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JAPAN

The H₂ Handbook

Legal, Regulatory, Policy, and Commercial
Issues Impacting the Future of Hydrogen

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PART I - POLICY OVERVIEW

Japan, a net importer of energy with a self-sufficiency rate consistently around 6 to 7 percent¹ in the past several years, has begun to implement energy policies that focus on hydrogen.

While Japan quickly exhausted its limited carbon-based resources to generate power domestically, its reliance on imported fuels was exacerbated by the 2011 earthquake and resulting tsunami that triggered the Fukushima Daiichi nuclear disaster. The nuclear disaster eliminated one of the few reliable sources of power generated in Japan. Pre-earthquake, nuclear energy accounted for 30 percent of electricity generation in Japan, but the figure dropped to zero in the following years.²

Transportation represents 23.2 percent of Japan's energy consumption, with less than 5 percent of that total powered by the electrical grid and the remainder by fossil fuels.³

In these circumstances, Japan announced its fourth Strategic Energy Plan in 2014 to kick-start its move toward a “hydrogen-based society.”⁴ The announcement was followed by the “Basic Hydrogen Strategy” in 2017, which set forth both broad objectives and specific numerical targets to be met by 2030. This was the first government-backed hydrogen energy plan in the world, and similar initiatives by the European Union, France, and South Korea quickly followed.⁵ The Basic Hydrogen Strategy was formulated not only to reduce reliance on imported fossil fuels, but also to reduce greenhouse gas emissions as required by the Paris Agreement.

¹ Ministerial Council on Renewable Energy, Hydrogen and Related Issues, *Basic Hydrogen Strategy 5*, MINISTRY OF ECON., TRADE AND INDUS. (Dec. 26, 2017), https://www.meti.go.jp/english/press/2017/pdf/1226_003b.pdf.

² *Nuclear Power in Japan*, WORLD NUCLEAR ASS'N, (last updated March 2020), <https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/japan-nuclear-power.aspx>.

³ Agency for Nat. Resources and Energy, *Energy White Paper*, MINISTRY OF ECON., TRADE AND INDUS. (2019), https://www.enecho.meti.go.jp/about/whitepaper/2019pdf/whitepaper2019pdf_2_1.pdf.

⁴ Agency for Nat. Resources and Energy, *Strategic Energy Plan*, MINISTRY OF ECON., TRADE AND INDUS. (Apr. 2014), https://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf.

⁵ Hydrogen and Fuel Cell Strategy Council, *The Strategic Road Map for Hydrogen and Fuel Cells*, MINISTRY OF ECON., TRADE AND INDUS. (Mar. 12, 2019), https://www.meti.go.jp/english/press/2019/pdf/0312_002b.pdf.

Following are some of the targets set forth in the Basic Hydrogen Strategy:⁶

- Reduce the cost of hydrogen to 30 yen/Nm³ by 2030 and to 20 yen/Nm³ thereafter
- Develop a liquefied hydrogen supply chain for commercialization by 2030
- Establish and commercialize organic hydride after 2025
- Introduce CO₂-free ammonia by the mid-2020s
- Develop technology that reduces the unit cost of water electrolysis systems to 50,000 yen/kW by 2020
- Reduce the unit hydrogen power generation cost to 17 yen/kWh by 2030 (which requires procuring 300,000 tons of hydrogen annually)
- Increase the number of fuel cell vehicles (FCVs) to 40,000, 200,000, and 800,000 units by 2020, 2025, and 2030, respectively
- Increase the number of hydrogen stations to 160 by FY2020 and 320 by FY2025
- Increase the number of fuel cell buses to around 100 by FY2020 and to around 1,200 by FY2030
- Increase the number of fuel cell forklifts to around 500 by FY2020 and to around 10,000 by FY2030
- Lower the price of residential fuel cell systems to 800,000 yen for a

standard polymer electrolyte fuel cell and to 1 million yen for a standard solid-oxide fuel cell by FY2020

In 2019, Japan continued its hydrogen push by creating a strategic roadmap to reach its hydrogen goals. The roadmap includes four big-picture goals: (1) develop a hydrogen supply chain, (2) increase the use of hydrogen across different sectors, (3) promote technological innovation and public buy-in, and (4) promote international collaboration concerning hydrogen technology.

I. Hydrogen Supply Chain

In developing a low-cost hydrogen supply chain, the strategic roadmap mainly calls for the development of technology that will reduce hydrogen costs. It also focuses on building relationships with foreign governments to procure inexpensive overseas energy resources, transporting overseas hydrogen supply sources to Japan, and assessing hydrogen supply capabilities of domestic byproduct hydrogen and other unused resources.

The roadmap also calls for obtaining hydrogen supply through the use of cheap and abundant foreign resources. In November 2019, Japanese electricity generation and transmission company J-Power, in conjunction with Japanese and Australian government agencies, began construction of a hydrogen development project involving the gasification of brown coal in Victoria, Australia. Coal gasification

⁶ Ministerial Council on Renewable Energy, Hydrogen and Related Issues, *Basic Hydrogen Strategy* (Key Points), MINISTRY OF ECON., TRADE AND INDUS. (Dec. 26, 2017), https://www.meti.go.jp/english/press/2017/pdf/1226_003a.pdf.

produces synthesis gas (which consists of hydrogen and carbon monoxide) by reacting coal and oxygen. The carbon monoxide reacts with steam to produce carbon dioxide and more hydrogen. The hydrogen is separated for electricity generation, while the carbon dioxide is captured and stored to prevent emission into the atmosphere.⁷

In May 2020, a group of Japanese companies, with support from the Japanese and Brunei governments, created the world's first international hydrogen supply chain.⁸ In that project, hydrogen produced in Brunei is bound to a liquid organic hydrogen carrier (usually a petrochemical) and shipped in liquid form to Japan, where it is dehydrogenated in a reactor and mixed with natural gas to generate electricity. Domestically, a group of Japanese companies, with support from the government, completed the construction of a hydrogen production facility in Fukushima that utilizes power-to-gas technology (electricity generated by renewable energy stored as hydrogen).⁹ The facility was completed in February 2020, and the hydrogen will be distributed for use in Fukushima, Tokyo, and other regions.

II. Hydrogen Utilization

In order to reduce the 23.2 percent of Japan's CO₂ emissions that emanate from the transportation sector, Japan is encouraging the development and use of hydrogen-based FCVs for both personal and commercial use.¹⁰ As of December 2018, approximately 3,000 FCVs were registered in Japan, and the aim is to increase the number to 800,000 by 2030. Efforts will be made to reduce the price differential between FCVs and electrical vehicles or hybrid electric vehicles. Also, new types of FCVs such as SUVs and minivans will be introduced by 2025. Japan also aims to increase its network of hydrogen refueling stations by building 320 stations by FY2025.

Further, Japan will expand the use of fuel cell technology in other areas, such as for household and industrial purposes. Ene-farm is Japan's prevailing household fuel cell system, with around 274,000 units in use as of January 2019. Japan aims to increase its use to 5.3 million units by 2030 by reducing construction and installation costs. While Japan's large-scale push for hydrogen is a relatively recent phenomenon, Japan has devoted a considerable amount of resources to fuel cell technology since the start of the century. From 2003 to 2015, Japan

⁷ Office of Energy Efficiency & Renewable Energy, Hydrogen and Fuel Cell Technologies Office, *Hydrogen Production: Coal Gasification*, U.S. DEP'T OF ENERGY, <https://www.energy.gov/eere/fuelcells/hydrogen-production-coal-gasification> (last visited Aug. 1, 2020).

⁸ *The World's First International Hydrogen Supply Chain realised between Brunei and Japan*, MINISTRY OF ENERGY (May 5, 2020), <http://www.memi.gov.bn/Lists/News/NewDispForm.aspx?ID=214>.

⁹ *The world's largest-class hydrogen production, Fukushima Hydrogen Energy Research Field (FH2R) now is completed at Namie town in Fukushima*, TOSHIBA ENERGY SYS. AND SOLUTIONS CORP., (Mar. 7, 2020), https://www.toshiba-energy.com/en/info/info2020_0307.htm.

¹⁰ See Ministerial Council on Renewable Energy, Hydrogen and Related Issues, *supra* note 1, at 31-32.

spent a total of US\$12.3 billion on fuel cell research and development (R&D), of which US\$4.1 billion was government funded and the rest funded by corporations (mostly automakers¹¹). In the same period, the EU's total fuel cell R&D spending was US\$5.7 billion (of which US\$1.9 billion was state-funded), and the United States spent a total of US\$3.8 billion (of which US\$1.9 billion was state-funded).

III. Technological Innovation and Public Buy-in

In a June 2018 meeting, the Japanese cabinet called for collaboration among industry, academia, and government in developing technology related to the production, transportation, storage, and use of hydrogen. With regard to hydrogen production, Japan will conduct research on highly efficient water electrolysis, artificial photosynthesis, and high-temperature water vapor electrolysis. There also will be research on energy sources that are currently not used in hydrogen production. For transportation and storage, Japan will work to develop efficient hydrogen liquefiers, as well as low-cost energy carriers. For hydrogen use, the emphasis will be on fuel cell technology with a specific focus on the development of solid oxide electrolysis cells that can operate efficiently even at temperatures below the current 700-1000°C range,¹² as well as fuel cells

that can operate without the use of rare metals as catalysts.

In addition to the development of new technology, Japan will try to promote public awareness and the use of hydrogen energy. Demonstrations during global events like the Tokyo Olympics, Paralympics, and EXPO 2025 in Osaka are one of the ways in which awareness may be increased.

The government has previously created incentives to purchase hydrogen-powered technology through subsidies. In 2015, the government offered a US\$25,000 subsidy to buyers of the hydrogen-fueled 2016 Toyota Mirai, which was priced at US\$68,000 before incentives. A variety of incentives also are available for users of a range of residential fuel cells. The Japanese government granted over US\$80 million in subsidies for purchases of residential fuel cells in FY2018. Local governments also have granted subsidies for the installation of residential fuel cells with the Tokyo Metropolitan Government, offering to cover up to one-fifth of the equipment cost.

IV. International Collaboration

In addition to developing the hydrogen market locally, Japan is looking to expand its technology globally and create a new growth industry. Japan has led international discussions on the use of

¹¹ Noriko Behling, Mark C. Williams, & Shunsuke Managi, *Fuel cells and the hydrogen revolution: Analysis of a strategic plan in Japan*, 48(C) ECON. ANALYSIS AND POLICY 204-21 (2015).

¹² Solid Oxide Electrolysis Cells, TECHNICAL U. OF DEN. DEPT OF ENERGY CONVERSION AND STORAGE (last updated Jan. 31, 2019), [https://www.energy.dtu.dk/english/Research/Electrolysis-Cells/Solid-Oxide-Electrolysis-Cells#:~:text=A%20Solid%20oxide%20Electrolysis%20Cell,makes%20the%20efficiency%20very%20high.&text=An%20SOEC%20can%20also%20electrolyze,to%20carbon%20monoxide%20\(CO\).](https://www.energy.dtu.dk/english/Research/Electrolysis-Cells/Solid-Oxide-Electrolysis-Cells#:~:text=A%20Solid%20oxide%20Electrolysis%20Cell,makes%20the%20efficiency%20very%20high.&text=An%20SOEC%20can%20also%20electrolyze,to%20carbon%20monoxide%20(CO).)

hydrogen by hosting the first Hydrogen Energy Ministerial Meeting in 2018 and the second in 2019. Japan has cemented its status as a leader in hydrogen growth through a consistent focus on hydrogen policy, regardless of changes in administration.



PART II - REGULATIONS

The High Pressure Gas Safety Act (Act) regulates all activities related to the handling of high-pressure gas including production, storage, and transportation.¹³ The Ministry of Economy, Trade, and Industry (METI) administers the Act, which is especially relevant to Hydrogen Refueling Stations (HRSs).

The Act classifies hydrogen as a type-2 gas. If a manufacturer's daily hydrogen production capacity exceeds 100Nm³, the manufacturer is treated as if it were producing a type-1 gas (such as helium or carbon dioxide) and therefore must obtain prior approval from the prefectural governor to produce hydrogen. If a manufacturer's daily hydrogen production capacity is less than 100Nm³, approval is not required, but the manufacturer must still notify the prefectural governor of its hydrogen production. Similar reporting and approval requirements exist for the storage of hydrogen, where a daily hydrogen storage capacity of over 1000Nm³ requires approval from the governor, a capacity of 300-1000Nm³

requires notification but no approval, and a capacity of less than 300Nm³ requires neither approval nor notification.¹⁴

The Act also requires HRSs to dedicate a minimum eight meter distance between a hydrogen fuel dispenser and a public road, between a high-pressure gas facility and any flammable substance, and between a high-pressure gas facility and the property boundary of the HRS.¹⁵ The minimum distance is reduced to six meters if the pressure of the dispenser is less than 40MPa. The higher land cost resulting from this regulation may be problematic in urban areas where land prices are high.

Another regulatory limitation is that ordinary drivers are prohibited from self-refueling hydrogen fueled vehicles. This means that each hydrogen refueling station must employ licensed specialists to be available throughout the day, significantly increasing the day-to-day cost of operating an HRS as compared with a traditional gasoline station. Under the Act, an ordinary HRS requires one certified supervisor to oversee operations while an HRS with hydrogen shipping capabilities

¹³ HIGH PRESSURE GAS SAFETY ACT, Act No. 204 of 1951, Art. 1 (Japan).

¹⁴ *Report on the Hydrogen Supply Chain*, MINISTRY OF THE ENV'T (March 2020), https://www.env.go.jp/seisaku/list/ondanka_saisei/lowcarbon-h2-sc/support-tool/PDF_Excel/support-tool_report_202003_2.pdf.

¹⁵ GENERAL HIGH PRESSURE GAS SAFETY ORDINANCE, Art.7.3.2 (Japan).

requires at least three supervisors. While these regulations are restrictive, the Act was amended in February 2020 to broaden the definition of a certified supervisor, hinting at more liberal HRS regulations to come in the future. Prior to the amendment, certification was conditioned on prior experience in the production of pressurized or liquefied hydrogen, but it now treats experience in the production of pressurized or liquefied natural gas as sufficient, provided that the supervisor undertakes six months of training specific to HRSs.¹⁶

The Act also applies to the manufacturing, sales, and use of drones powered by hydrogen fuel cells. The Act provides that “companies should not engage in any reckless handling of tanks of high pressure gas in order to not drop or have such tanks fall resulting in causing any impacts on the tanks or damages to valves thereof.” Drones that fly above a predetermined altitude have a significant risk of falling and being “recklessly handled.” Companies that manufacture and sell such drones are required to obtain special approval from the METI Minister. In April 2020, METI released guidelines to help drone manufacturers, sellers, and users comply with these approval requirements and the Act itself. The guidelines call for manufacturers to secure the safety of hydrogen tanks if a

drone were to fall during flight. Possible solutions proposed in the guidelines include the installation of a protective device such as an airbag around the drone or a parachute.¹⁷ The guidelines also call for hydrogen storage tanks made for drones to be stored in a location with adequate airflow and to be maintained below 40°C.¹⁸

The Building Standards Law, regulated by the Ministry of Land, Infrastructure, Transport, and Tourism, allocates land based upon designation of “use districts,” such as those reserved for solely residential or industrial use. Within these districts, the Building Standards Law specifies an upper limit on the amount of hydrogen that can be stored. Under the current law, there are no limits for storing hydrogen in purely industrial areas, but residential districts are subject to strict limits that may be problematic in building HRSs in urban areas. The current law limits hydrogen storage to 3500Nm³ in “semi-industrial” districts, 700Nm³ in commercial districts, and 350Nm³ in some residential districts, and imposes an absolute ban in other residential districts.¹⁹ A related law is the Noise Regulation Act, which requires enumerated producers of excessive noise to report to the relevant local authority before production. Hydrogen producers may be subject to the Act if the producer

¹⁶ *Amendments to the High Pressure Gas Safety Act*, MINISTRY OF ECON., TRADE AND INDUS., (Feb. 28 2020), https://www.meti.go.jp/policy/safety_security/industrial_safety/sangyo/hipregas/files/20200228_3.pdf.

¹⁷ *Guidelines for Safe Use of High Pressure Gas in Drones Driven by Hydrogen Fuel Cells*, MINISTRY OF ECON., TRADE AND INDUS., (Apr. 10 2020), <https://www.meti.go.jp/press/2020/04/20200410002/20200410002-2.pdf>.

¹⁸ *Guidelines for Safe Use of High Pressure Gas in Drones Driven by Hydrogen Fuel Cells*, MINISTRY OF ECON., TRADE AND INDUS., (Apr. 10 2020), https://www.meti.go.jp/english/press/2020/0410_001.html.

¹⁹ Building Standards Law Enforcement Order, Art.130.9, *Hydrogen standards*, laws, and guidelines, ENG'G ASS'N OF JAPAN, <https://www.ena.or.jp/WE-NET/rule/ht/syohi.html> (last visited Sept. 4, 2020).

employs air compressors or ventilators that have a prime mover with a drive power of over 7.5 kW. Similar to the Building Standards Law, local regulations generally designate a permissible level of noise pollution based on use districts. For example, the city of Yokohama restricts noise levels in industrial districts to 70 decibels from 8am-6pm, 65 decibels from 6am-8am and 6pm-11pm, and 55 decibels from 11pm-6am.²⁰

The Fire Service Act, regulated by the Fire and Disaster Management Agency, regulates gasoline stations that also have hydrogen refueling facilities. The ability to add hydrogen refueling facilities to existing gasoline stations will be a major positive factor in facilitating the large-scale commercialization of hydrogen.

The Fire Service Act limits the ability of gasoline station operators to add an HRS, as hydrogen stands must be located some distance away from the gasoline pumps. Moreover, the presence of a hydrogen pump limits the volume of gasoline and kerosene that can be stored, which may require larger storage tanks to be replaced, thus limiting the commercial viability of co-location.

The Road Act of Japan prohibits large trucks carrying more than a specified amount of pressurized material through tunnels.²¹ This will constrain road transport, as Japan has thousands of kilometers of tunnels on key arteries in both urban areas and the mountainous areas between them.

²⁰ See MINISTRY OF THE ENV'T, *supra* note 14.

²¹ ROAD ACT OF JAPAN, Art. 46 (Japan).

GLOSSARY JAPAN

FCV	fuel cell vehicle
HRS	Hydrogen Refueling Station
METI	Ministry of Economy, Trade, and Industry
R&D	research and development

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We would like to acknowledge the extensive contributions of our 2020 summer associate, Yoshihito Tada, in the preparation of this portion of *The Hydrogen Handbook*.

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