Measures for the development of hydrogen stations for fuel cell vehicles (FCV)

◎ Yuichiro Yamaguchi, Yuto Yasukochi, Yasuhiko Urabe, Ichiro Muranaka, Hiroshi Fujiki, Masashi Hayamizu*, Yoshinori Shirasaki*

R&D Department, The Japan Gas Association (JGA)

*: former affiliation

1. Introduction

In the Kyoto Protocol, Japan promised the international community that it would reduce its greenhouse gas emissions by 6% (from 1990 levels) between 2008 and 2012. Through the promotion and introduction of high efficiency devices, an increase in the absorption of greenhouse gases by forests, and the purchase of emission credits from abroad, Japan is expected to achieve its goal of a 6% reduction. However, following the Great East Japan Earthquake in 2011, the Prime Minister of Japan requested a reexamination of the country's 2020 medium term target (a 25% reduction with preconditions). With this as background, it is important that Japan pushes forward with the cooperative efforts of all countries in the world for the reduction of greenhouse gas emissions to meet the legal framework scheduled to be enacted and executed in 2020. Japan's industrial sector accounts for approximately 27% of the country's total CO2 emissions. Through the promotion and expansion of environment-friendly natural gas[1)] usage and cogeneration, the gas industry of Japan contributes to this sector in energy conservation and CO2 reductions.

Alternatively, CO2 emissions in the transport sector account for approximately 20% of the country's total CO2 emissions, with automobiles accounting for 88.1% of this number, or 17.1% of Japan's total CO2 emissions. Since the transport sector accounts for the 2nd largest share of greenhouse gas emissions next to the industrial sector, it is important for the country to develop measures for reductions in this area. Hydrogen, renowned as a clean energy, is expected to assume a key role in the transport sector as it does not emit CO2 when burned. In supplying compressed hydrogen for the filling of fuel cell vehicles (FCV), the ultimate form of clean cars, hydrogen stations provide an indispensable supply infrastructure. In this article, we report on the latest measures for the development of hydrogen stations for fuel cell vehicles.

2. Movements concerning fuel cell vehicles and hydrogen supplying infrastructure development

In March 2010, based on a July 4, 2008 press release, the Commercialization Scenario for Fuel Cell Vehicles and Hydrogen Stations (Figure 1) was presented at the Fuel Cell Commercialization Conference of Japan (FCCJ). In this report, the FCCJ stipulated that it would continue to study more specific development scenarios for the introduction and popularization of FCVs and hydrogen stations.

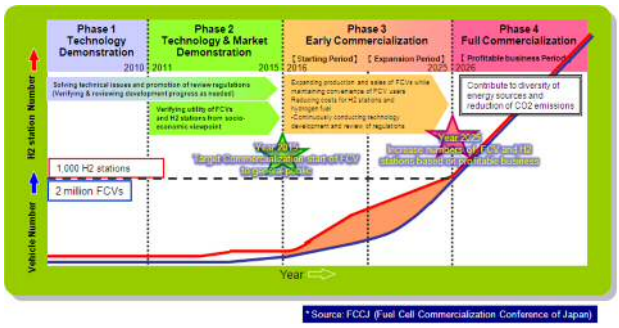
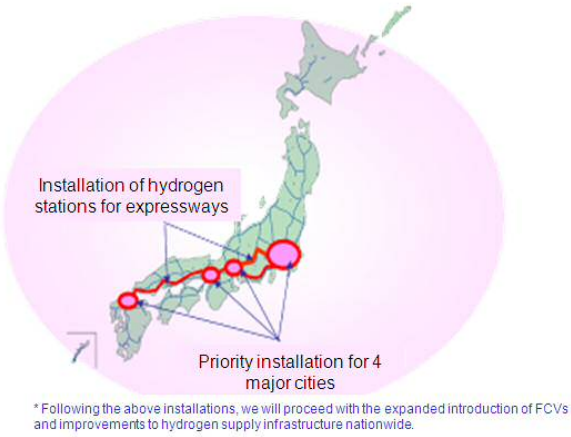


Figure 1: FCCJ's scenario announced in March 2010

Additionally, on January 13, 2011, 13 private companies including automobile manufacturers, oil companies, city gas companies, and industrial gas companies, announced a press release entitled: Joint statement by private companies concerning the introduction of fuel cell vehicles onto the domestic market and the development of hydrogen supply infrastructure. At the same time, in response to this release, the Ministry of Economy, Trade and Industry (METI), Chubu Bureau of Economy, Trade and Industry, Osaka Prefecture, and Fukuoka Prefecture also announced their own plans for their efforts concerning this issue.



Private Companies

Automobile: Toyota Motor Corporation, Nissan Motor Co., Ltd., Honda Motor Co., Ltd.

Oil: JX Nippon Oil & Energy Corporation, Idemitsu Kosan Co., Ltd., Showa Shell Sekiyu K. K., Cosmo Oil Co., Ltd.

City Gas: Tokyo Gas Co., Ltd., Osaka Gas Co., Ltd., Toho Gas Co., Ltd., Saibu Gas Co., Ltd.

Industrial gas companies: Iwatani Corporation, Taiyo Nippon Sanso Corporation

3. Supply systems for hydrogen stations

Hydrogen stations supplying hydrogen are comprised of two kinds: on-site stations and off-site stations. City gas industry is primarily concerned with on-site stations and the generation of hydrogen from city gas, the compression and accumulation of gas with compressors, and the supply of hydrogen to fuel cell vehicles through dispensers.

Alternatively, off-site stations transfer hydrogen generated by other locations, and supply that hydrogen to hydrogen stations with compressors, storage cylinders, and dispensers.

To date, city gas companies have developed and experimented with equipment to manufacture hydrogen from natural gas.[2), 3)] For the future, while giving due consideration to the introduction of hydrogen stations, the development of larger capacity hydrogen production equipment will be necessary.

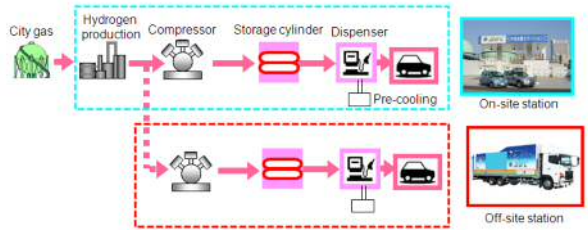


Figure 2:
The two types of supply systems for hydrogen stations

4. A comparison of hydrogen stations in Japan and abroad

Developments to hydrogen stations are necessary for the introduction of fuel cell vehicles. Currently, developments to hydrogen stations are planned in four metropolitan areas of Japan. However, costs associated with hydrogen stations in Japan remain high, and the use of overseas products would require that they be converted for use in Japan. Consequently, including the cost of conversion, the estimated cost of such products will presumably amount to two or three times their original price. While overseas products can utilize low-cost chrome molybdenum steel in their construction, according to Japanese domestic standards, in Japan, stainless steel must be used for all compressors and aluminum liners for all storage cylinders.

Table 1: Examples of station differences between Europe, the US, and Japan [4)]

Equipment	Overseas specifications	Required specification changes for introduction in Japan
Compressors	Chrome molybdenum steel	Stainless steel
Storage cylinders	Chrome molybdenum steel	Aluminum liner
Pre-coolers	Compact solid type	Gas-liquid heat exchange
Piping materials etc.	European specifications	Steel materials, domestically approved explosion-proof equipment, etc.
Packaging	Stored in 10 ft containers	Stored in 20 ft containers

5. Regulations concerning fuel cell vehicles and hydrogen infrastructure development

Facility development for hydrogen infrastructure are part of a relatively new field, and if high-cost structures and regulatory, institutional, and other constraints are to remain unchanged in the future, they will prove to be major obstacles for commercialization. For this reason, city gas companies and the Japan Gas Association (JGA) are working with related organizations for the relaxation of regulations.

In December 2010, the government ministries and agencies concerned reviewed each of the major regulations for hydrogen infrastructure, and progress schedules for 16 items were announced so that the necessary revisions to ministerial ordinances could be conducted for the development of hydrogen infrastructure. Furthermore, for the expanded introduction of hydrogen infrastructure in the future, the following 8 items were added as items in need of further regulation and reform (Table 2).

Table 2: Additional requested items

(1) Review of the upper temperature limit for containers for hydrogen transport trailers (40°C ⇒ 85°C)
(2) Standards for the approval of installation of hydrogen stands in controlled urban areas
(3) Review of the regulations and standards for hydrogen stands providing liquefied hydrogen
(4) Review of the standards concerning small-scale hydrogen filling equipment which can be installed in urban areas
(5) A definition for boosters with water electrolysis functions
(6) Expansion of the performance standards for the steel materials which can be used
(7) Review of the technical and exemplification standards for 70MPa hydrogen stands ① Streamlining of safety distances for refrigeration facilities with pre-coolers ② Usage of storage cylinders with compound containers
(8) Increases in hydrogen stock in urban areas

((1) - (6): new; (7) and (8): follow-up)

In April 2013, a study was conducted regarding international benchmark tests at the Council for the Promotion of Regulatory Reform. International benchmark tests inspect 1) the necessity and rationale for each regulation in comparison to international regulations; 2) the rationale requested by the Council for the Promotion of Regulatory Reform of competent authorities for the need for new regulations, based on international regulations, and 3) the necessary requests of the Council for competent authorities to review a given regulation. For cabinet approval in June of this year, the Cabinet Office will work together with competent authorities to complete the final selection of, and negotiations pertaining to, regulations to be investigated for the international benchmark tests.

6. Future efforts

The Japan Gas Association (JGA) will continue to work together with related organizations in order to promote technical developments and the easing of regulations related to hydrogen stations, and to contribute to the establishment of a hydrogen society for the future.

References:

1) IEA: Natural Gas Prospect to 2010
2) Furuta, Fukuchi, and Nishio: City Gas Symposium summary, P-2 (2012)
3) Asakura, T. Tanaka, Y. Tanaka, and Azuma: The Japan Society of Mechanical Engineers, Kansai Branch, Collected papers for Regular Meeting's lectures, Vol. 80, P31 (2005)
4) Cabinet Office, Council for the Promotion of Regulatory Reform, materials from the 1st energy and environment working group in 2013 (Fuel Cell Commercialization Conference of Japan (FCCJ))