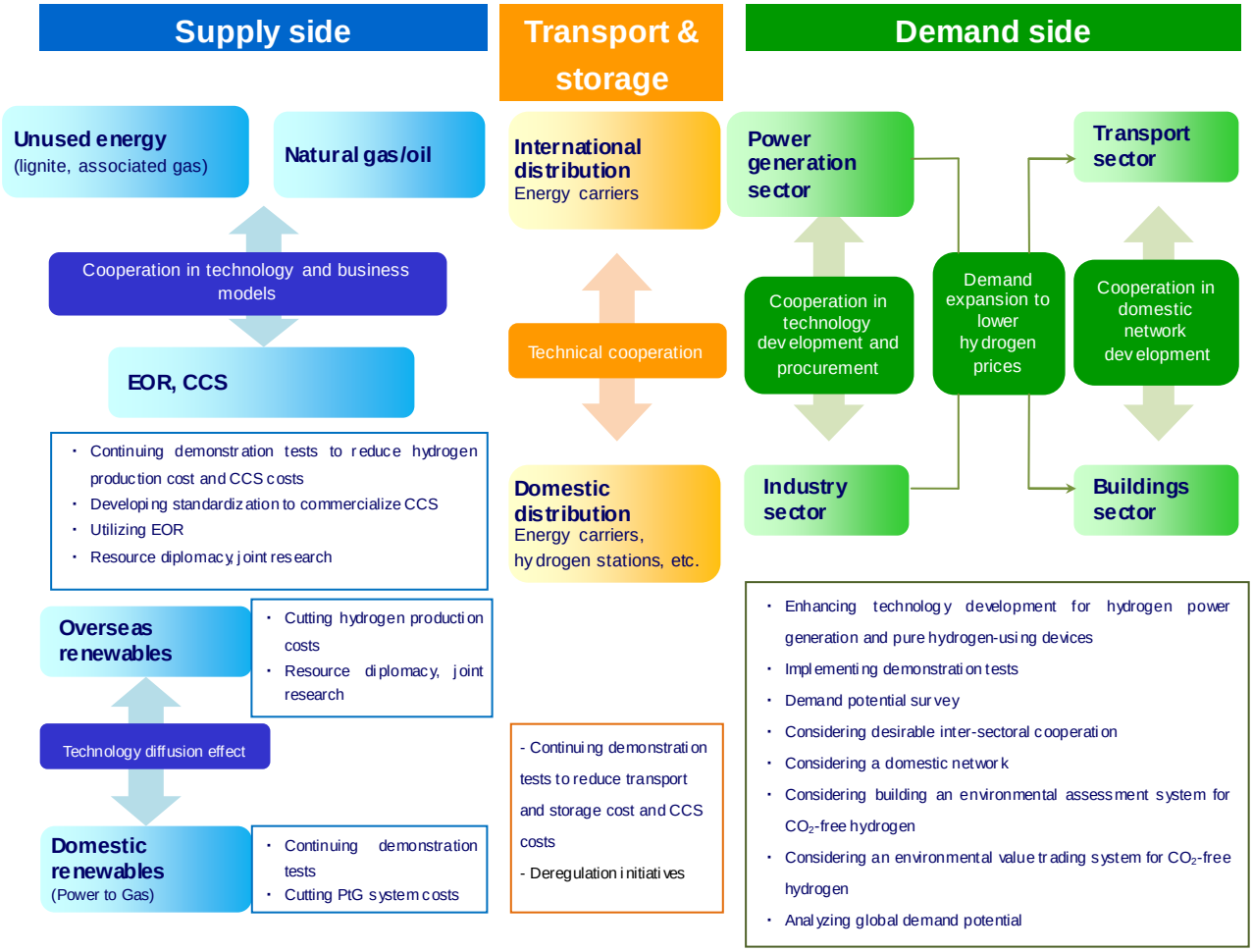
detail in the future.

This challenge may be resolved to some extent if a kind of green certificate mechanism is created to distribute hydrogen with environmental value added. To this end, Japan should build a certification system for the environmental value of hydrogen like the European CertiHy Project as early possible, instead of waiting until the realization of CO_2-free hydrogen imports. Calling for using low-carbon hydrogen instead of completely CO_2-free hydrogen could lead to creating and raising hydrogen demand.

Global hydrogen demand

Hydrogen demand in Japan alone may be limited. Research and analysis on potential hydrogen demand by region, by sector and by device must be conducted in pursuit of global hydrogen demand expansion. Japan's hydrogen-related technologies could be exported to countries and regions with great potential hydrogen demand. Particularly, the introduction of Japan's hydrogen-related technologies in promising hydrogen-exporting countries or regions will apparently contribute to developing a strategic resource diplomacy to obtain cheap and massive hydrogen in the future.

Relevant organizations in Japan should cooperate with the International Energy Agency, the World Hydrogen Energy Conference and other international organizations and enhance initiatives to internationally standardize hydrogen-related technologies.



Sector-by-sector measures to expand hydrogen demand