THE LATEST NEWS NUMBER 255, 2017 FCDIC

Charging & Discharging Program in Yamanashi with Longest Hours of Daylight

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1. Governmental Measure

(1) METI

On December 22nd, the Cabinet of Japan approved the budget bill for FY2017. The Ministry of Economy, Trade and Industry, (METI) secured a total of ¥1,336.6 billion, a 1.2% increase of that of the initial budget for FY2016. The amount consists of ¥342 billion, a 1.5% increase, for the general account and ¥994.6 billion, a 1.2% increase, for the others including the special account of energy measures. The subsidy for "clean energy vehicles" including fuel cell vehicles (FCVs) and clean diesel cars takes ¥12.3 billion, a 10.2% decrease of that of the initial budget for FY2016. The subsidy for infrastructure of electric vehicles (EVs) and plug-in hybrid vehicles (PHVs) is ¥1.8 billion, a 28% decrease. The subsidy for hydrogen refueling stations for FCVs takes ¥4.5 billion, a 27.4% decrease. (Nikkan Jidosha Shimbun, December 24, 2016)

(2) AIST & Kyushu University

On December 11th, the National Institute of Advanced Industrial Science and Technology (AIST) announced that AIST-Kyushu University Hydrogen Materials Laboratory (HydroMate), in Kyushu University was set up to develop a material which is to becomes less brittle by diffusion of hydrogen. This institute will carry out fundamental research aiming to understand the phenomenon that hydrogen embrittlement occurs in materials used for hydrogen refueling stations and FCVs and for new materials. Furthermore, they will build a network to connect industry, academia and government to hand over study results to the private sectors in order to lead to commercialization of highly reliable materials for hydrogen infrastructure at low cost. Kyushu University has a world-class technology to evaluate material strength in high pressure hydrogen, and so does AIST in evaluation and observation of materials in hydrogen. Being located on the university's Ito campus, the laboratory will fuse the expertize of both organizations to analyze the effects of hydrogen on the strength and composition of materials including high purity steel at nano-, meso- and macro- levels in order to elucidate the mechanism of fracture by hydrogen embrittlement. (The Chemical Daily, January 12, 2017; Dempa Shimbun, January 18, 2017)

2. Local Governmental Measures

(1) Tokyo

Tokyo will introduce fuel cell (FC) buses into its public transport operation by March 2017. Two FC buses will be used for the route of the coastal area to start with, and the number is planned to be increased to five by FY2017. The bureau of transportation of Tokyo will use FC buses first as an environmentally-friendly transport mean to encourage the private operators to use these buses. According to the local government, this is the first actual transport operation of FC buses in Japan except testing operations. FCVs have FCs which generate electricity using hydrogen, and drive on motors. Because these cars produce no CO_2 during driving, they are considered ultimate eco cars. The local government will use a hydrogen refueling station of a private operator.

A FC bus sells for a high price of ¥100 million, which stops private bus operators using these vehicles. The first two FC buses will be leased to the Tokyo Metropolitan Government. For the 2020 Tokyo Olympics and Paralympics, the bureau of transportation plans to introduce 80 FC buses by FY2021. Public transport is increasingly in demand in the coastal area, and the local government is trying to solve this issue as fast as possible for the Olympics. As well as the expansion of the route, they also plan to set up a new branch of transport. (The Nikkei, December 14, 2016)

(2) Tohoku Economic Federation

The Tohoku Economic Federation will set up a general incorporated foundation to construct and operate "Synchrotron Light in Tohoku, Japan (SLiT-J) by March 2017, and ask businesses for financial assistance of the construction in return for priority of use. The existing synchrotron radiation facilities such as SPring-8 in Sayo-cho, Hyogo Prefecture, have been increasingly used by industries for eco tires and FC development, and it is becoming difficult take all the requests. An expert committee of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is examining whether to approve the construct of SLiT-J or not, and SLiT-J will aim to start operation in 2020.

"Synchrotron Radiation Innovation Center", provisional, is to be launched as a general incorporated foundation, and its officers are planned to be chosen from industry and academia. About ¥15 billion, out of about ¥30 billion of total estimated construction costs, is planned to be funded by businesses, and the rest is planned to be funded by governmental bodies. A single unit of private contribution is ¥50 million, which comes with priority to use the facility. This right is planned to last for 10 years after the completion of the facility, and single unit of contribution is to give maximum 200 hours of use.

This facility concept was proposed by seven national universities including Tohoku University and Yamagata University. The facility is to have a ring accelerator of 354 m circuit which is smaller than 1,400 m of SPring-8. This compact design is an advantage. The accelerating energy is 3 billion electronvolts and the facility can produce 100 times more brilliant beams than SPring-8 in the soft X-ray region at a tenth the energy, which offers energy saving operation. The fee is also to be half of that of SPring-8. The potential locations are Marumori-cho, Osato-cho and Matsushima-cho. The facility is to visualize structures and properties of materials at a nano-level by using synchrotron radiation. SPring-8 is the largest synchrotron radiation facility in Japan, and already 20 years has passed since its construction. The facility now has some drawbacks over the latest facilities abroad. It is also used by over 180 businesses. Because booking is sometimes required a few months in advance, the academia and industry are enthusiastically requesting a new facility. (The Nikkan Kogyo Shimbun, December 14, 2016)

(3) Ishinomaki, Miyagi Prefecture

On December 10th, Miyagi Prefecture held a test driving event of FCVs for the general public in Ishinomaki City. Two vehicles of Toyota's "MIRAI" and one vehicle of Honda's "CLARITY FUEL CELL" all owned by the prefecture were brought there for the public to experience FCV driving and operation. This is the fifth event, and had 43 parties mainly residents of Ishinomaki City or neighboring areas. The participants drove about 5 km in 15 minutes. The series of event started in FY2016 to let residents become more familiar with "hydrogen", and events were held in Sendai City, Osaki-cho, Rifu-cho and Ogawara-machi. "The FCV has the same performance to gasoline cars. However, it is too expensive to buy unless the price comes down to the level of hybrid cars." says one of the participants who found an advert for the event in a newspaper. The prefecture intends to continue this promotion. (Nikkan Jidosha Shimbun, December 16, 2016)

(4) Miyagi Prefecture

Miyagi Prefecture compiled "Miyagi Promotion Vision of Hydrogen Energy Use" for next five to 10 years in June 2015, and it shows the three keys of "well-prepared cities/towns for disasters", "community giving less impact to the environment" and "use and growth of related industries". The local government promotes FCV as one of the keys, and has held event to offer test driving in the prefecture. They currently own two vehicles of Toyota's "MIRAI" and one of Honda's "CLARITY FUEL CELL". The number of official FCVs will be increased to five by adding two of CLARITY FUEL CELL in 2017. "Smart Hydrogen Station" jointly developed by Iwatani and Honda is already installed in the prefecture exclusively for these FCVs. "Iwatani Hydrogen Station Sendai" will be ready for operation in Miyagino-ku, Sendai City, in February 2017. This is open to the public, which helps FCVs to be fully used in the prefecture. Being a center of the Tohoku region, Sendai can work as a hub for FCV drivers from other areas to travel to other Tohoku prefectures easier by opening a hydrogen filling facility. Miyagi Prefecture will prepare its own subsidy of about ¥1 million. The subsidy is the same level as Tokyo or Kanagawa where more FCVs are used, and will be on top of the governmental subsidy as the prefecture's own promotion of purchase for fast FCV growth. The prefecture has been committed to promoting hydrogen as next generation energy due to the Great East Japan Earthquake. (Nikkan Jidosha Shimbun, December 26, 2016)

(5) Yamanashi Prefecture

Yamanashi Prefecture along with another organization increased the output of Komekurayama Solar Power Plant in Kofu City by 1 MW in 2014 taking an advantage of the longest hours of daylight in Japan. They are enthusiastically inviting FC related human resources and facilities to be a "FC valley", and also support development of power storage technologies to promote renewable energy use. "This facility allows experiments using a large-scale solar power plant. Also, it is difficult to find facilities to hire for experiment." says the Electric Power Generation Division of the prefectural Public Enterprise Bureau, and this explains the background of laboratory to have been set up by business there. The aim of the prefecture is "to develop a wide communication between major manufacturers and firms and businesses in the prefecture through research to build a supply chain". Power output fluctuation can be moderated by equipment to store electricity when power generation increases or to discharge electricity when power production decrease due to a sudden weather change.

As a power storage, a group is developing flywheel energy storage using superconducting magnetic bearings without friction, and these bearings are used in a maglev train of the Railway Technical Research Institute (RTRI). As advantages, a capacity of flywheel energy storage can be set to a designated scale, and it does not reduced by repeated charging and discharging. It also does not produce hazardous waste. Another power storage system is an improved nickel–metal hydride battery of Exergy Power Systems, a venture of the University of Tokyo, and it can charge and discharge power fast. These secondary cells can quickly charge or discharge electricity to accommodate fluctuated solar power production, and have better durability and radiating performance than conventional cells. Excess power from solar panels and small-scale hydropower generation are converted into hydrogen by water electrolysis equipment developed by Kobelco Eco-Solutions for storage. When electricity is needed, produced hydrogen is supplied to FCs to generate electricity. Panasonic expects a hydrogen supply system to be prepared for home use, and is testing pure hydrogen FCs to be possibly used for ENE-FARM.

The major issue is how to control fluctuated power output for a larger amount of renewable energy use. To solve this issue, the technologies draw attention to converting energy into another form temporally for storage. Bloomberg New Energy Finance estimates the power storage capacity in Japan to increase from 847 MW for 2016 to 7,440 MW by 2024 leveling with the US. Komekurayama Solar Power Plant has a facility to output 10 MW jointly built by the prefecture and Tokyo Electric Power Company Holdings (TEPCO). TEPCO, Toray, Takaoka Toko and the prefecture plan joint technological development and usage tests. This project is selected as a contract of the New Energy and Industrial Technology Development Organization (NEDO). (Fuji Sankei Business i, January 3, 2017)

3. FC Element Technology Development & Business Plan

(1) Shinshu University

A team of Prof. Wataru Sugimoto at Shinshu University has developed a new technology to reduce the amount of platinum used as a catalyst of FCs to tenth or less. The technology uses a catalyst material containing ruthenium, a rare metal, which has improved reaction activity by increased surface area. It can reduce the amount of platinum use, and also improve the durability of the platinum catalyst. A reduction in expensive platinum can lead to a significant price cut of FCs. Shinshu University prioritizes scientific study to improve performance, and will carry out further research for commercialization. FCs for automobiles and ENE-FARM require a large amount of platinum, which is a major factor to stop these products being widely used. The paper was published on website of a Dutch Journal specialized in catalysts. (The Nikkei Business Daily, December 21, 2016)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) Toshiba

On December 19th, Toshiba announced that Tohoku-Electric Power Co. has placed an order for "H_2One", an energy system to produce hydrogen using renewable energy. The electricity provider will use the system for research on hydrogen energy use to control renewable energy of which the output changes sharply depending on weather. This is the forth order for the system for Toshiba. The system will be delivered to the energy provider in March 2017. It produces hydrogen by electrolysis equipment operating on electricity generated by solar power. Hydrogen is stored in a tank, and sent to FCs to generate electricity as needed. The energy provider will set up a research and development center in Aoba-ku, Sendai City, and investigate hydrogen as a possible mean to absorb output fluctuations of renewable energy. (The Nikkan Kogyo Shimbun, December 20, 2016)

(2) Hitachi Zosen

Hitachi Zosen is proposing Power-to-Gas (P2G) systems to store and distribute methane produced from hydrogen which has been made using renewable energy as a mean of reduction in CO_2 emissions. To achieve this, a European venture was acquired, and a research group was launched to promote the idea of P2G in Japan. We interviewed the executive officer of the firm working on P2G commercialization.

Because renewable energy does not output power uniformly, the system can produce hydrogen by water electrolysis using excess renewable power to moderate output. Hydrogen is difficult to use with current technologies. Organic hydride and liquid hydrogen, hydrogen carriers, require new infrastructure, and hydrogen stations are expensive. Hydrogen produced using renewable energy can be reacted with CO_2 coming from industries to make methane. This allows using the existing infrastructure for gas. FCV will take time to be widely used, but over 10 million natural gas vehicles are already on the road worldwide.

The German government has set up a study group with businesses to openly research P2G, and Japanese firms join it. If emerging countries work on reduction in CO_2 and promotion to widen renewable energy use in the future, P2G system using methane is easier to spread rather than hydrogen infrastructure. Hitachi Zosen is developing a CO_2 separator, hydrogen producer and reaction equipment for methane production, and can build the system. Based on this background, they aim to be a global leader in P2G system. To achieve this, they acquired German-based Etogas, a P2G system producer. Hitachi Zosen will basically work in the Carbon Capture and Reuse (CCR) Study Group with JGC Corporation, the University of Tokyo, AIST and EX Research Institute to make P2G system known more using methane in Japan. In Japan, energy consumption consists of 40% electricity and 60% thermal energy. It is important to store surplus production of renewable energy as fuel. Because CO_2 produced in industries are to be used, another subject is economical equipment to capture CO_2. Currently the group's focus of research is on a large-scale CO_2 capturing system. The group wants to be more open for other business to join in. (The Chemical Daily, December 20, 2016)

(3) Kobelco Eco-Solutions

Yamanashi Prefecture and another organization have set up Komekurayama Solar Power Plant outputting a maximum 10 MW in Kofu City, and Yume Solar-kan Yamanashi is open as a promotional facility there. Kobelco Eco-Solutions has delivered a hydrogen producer to the promotional facility. During high insolation, hydrogen to be store is produced using excess power. When insolation is low such as a cloudy period, FCs generate power using hydrogen. This is how the system works. According to METI, the number of the power stations certified for the feed-in tariff (FIT) reached about 3.2 million nationwide. However, excess power is often unused in many cases. This means renewable energy is not used efficiently. Although surplus production can be stored in a storage battery for later use, power does not stay stored for a long period due to self-discharge. Additionally, a storage battery is too heavy to transport, and has to be used on-site. Thus, a method of a power station combining storage battery, hydrogen producer and FCs comes to attention.

The number of orders from renewable energy operators to Kobelco Eco-Solutions is increasing each year. The number of orders for hydrogen producers to the firm is expected to be 15, over 1.5 times of that of the previous year. A higher profile product is "H2Box", small equipment to produce hydrogen at $1m^3$/hr. The Advanced Energy Systems and Structure Division of METI evaluated "renewable energy use which can be backed up more", and has been supporting this. In September, the ministry chose six applications for the subsidy of "technological development projects to form hydrogen society" through NEDO. Kobelco Eco-Solutions has worked on the hydrogen producer business since 1993, and takes the largest share in the Japanese market of industrial electrolysis systems. They have received orders from semiconductor and thermal power plants. For the hydrogen production system to be widely used, further a price cut is essential. The current price of the small-scale system is from a few million yen. The manufacturer aims to reduce the price to under half of that of the current one, and is working on technological development and reviewing specifications in haste. For industrial use, hydrogen purity has to be high. FC use requires a low price of a certain level of hydrogen purity due to cost efficiency. The firm plans to propose attractive technology and costs to power generation operators in the renewable energy area which is expected to grow. (The Nikkei Business Daily, December 21, 2016)

(4) Press Kogyo

Press Kogyo, an automobile parts producer, has jointly developed equipment to extract hydrogen from "organic hydride", an organic compound, with Hrein Energy which develops hydrogen producers in Sapporo City. In FY2017, a project will start to test to transport hydrogen produced using renewable energy. Because hydrogen is one third of natural gas in energy per volume, it has to be made dense for transport and storage. The High Pressure Gas Safety Act applies to high pressure hydrogen gas, and liquid hydrogen requires a plant to reduce the temperature to -253 ℃. If hydrogen is converted into an organic hydride to transport and is turned back to hydrogen at a destination, it can be transported in a 20 foot size container including equipment such as a storage tank, by a trailer. Organic hydride is liquid under normal pressure and temperatures, and allows the volume of hydrogen to be compressed to 1/500 of hydrogen itself. The compound can be handled under the law which applies to gasoline, and needs no special infrastructure for transport and storage. A large-scale similar plant already exists, but the issue for commercialization is reducing size.

Press Kogyo' facility promotes a catalytic reaction while applying 300 ℃ heat to an organic hydride to extract hydrogen. It can extract hydrogen at 30 m^3/hr under atmospheric environment. For using liquid or high pressure hydrogen, nearly ¥200 million is required for a hydrogen refueling station, accumulator and compressor as well as ¥80 million for transport vehicles. Press Kogyo says its equipment cost is about ¥100 million at the testing phase. In cooperation with local governments, they will carry out an evaluation project of "P2G" to produce hydrogen using renewable energy and to transport it. For example, water is electrolyzed using electricity from wind power, and produced hydrogen is transported and stored as an organic hydride. At the destination, the chemical is used for hydrogen power generation or fuel for boilers. METI's long-term objectives for hydrogen refueling stations are installation at 160 locations by 2020 and 320 locations by 2025. Toyota and Honda sell commercial FCVs, but the prices of these vehicles are higher than of that of EVs at ¥ 2.5 to 3 million. Hence a reduction in FCV costs is wanted. Furthermore, the costs of hydrogen refueling stations are also high, and it is essential to reduce the costs of these stations in various ways for them to be used more. Hydrogen price at refueling stations is ¥1,000 to 1,200/kg which is close to the fuel costs of hybrid vehicles. According to Nomura Research Institute, the price, however, needs to be reduced by about ¥500/kg for hydrogen refueling stations to be self-sustained The method using organic hydride requires no high pressure tanks, and leads to reduction in the preparation expense of hydrogen refueling stations. (The Nikkei Business Daily, December 26, 2016)

(5) AIST

AIST has been working on the "technological development of highly efficient and cheaper storage and the use of hydrogen for CO_2 free hydrogen society", and this was selected for the "Global Joint Research and Development Projects for Innovative

Energy Technology" of METI for FY2016. AIST will develop hydrogen storage alloy materials and a new FC for FCVs in cooperation with research institutes of Pacific Northwest National Laboratory (PNNL), USA, University of Missouri-St. Louis, USA, University of Bordeaux, France, and Delft University of Technology, Netherlands for 42 months until FY2019. Current FCVs are filled with hydrogen at high pressure of 70 MPa in hydrogen refueling stations, and proton exchange membrane fuel cells (PEFCs) generate electricity. The cost of the whole system is pushed up by energy for raising pressure, carbon fiber for the tank and platinum catalyst for PEFCs. AIST aims for a reduction in the cost of the whole system by achieving a lower pressure of hydrogen storage by developing a material for hydrogen storage alloy which is to have a weight of 1.2 times of conventional ones while to reduce the volume to one third. This time, they will investigate a system to reduce the dispensing pressure to 20 MPa by developing a storage alloy using a magnesium material. To achieve the objective, the formation of magnesium and protective films needs to be controlled at a nano-level. Hydrogen storage alloy requires a temperature of 300 ℃ to release hydrogen, while PEFCs produce only 80 ℃. Additionally, they will work on the development of new cells producing 300 ℃ to replace PEFCs. Proton conducting glass is the candidate for the FCs. AIST aims for the 20 MPas system to be an option for the system by 2050. (The Chemical Daily, January 11, 2017)

(6) Sanno

Sanno will commercialize technology to extract hydrogen from biogas by using a hydrogen permeable membrane under development. Once the technology is commercialized, recycling organic waste such as livestock waste, food waste, and sewage/used water can be recycled. Aiming to sell the technology as its product in two to three years, the firm will also develop a hydrogen refining technology for FCVs in the future. High purity hydrogen can be produced by filtering methane gas using their hydrogen permeable membrane under development. Because the membrane cannot be made in large areas, it is difficult to refine a large amount of hydrogen in a short time. Once the technology is established, it is, however, expected to lead to a smaller and cheaper reformer. (Nikkan Jidosha Shimbun, January 11, 2017)

5. ENE- FARM Business Plans

(1) Panasonic

Panasonic plans to introduce "ENE-FARM", which is a domestic FCs using no platinum catalyst into the market by the first half of 2020's by reinforcing FC product development. Also, they have a plan of mass production of pure hydrogen FCs using solely hydrogen by 2020. They intend to contribute to realizing hydrogen society by promoting the use of FC systems at home by reducing costs.

Panasonic has sold ENE-FARM to generate power using hydrogen made from natural gas since 2009. The latest model is the fourth generation released in 2015. The current system reduced the number of parts by 50% of that of the first generation by simplifying the system and a reduction by 75% of the amount of platinum in catalyst. As of March 2016, 160 thousand units of ENE-FARM are used at home. Panasonic's shipping is over 50 thousand out of the figure. The Hydrogen And Energy Research Laboratory of the Advanced Research Division of Panasonic emphasizes that it is essential to reduce the system cost for further expansion of use.

As a measure to reduce costs, they have a plan to gradually cut down platinum use for catalyst. The current model use less platinum, and the next generation system is likely to decrease the use further. Panasonic intends to introduce platinum free FCs as early as the first half of 2020's, and the system is to be introduced into the market as one after the next generation or later. On the other hand, new pure hydrogen FCs can be designed to be a small system, because they require no fuel processing unit to produce hydrogen from natural gas which is used in the current system. Three units of this system outputting 700 W are installed in Yamanashi Prefecture to test efficient operation by coordinating operation. The firm plans to commercialize the new FCs by 2020. As well as 700 W system, a 5 kW system is considered to be mass produced. They intend to use hydrogen produced using renewable energy in the future. For example, technological development will be carried out to produce hydrogen by directly splitting water using a photocatalyst and sunlight.

Since the Japanese government targets to establish a CO_2 free hydrogen supply system by 2040, Panasonic aims to develop the system ahead of schedule by carrying out its own development. (The Chemical Daily, December 14, 2016)

(2) Osaka Gas & Sekisui House

Osaka Gas and Sekisui House have jointly developed a service to suggest easy energy saving actions through TV at home to each unit of a high-rise condominium using cloud computing and the "internet of things (IoT)". They will start the experiment on the property under construction in Osaka City. The new service will start at two buildings including "Grande Maison Shin-Umeda Tower" under construction which is aiming to complete the building in 2019. New ENE-FARM" that Osaka Gas released in April 2016 will be installed at each unit to collect a large amount of home data in the cloud computer, and experts of OGIS-RI will analyze the data. The analysis will take environmental information such as weather and temperature and energy consumption which changes depending on family structures and working states in order to found out effective energy saving actions for timing of hot water preparation for bathing and temperature for under floor heating. The energy information will be delivered through "Hikari Box+" provided by NTT West to the residents. Each unit will be supplied with an exclusive device to connect to the TV and internet to automatically display tailored energy information and messages. By all the units of the building taking part, CO_2 emissions are estimated to be reduced by 40 % of that of a similar size condominium. The majority of energy management systems use smartphones and tablet computers to display energy management information at home such as consumption. However, residents who are not used to these devices do not use the systems much, which is an issue. Due to this reason, the effect of promoting energy saving actions has been limited. The new system is expected to bring energy saving effect up by showing information on TVs which are more familiar devices to continuously encourage residents to change their behavior. In the future, the firm plans the system to automatically control devices at home. (The Nikkei Business Daily, December 28, 2016)

6. FCV

(1) Toyota Motor

On December 15th, Toyota Motor announced that its division of each function for powertrain systems would be discontinued at the regular organizational change for January 1st, and the development system would be reorganized for total optimization. They will discontinue the "Advanced Power Train Engineering", "Engine Engineering Field", "Drivetrain Engineering Field", "Hybrid Vehicle Engineering Field" and "Unit Production Engineering Field" of their Powertrain Company. The divisions in these fields will be reorganized into the Power Train Product Planning Division. Also, "Honsha Plant Fuel Cell Unit Manufacturing Division" will be launched in the Honsha Plant taking divisions for chassis, battery and FC production to be able to produce whole FC unit by itself. (The Nikkan Kogyo Shimbun, December 16, 2016)

(2) Hyundai Motor

Hyundai Motor plans to introduce new FCV in January, 2018, and this is to be the second commercial FCV of sport utility vehicle (SUV) model for it after "Tucson ix" released in 2013. According to the manufacturer, the new FCV can drive 560 km on a full tank of hydrogen based on the US standards, which overruns Toyota's FCV "MIRAI" of 502 km. The driving range of the first generation is 426 km. The price of the new FCV is set ₩60 million, about ¥6 million, and the actual price for the consumer including subsidy is planned to be at a ₩30 million level. Additionally, their FC bus will be released in 2017. Toyota also announced that its FC bus would be brought out in the same year, although the details are unknown. These two firms are racing for commercialization. (The Nikkei, December 21, 2016 & January 6, 2017)

(3) Narita International Airport

Narita International Airport purchased one of Honda's FCV "CLARITY FUEL CELL" for its operation, and the delivery ceremony was held at the hydrogen refueling station there on December 26th. In contrast to normal cars, FCV emits no CO_2 during driving, but produces only water vapor. Because of this performance, it is called an ultimate eco car. In March 2016, the first commercial hydrogen refueling station for an airport in the eastern Japan was opened.

This FCV can drive about 720 km on full tank of hydrogen, about 5 kg. (The Chemical Daily, December 27, 2017)

(4) KPMG

KPMG International has revealed the survey results of officers of global firms related to automobile. The result of solely Japanese firms shows that their most important issue is EVs which went up to the first place this year from the fifth place last year. An enterprise survey was carried out to 953 officers of automobile parts manufacturers and 2,418 consumers. The results on the trend of the automobile industry for 2025 were EV as the first place, 50%, followed by connected car technology, 49%, as the second place and FCV, 47%, as the third place. 78% gave positive answers to FCV for investment in powertrain technology for next five year as it can be "true breakthrough in electric powered mobility", and this shows their high anticipation. (The Nikkan Kogyo Shimbun, January 10, 2017)

7. FCV Parts & Component Development

(1) Screen Holdings

Screen Holdings has established a technology to coat and dry electrode catalyst directly on electrolyte membranes for PEFCs, and the technology is commercialized as "RT Series", FC production equipment. Delivery to users already started, and the firm aims to expand this business. Using expertize on coating and drying technology from display production machines and the results of a NEDO project carried out between FY2013 and FY2014, the firm achieved a technology allowing roll to roll production of electrolyte membranes with an electrode catalyst layer coating on which was difficult with the conventional technology. The new product enables FC production to be faster and cheaper. The firm will try to sell the product as a technology to backup FCV and ENE-FARM growth. (Nikkan Jidosha Shimbun, January 13, 2017)

8. Hydrogen Refueling Station Element Technology Development & Business Plans

(1) JFE Container

The gas container plant of Kawasaki plant of JFE Container has been operating as a development and production center of containers for high pressure gas with rich sociality, since the factory for steel tube production, its predecessor, was built in 1997. The plant has been working on an accumulator for hydrogen refueling stations as a NEDO project, and just completed a test product in same size as actual one. They will try to expand their product range to take a variety of market needs mainly in the business of high pressure gas containers.

The main annual production capacities are 12,000 units for small fiber-reinforced plastic (FRP) containers and 5,000 units for automobiles. These products are oxygen containers (20 MPa, Type 3) for home medical care and natural gas containers (20 MPa, Type 1) for automobiles produced in a subsidiary in Thailand. Following these products, accumulators for hydrogen refueling stations have come to attention of the Kawasaki plant. They employ a high pressure gas container called "Type 2". This uses a seamless pipe of high strength low-alloy steel as an inner liner, and its body is wounded with carbon fiber reinforced plastic (CFRP). The test product in actual size is 4.5 m long, and weighs just under 2 tons as its specifications. Two of the products were brought in to the plant in November 2016.

Since NEDO designated the development as "Research and Development Project for Hydrogen Use Technology" in September 2015, it has been carried out in trilateral cooperation with JFE Steel and Mitsubishi Rayon. The target cost is ¥12,000 per liter, half of that of the existing two types, and the project will work on repeated design improvement and performance evaluation for commercialization by FY2018. They will participate in "FC Expo", the world's largest exhibition for FC to be held at Tokyo Big Sight in Ariake, Tokyo, in March 2017. According to the latest roadmap published by "Hydrogen/FC Strategic Committee" in March 2016, hydrogen refueling stations are planned to be built at 160 locations, over double of that of FY2015, by 2020, and the number of FCVs in use are anticipated to be increased from current 600 vehicles to 40,000 vehicles. (Japan Metal Daily, December 14, 2016; The Chemical Daily, January 13, 2017)

(2) Suzuki Shokan

Suzuki Shokan has joined the research and development carried out by academia for the coming hydrogen society. This is considered as a part of their contribution to the society, and they are in charge of the hydrogen supply system for an experiment of a FC ship carried out by Tokyo University of Marine Science and Technology. They will provide facility assistance to academia fully using their maneuverable business structure. Their business is sales of industrial gases and chemical products, and they determine sales, mainly industrial gas, for research and development as a cash cow. Related to this, genuine efforts are being made into exploring new fields and creating markets, and the firm is working on measures for the coming hydrogen society.

In February 2015, the firm signed a partnership for design, construction and operation of hydrogen refueling stations for material carriers with US-based Air Products. Recently, Suzuki Shokan announced a FC forklift and hydrogen filling facility would be introduced into Toyota Business Office in Toyota City of Aichi Prefecture. These will be used from April 2017, and the firm expects them to operate shipping and demonstration in the office.

The firm also sells hydrogen supply systems for FC ships to academia in parallel. Having signed a partnership with Tokyo University of Marine Science and Technology, they participate in the joint research project for the commercializing of hybrid electric powered ship which is carried out by the university. The university is studying a hybrid ship of a combination of lightweight FCs and lithium-ion battery (LIB) aiming to commercialize it by 2020 Tokyo Olympics. The FCs are to compensate the weight and recharging time of the LIB, and they will check its shock resistance performance through experiments. This is the first ship of this kind expected to be a commercial vessel in Japan. Hydrogen supply infrastructure including hydrogen refueling stations has not been prepared for FCV introduction yet, but FCVs have many advantages in reduction in fuel cost comparing to gasoline cars, with less noise and vibration. (The Chemical Daily, December 15, 2016)

(3) Iwatani

Iwatani has unified technologies for facility maintenance distributed in departments for industrial gas business, its core, into one. Construction of gas supply facilities are contracted out to subcontractors, and facility inspection method were different at each plant. While working on hydrogen refueling stations for FCVs, the newly launched technology division aims to push up safety standards by "controlling centrally". "Technology & Engineering Division" was established, in 2015, and works from concept to basic design for new lines, selecting equipment for the plants, optimizing composition and construction management all the way through. The firm previously had a team in charge of technology, safety and quality assurance in each department. Now hydrogen refueling stations have moved on from an experiment phase to a commercial sales one. The firm thought unification was required, and brought the teams for six areas together to form a single division. New safety standard will be established to reduce technological variation among operations aiming for a reduction in costs and improved work efficiency. Establishing common standards gives good sales results as well, and Iwatani's engineers have been posted to manufacturers developing FCV such as Toyota and Honda in some case. This is also used in quality control at other departments such as food and industrial gas. (The Nikkei Business Daily, January 13, 2017)

—Reported from Dec. 14, 2016 to Jan. 13, 2017—