

## Large-scale Project Starting for Hydrogen Storage in Fukushima

Reported by K. Onda

### 1. Governmental Measures

#### (1) MOE

On March 1<sup>st</sup>, the Ministry of the Environment (MOE) showed a draft of the long-term vision of reduction in carbon emissions towards 2050 to related members of the Central Environment Council. To hit the target of a reduction in greenhouse gas by 80%, they will start discussion on the design of institutional arrangements to trigger changes in all directions in April. The vision clearly states an aim to be the advanced country in solutions to achieve the world's most significant reduction in carbon emissions while being economically successful by connecting the measures to economic growth and regeneration of regional areas. In the automobile areas, electric vehicles (EVs) and fuel cell vehicles (FCVs) are expected to take a significant part, and transport will become more efficient through carsharing and automated driving technology. EVs while they are parked are expected to take a role to adjust oversupply and shortage of power in communities. Logistics will improve efficiency using artificial intelligence (AI) and the Internet of Things (IoT). Earlier introduction of carbon pricing such as carbon tax and emissions trading is expected. (Nikkan Jidosha Shimbun, March 2, 2017)

#### (2) German Government

The Federal Ministry of Transport and Digital Infrastructure of Germany has announced that €0.25 billion, about ¥30 billion, would be invested in research and development of hydrogen and fuel cells (FCs) in the transport area over the period until 2026 to back up FCVs and hydrogen infrastructure preparation. This might lead more cooperation with Japan. Daimler and BMW have a long history of hydrogen energy. (The Nikkei, March 4, 2017)

#### (3) METI

The Ministry of Economy, Trade and Industry (METI) has published the report of a meeting of the working group on CO<sub>2</sub> free hydrogen of the Hydrogen/FC Strategic Committee.

For CO<sub>2</sub> free hydrogen to be widely used, the report says that design of institutional arrangements will be required including use of power to gas (P2G) and reduction in CO<sub>2</sub> of the hydrogen supply chain. To do so, the hydrogen production process from fossil fuel should be combined with CO<sub>2</sub> capture and storage (CCS). To increase renewable energy use, hydrogen is an effective mean for energy storage to stabilize the power grid. Water electrolysis technology needs to improve, and it is important to develop a technology to achieve ¥260,000/(Nm<sup>3</sup>/hr). Another agenda is defining CO<sub>2</sub> free hydrogen. The report also suggests the use of power transport from one supplier to another through the existing power grid, tradable green certificates, and a reduction in greenhouse gas emissions/carbon offset credit for smooth CO<sub>2</sub> free hydrogen trade. Renewable energy has increased the output by the governmental feed-in tariff (FIT). However, this will increase utility bills of consumers. Also growing renewable energy is putting pressure on the power grid, and stabilizing the power grid is a big problem. Considering these, hydrogen is expected to make distribution of renewable energy even and to moderate the output. (The Chemical Daily, March 9, 2017; Nikkan Jidosha Shimbun, March 10, 2017)

#### (4) Gas Safety Subcommittee of METI

Hydrogen is planned to be supplied to FCs in the athletes' village of the 2020 Tokyo Olympics and Paralympics from a hydrogen refueling station through about a 1.2 km pipe. Natural gas is odorless, but a smell is added from a safety point of view. Tokyo has planned out to supply hydrogen without this additive, and METI says that it is important to make sure to keep the same safety level of gas with smell. The ministry indicated its direction of hydrogen supply through pipes at a meeting of the Gas Safety Subcommittee held on March 10<sup>th</sup>. The technical standards of natural gas supply through pipes can be applied to hydrogen. An alternative detection mean for hydrogen supply through pipes without smell is shown. For

example, airtightness tests are to be carried out while hydrogen supply is stopped, and leak detection holes are to be installed for constant monitoring. The odorant obligated by the Gas Business Act reduces FC performance, and FCs are required to have deodorizing equipment. Tokyo will chose a construction operator in FY2017, and develop a solid plan. METI will discuss technical specification and safety measures at the Gas Safety Subcommittee as soon as the technical requirements such as pipes are announced. (The Denki Shimbun, March 13, 2017)

#### (5) Talk by Lovins and Arent

Mr. Amory Lovins of the Rocky Mountain Institute and Mr. Doug Arent of the National Renewable Energy Laboratory (NREL) both in the US are visiting Japan. Holding a press conference in Tokyo, they said that wind and solar power was expanding by reducing the costs, and this expansion trend of renewable energy was not likely to change under the Trump administration. It will take four years to withdraw from the Paris Agreement and, the government will be split into two for this issue. Moreover, many businesses and states assent to the agreement. The majority of the energy policies in the US are led by states and businesses, and the scope of the federal government for the policy is limited. Renewable energy in the US has largely grown due to technological innovation. Assuming the battery price is to go down to a quarter in six years, the EV price is expected to be level with conventional cars by 2020, and EVs and renewable energy combination are anticipated to promote distributed power use. Tomas Kåberger from the Renewable Energy Institute said that the cost of renewable energy had been significantly reduced in Europe and support competition in the industry. He also pointed out slow growth of renewable energy in Japan. (Nikkan Jidosha Shimbun, March 13, 2017)

## 2. Local Governmental Measures

### (1) Hokkaido

In April, Hokkaido will launch the “New Energy Promotion Foundation” to support the introduction of new energy use such as wind and biomass in its area from FY2017 to back up local governments and businesses for mid- to long-term period. The total foundation is about ¥6 billion over five years. For FY2017, ¥1.2 billion is expected to be allocated. The foundation aims to give continuous support rather than a subsidy to apply every year. Foundation projects cover new energy and energy saving, and are planned to be carried out in four areas in Hokkaido. The subjects of the foundation will include preparation of hydrogen refueling stations for FCVs.

(The Nikkei Business Daily, February 17, 2017)

### (2) Muroran City

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has selected four projects including Muroran Green Energy Town Concept of Muroran City for the Minister’s prize of the “First Advanced City Planning Competition”. Muroran has developed as a manufacturing city focusing on steel works, and has promoted the environmental industry with advanced technologies, human resources, logistics and research and development organizations grown from manufacturing. Their concept has been carried out with the cooperation of industry, government, academia and residents, aiming to double the current use of hydrogen, renewable and unused energy. The city also saw advantages of hydrogen energy in an early stage, and has introduced unified use of hydrogen refueling station and FCVs. The local government is taking a lead in ENE-FARM use by installing the FCs at public facilities, and encouraging businesses to enter the hydrogen related industry. (Japan Metal Daily, February 23, 2017)

### (3) Setagaya City

Setagaya City will hire a FCV for ¥1 million each year from April for its operation. A hydrogen refueling station will be prepared in the city, and will be installed on a large truck to be mobile. The city will invest ¥3.42 million to prepare power source on its own land, and a business will operate the station there by paying for other equipment and maintenance costs. (The Asahi Shimbun, March 1, 2017)

### (4) Yokohama City

Yokohama City will install hydrogen production equipment at Yokohama Wind Power Plant (Hama Wing) of which the annual output is 2,200 MW/hour to use some of electricity to produce hydrogen to store for fuel of FC forklifts to be used in the warehouse of the Central Wholesale market from FY2017. Last December, the construction started to install a storage battery of 0.15 MW/hour, water electrolysis for hydrogen production and hydrogen storage tank on the premises of the power plant. The construction is planned to be completed in the summer of 2017. Hydrogen will be compressed to be loaded on hydrogen transport vehicles, and will be used at the wholesale market and the Yokohama Plant of Kirin Brewery Company. (The Nikkei Business Daily, March 2, 2017)

### (5) Kyoto City & Honda Cars Kyoto

Kyoto City will start the first hands-on hydrogen education project in Japan in cooperation with Honda Cars Kyoto (HC Kyoto), and try to spread hydrogen energy use by using smart hydrogen refueling station and FCVs. Having been contracted from Kyoto City, HC Kyoto opened a smart hydrogen

refueling station jointly developed with Iwatani in Yamashina-ku, Kyoto City. The education center will have three vehicles of CLARITY FUEL CELL, and produce hydrogen using solar power to aim to give residents experience-based education explaining the system of hydrogen society. It will offer test rides of about 50 km in the city in two hours, and will take two parties of a maximum of five people each a day. The test ride will be free of charge. (Nikkan Jidosha Shimbun, March 2, 2017)

### 3. FC Element Technology Development & Business Plan

#### (1) Toray

Toray will develop applications of hydrocarbon electrolyte membranes to propose usage for water electrolysis and hydrogen compression as well as FCs. They have the largest share in the global market of carbon paper for a base material of electrode and carbon fiber for tanks. A new electrolysis membrane will be added to the product range to fortify the business ready for the coming hydrogen society. The firm will newly build its first facility in Japan to produce FCV parts including structural components made of carbon fiber in its Ehime Plant. Hydrocarbon electrolysis membranes can reduce hydrofluoric acid produced by platinum catalyst compared to fluorine membranes, which leads to improvement of safety and durability. Water electrolysis can be improved by using hydrocarbon membranes which can be thinner. If this membrane is used to compress hydrogen, energy saving and easier maintenance can be achieved as well as a reduction in noise compared to mechanical hydrogen compressors. In 2015, the firm acquired German-based SolviCore which produces fluorine membranes, and is preparing a system to meet a wide range of user demand. (The Chemical Daily, February 17, 2017; The Nikkei, February 22, 2017)

#### (2) Brother

Brother Industries entered the market of FC systems for emergencies in 2016, and plans to introduce a new system in the autumn of 2017. The new FC system uses an improved hydrogen storage alloy. By enhanced cooling performance, its maximum operating temperature was increased by 10°C allowing the system to work in warmer environments of 50°C such as a power room. To advance weathering performance, the manufacturer added a mechanism to prevent the coolant freezing, when the FC system breaks down in sub-zero conditions. The FCs output is 700W, and can generate for over 72 hours. The price has been reduced from ¥5 to 6 million, excluding tax, of the existing system. The installation area is cut down by 7 to 8%. The firm has also developed a larger system

of 5kW output, and an experimental project is testing a system to supply electricity, water and hot water during disasters with Seiryu Power Energy of Gifu City. (Nikkan Jidosha Shimbun, February 27, 2017)

#### (3) AIST & Atsumitec

The National Institute of Advanced Industrial Science and Technology (AIST) and Atsumitec announced that they have developed compact and high power solid oxide fuel cells (SOFCs) which generate electricity directly using butane or ethanol. A nickel-cerium nano-structured material for electrodes was newly developed. All the devices are packed in a small size of 30 cm sides, and operate over 650 °C to output 100W. A start-up burner is also installed. Hydrocarbon fuel and air are supplied at the same time, and they are converted into H<sub>2</sub> and CO in partial oxidation reforming using also nano-structured electrodes. Using these units, the system generates power by also optimizing operation control technology. These two organizations tested for over a few hundred hours of continuous operation and a few hundred cycles of starts and stops. They will commercialize the system as a power source of hybrid FCVs, robots and drones next. (The Chemical Daily, March 1, 2017)

#### (4) NIMS & Hokkaido University

The National Institute for Materials Science (NIMS) and Hokkaido University have revealed that graphitic carbon nitride which is a two-dimensional framework compound of nitrogen and carbon had a corrugated crystal structure and periodic pores. Furthermore, a few layers of graphitic carbon nitride were bonded with Au to be a catalyst. The study group also discovered that the new catalyst exhibited highly efficient and selective chemical reactivity to synthesize water from oxygen. The results show that materials which are considered to be unsuitable due to reactivity and efficiency might be used as catalysts by bonding with another material to change the interface structure. (The Chemical Daily, March 7, 2017)

#### (5) Toyota Tsusho

Toyota Tsusho buys FCs from abroad to sell. Now, they are looking into an application for an emergency power source, and are considering the supply of FC components. Furthermore, a partner of the original equipment manufacturing is another idea for their business expansion. They introduced direct methanol fuel cells (DMFCs) from German-based SFC Energy in 2015 and polymer electrolyte fuel cells (PEFCs) of direct hydrogen and methanol reforming types both by Canadian-based Ballard Power Systems in 2016, and are targeting these as a backup power source for emergencies. Their range will be expanded from emergency use to portable

products, and a business is also planned to be launched to supply core components such as FC stack. Additionally, the firm is working on an experiment of hydrogen production using renewable energy and hydrogen storage and transport using an organic hydride. (The Chemical Daily, March 15, 2017)

#### 4. Hydrogen Infrastructure Element Technology Development & Business Plans

##### (1) Iwatani, Tokuyama & Tosoh

Yamaguchi Liquid Hydrogen (YLH) is set up as a joint liquid hydrogen plant in Tokuyama City, currently Shunan City, of Tokuyama and Iwatani in 2013 to revive the Shunan Industrial Complex. Liquid hydrogen produced at the plant is used at semiconductor factories and for fuel of rocket launched at Tanegashima Space Center as well as for FCVs. In 2015, Tokuyama and Tosoh started a joint business to effectively use excess hydrogen produced at an electrolysis plant. Fortifying the facility, YLH will double the production of liquid hydrogen to 6,000 l/hr. In April, construction will start to install a pipe line between Tokuyama and Tosoh, and they will begin to share hydrogen in FY2017. Idemitsu is interested in the project as a way to use hydrogen produced during its ethylene production. (The Nikkei Business Daily, February 16, 2017)

##### (2) Takenaka Corporation

Takenaka Corporation will try to sell energy management system (EMS) which are effective for energy saving and business continuity planning and aim for the product to be widely used. The system controls energy saving, storage and production at the optimal combination. Last October, the firm started an experiment of hydrogen energy use, and the project connected hydrogen production using excess power from photovoltaic generator, hydrogen storage using hydrogen storage alloy and tanks and hydrogen use by FCs. The firm will consider expanding the system to be able to remotely control buildings. (The Chemical Daily, February 22, 2017)

##### (3) Toyota

Toyota Motor will cooperate along with Aichi Prefecture to develop a supply chain of low-carbon hydrogen which is produced with a very small amount of CO<sub>2</sub> emissions during production. CO<sub>2</sub> emissions during hydrogen production and use will be reduced to the minimum by sending electricity and gas produced using renewable energy through existing cables and pipes, and by producing hydrogen close to where it is used. Electricity is generated by using waste incinerator, and methane is produced from sewage treatment. The supply system will be developed to connect the renewable energy to the power grid

and pipes to where it is in demand. Aichi Prefecture will play a coordinating role, and Toyota City where the waste disposal is located and Chita City which has the sewage treatment, Chubu Electric Power and Toho Gas will also cooperate. The members are considering this project to be certified by Aichi Prefecture as low carbon hydrogen as “Aichi Low-Carbon Hydrogen Supply Chain”. Toyota is thinking of building its own hydrogen production facility in its plant. Other organizations such as Kanagawa Prefecture are carrying out low carbon hydrogen experiments. (The Nikkan Kogyo Shimbun, February 24, 2017)

##### (4) Iwatani

FCVs are promoted to bring society to use hydrogen which is a clean energy without producing CO<sub>2</sub> reducing global warming. However, preparation of hydrogen refueling stations has not met its target. Iwatani wants deregulations and legal legislation to encourage realization of hydrogen society. This was reported by medial. (The Nikkei, February 26, 2017)

##### (5) Kwansei Gakuin University & Fuji Chemical Industries

Kwansei Gakuin University and Fuji Chemical Industries have published joint research results at an international conference for artificial photosynthesis held in Kyoto. They fixed a large amount of iron particles evenly on graphite oxide. This was mixed in water with material which emits electrons and pigment which passes light energy to catalysts. 2 mg of catalyst was mixed to every 20 ml of the solution. The research group confirmed 5 ml of hydrogen was produced by applying light for 40 hours. (The Nikkei Business Daily, March 3, 2017)

##### (6) East Japan Railway Company

East Japan Railway Company is accelerating development of technology for renewable energy aiming to reduce energy use of railway by 25% of that of FY2013 by FY2030 and CO<sub>2</sub> emissions by 40%. As a model of an eco-station, Musashi-Mizonokuchi Station of the Nanbu line will have a hydrogen power generation system, H<sub>2</sub>One, by Toshiba using a photovoltaic generator installed in the spring of 2017. Excess power from the photovoltaic generator will be used for water electrolysis to produce hydrogen to be stored in hydrogen tank. As needed, the FCs will generate electricity to be used for the station building, and emergencies. The railway company is developing a train using hydrogen as the fuel for an area of a largely non-electric local line to be CO<sub>2</sub> emission free at the same time as the introduction of a storage battery train. (The Nikkan Kogyo Shimbun, March 7, 2017)

##### (7) SMFL

Sumitomo Mitsui Finance & Leasing (SMFL) will lease a pure hydrogen PEFC system of 100 kW for industrial use by

Toshiba Fuel Cell Power Systems to Tokuyama. The system will be installed at a swimming pool of Shunan Swimming Club which is operated by a group member of Tokuyama in Shunan City, and will start the operation in late March. This is the first for the industrial system to be leased in Japan. Tokuyama is the leader of the contracted experiment of the Community Low-carbon Hydrogen Technology Demonstration Project for FY2015 of MOE. The project is being carried out to use unused hydrogen as a by-product from Tokuyama's plant for sodium hydroxide to test the CO<sub>2</sub> reduction effect in various ways for five years. Tokuyama will supply hydrogen through pipes to the swimming pool. Hot water produced during power generation will be used to pre-heat a boiler for hot water. (The Nikkan Kogyo Shimbun, March 8, 2017)

(8) Toshiba, Iwatani & Tohoku Electric Power

A project will start to develop a system to use hydrogen energy at the world's largest level in Fukushima Prefecture, aiming to commercialize the system by April 2020. The system will produce hydrogen for 10,000 FCVs using renewable electricity to be used at the Tokyo Olympics and Paralympics. Being members of the project, Toshiba, Iwatani and Tohoku Electric Power Co. will start construction of the system in April 2018, and a test run will start in October 2019. They will finish business feasibility research by this June to decide the specifications of the system and the location. This project is a part of the New Energy Social Concept to make Fukushima the leader in new energy. This was selected as a project of the New Energy and Industrial Technology Development Organization (NEDO), and the three firms will develop a system to produce, transport and store hydrogen. The renewable electricity will be used for hydrogen power production, and hydrogen will be supplied to the areas inside and outside of Tohoku. If the production still exceeds the demand of the power supplier, it will be used to adjust grid power. The renewable power source for the hydrogen production is a 20 MW photovoltaic generator to be installed on a piece of land of 36 ha. The hydrogen production can take about 10 MW, and be built on 4.5ha land. Hydrogen for 10,000 FCVs is an annual 800 t production level. Because the hydrogen production will also use grid power, an issue is whether the project can use the existing power cables. (The Denki Shimbun, March 8, 2017; Nikkan Jidosha Shimbun, March 10, 2017)

(9) Inabata

Inaba & Co. has introduced an anion exchange membrane (AEM) hydrogen producer by German-based Odasco Heliocentris Europe and a proton exchange membrane (PEM)

cell stacks/system by PowerCell Sweden into the hydrogen energy market which is expected to grow as a new market development. (The Chemical Daily, March 9, 2017)

## 5. ENE-FARM Business Plans

(1) Sekisui House

Sekisui House is promoting zero energy house (ZEH) which offers to negate electricity use for rent, and has requested measures to help a reduction in FC price to MOE for this target. Although ZEH has already taken 70% of newly built houses by Sekisui House, FCs are essential for rented and existing housing to become ZEH. The government was asked to provide investment incentive for businesses to reduce FC costs and to promote the products. (The Nikkei Business Daily, February 17, 2017)

(2) Saibu Gas

On March 16<sup>th</sup>, Saibu Gas announced that new ENE-FARM by Panasonic would be available from April 1<sup>st</sup>. The price is ¥1.598 million, excluding tax and installation, reduced by ¥0.07 million from existing product. The firm has sold about 8,100 units of ENE-FARM in total as of the end of 2017. Their sales target is 2,600 units for FY2016. (The Denki Shimbun, February 17, 2017)

(3) Panasonic & Aisin Seiki

Firms selling ENE-FARM in Japan are trying to develop full-scale sales in overseas markets. Panasonic has introduced two new models into the European market which is mainly divided into two types of systems. They have aimed to expand the use to the whole of Germany with new systems since they sold a system which is jointly developed with German boilermaker Viessmann, experimentally in a certain area. After that, their market expanded to Switzerland, Austria and the UK by using Viessmann's sales channel. Their target of the overseas sales is increased to 5,000 units for FY2018, and they plan to raise the overseas sales to 10% or more in the whole sales of FCs. The standard cost is about ¥3 million, and the federal states subsidize ¥1 million for each system. By supplying core components, Aisin Seiki participates in an experiment project of 70 units of domestic FCs installed by German-based Bosch. They will investigate future sales by examining operation by this September. Toshiba sells systems for hot water central heating in Germany and France through a German battery producer. Domestic FC systems are subsidized also in Europe and South Korea, and the global market of these systems is expected to increase from ¥37 billion for FY2015 ¥170 billion by FY2020 and ¥800 billion by FY2030. (The Nikkei, March 11, 2017)

## 6. FCV

### (1) Dongfeng Motor & First Automobile Works

On February 17<sup>th</sup>, it was revealed that Dongfeng Motor in Hubei and First Automobile Works in Jilin, both major Chinese automakers, signed a strategic partnership for advanced technologies such as connected car and FCs. These firms hold the second and third places in the market, and a partnership between large competitors is unusual. This partnership is seen as preparation for a merger in the future. However, both firms are already in partnership with multiple oversea businesses, and it seems these Chinese firms are not easily merged in the short term. (The Nikkei, February 18, 2017)

### (2) Tokyo

On February 24<sup>th</sup>, Tokyo announced that two FC buses sold by Toyota Motor would be used for its bus service from March 21<sup>st</sup>. This is the first proper operation of commercial FC bus in Japan. These buses emit no CO<sub>2</sub> during driving, and will run between the Tokyo Station and Tokyo Big Sight. Their continuous driving range is over 200 km. The bus uses the FC system developed for FCV MIRAI, and the capacity is 77 passengers. The price is about ¥100 million. Additionally, the bus has a power supply system of maximum 7.2 kW output for external equipment. (The Asahi Shimbun, February 25, 2017; Fuji Sankei Business i, February 25, 2017)

### (3) Iwatani

On February 24<sup>th</sup>, Iwatani announced that a large hydrogen refueling station would operate for FC buses in Ariake, Tokyo, from March 6<sup>th</sup>. This refueling station has three times of that of hydrogen refueling capacity compared to existing ones. Hydrogen infrastructure preparation has been accelerated for the 2020 Tokyo Olympics and Paralympics (The Nikkei, February 25, 2017)

### (4) French-based Symbio

Symbio FCell, a French FC equipment manufacturer, has announced that a seven-seater wagon taxi was developed with hydrogen FCs as range extender using EV running on lithium-ion battery (LIB) of Nissan Motor as the base. The price is expected to be €55,000. Installed under the back seat, the two hydrogen tanks for FCs hold 3.6 kg, and are suitable for 70 MPa. It takes three minutes to refill. The FC output is 15 kW. The LIB capacity is 24 to 36 kW/hr. The driving range is 500 km at 80 km/hr, 750 km at 50 km/hr or 900 km at 20 km/hr. Although Symbio is a venture, FCs are produced by a solely French manufacturers. (The Chemical Daily, March 3, 2017)

### (5) Saitama Resona Bank

Saitama Resona Bank offers a mortgage with an annual interest rate reduced by up to 1.375% of the normal rate for consumers who purchase EV or FCV for home use and whose house clears certain environmental standards around Urawamisono, and this mortgage offer is the same as for energy saving electric appliances. The bank supports the development of an environmentally friendly town led by Saitama City. (The Nikkei Business Daily, March 7, 2017)

### (6) Honda

On March 7<sup>th</sup>, Honda announced its Electric Vision aiming to replace two thirds of sales with four-wheel electric powered vehicles such as hybrid vehicles (HVs) plug-in hybrid vehicles (PHVs), EVs and FCVs in Europe at the 2017 Geneva Motor Show. They have a target to replace two thirds of their global sales with four-wheel electric powered vehicles by 2030, but set the goal for the European market five years earlier. (Nikkan Jidosha Shimbun, March 9, 2017)

### (7) Honda & GM

On March 8<sup>th</sup>, Honda and GM announced the management setup of Fuel Cell System Manufacturing established in January in Detroit, Michigan, of which capital is evenly provided by each firm. The first president is from GM, and the vice president is from Honda. They will conduct and manage the production. Both firms take turn for president and vice president in a two year cycle. Three board members are designated by each firm to form the board. They choose the chair in turn, and the first one is from Honda. The venture plans to produce FC systems at GM's battery pack plant in Michigan from 2020. (Nikkan Jidosha Shimbun, March 9, 2017)

### (8) Honda

On March 9<sup>th</sup>, Honda announced that commercial models of CLARITY PLUG-IN HYBRID and CLARITY ELECTRIC would make their global debut in the 2017 New York International Auto Show to be held between April 12<sup>th</sup> and 23<sup>rd</sup>. These models will be produced in Japan, and released into the US market in this year. Being a medium-size sedan, they take five people, and share the platform of CLARITY FUEL CELL. The firm targets at two thirds of its global four-wheel vehicle sales to be electric powered by 2030. (Nikkan Jidosha Shimbun, March 10, 2017)

### (9) Senshu University

Prof. Naotsugu Suzuki at Senshu University says in his recent book that 58 engine cars, 23 EVs of lead-acid battery, and 58 steam powered cars were displayed in the 1901 New York International Auto Show, and the three technologies fiercely competed with each other. The book continues that gasoline cars became dominant of all for its durability and

speed in within 10 years supported by discovery of oil in Texas. While the fuel efficiency of gasoline engine cars and environmental regulations are becoming strict, the automobile industry is developing and promoting HV, PHV, EV and FCVs. The question is which one of them will win the competition. (The Nikkei, March 13, 2017)

## 7. FCV Component Development & Business Plans

### (1) JFE Container

JFE Container has developed a test product of light weight carbon fiber reinforced plastic (CFRP) composite container lined with resin of type 4 at a low price for FCV tank. A resin tank is reinforced by being wounded with CFRP to form a layer, and has a further protective layer of fiberglass reinforced plastic (GFRP). The firm aims to commercialize the product by early 2020's by proposing the product to FCV manufacturers. The capacity is 10ℓ. The container is 58 cm long, 22 cm diameter and about 14 kg. It is suitable for 70 MPa. Compared to ones using type 1 steel, the new container significantly reduced cost and weight, and is planned to be commercially produced for accumulators of hydrogen refueling stations in FY2018. The manufacturer intends to get the product certified for UNR134, international standards, to improve reliability. (The Nikkan Kogyo Shimbun, March 2, 2017)

## 8. Hydrogen Refueling Station Technology Development & Business Plans

### (1) The Japan Steel Works

On February 16<sup>th</sup>, the Japan Steel Works announced that a new accumulator made of type 1 steel for hydrogen refueling stations has been developed. The accumulator uses steel tube produced by the Wakayama Works of Nippon Steel & Sumitomo Metal combined with durability improvement technology of Japan Steel Works to achieve significant cost cutting while keeping the feature of existing products. (The Chemical Daily, February 17, 2017)

### (2) Suzuki Shokan

Suzuki Shokan will install new simple hydrogen refueling equipment for FC forklifts in the refueling station currently under construction in its Toyota Business Office, this refueling equipment is to be the second one for the station. Industrial hydrogen is basically pressurized at 20 MPa. The new equipment uses no pressure booster to make the system simpler and cheaper for in-plant use. Installation of the first hydrogen equipment will be completed in May, and the equipment will start operation at the same time. The design and construction of the second equipment will start in parallel, and this equipment

will begin its operation at the same time as the first one. (The Chemical Daily, February 21, 2017)

### (3) Hiroshima Toyopet

On February 21<sup>st</sup>, Hiroshima Toyopet announced that the first hydrogen refueling station for Hiroshima Prefecture opened in Higashihiroshima City. The investment is about ¥300 million, and METI subsidized half. The refueling facility is on a truck to be mobile, and goes around in Hiroshima City to supply hydrogen. The hydrogen price is ¥1,500/kg excluding tax. This is the first hydrogen refueling station in Japan solely operated by a car dealer. (The Nikkan Kogyo Shimbun, February 22, 2017)

### (4) Shell & Toyota

Royal Dutch Shell will start to prepare hydrogen infrastructure for FCVs in California, USA, in cooperation with Toyota Motor. This is a part of a subsidy project of \$16.4 million, ¥1,800 million, by the state to install hydrogen refueling facilities at seven established refueling stations. The state currently has 25 hydrogen refueling stations. (Fuji Sankei Business i, February 22, 2017)

### (5) Kobe Steel

On February 22<sup>nd</sup>, Kobe Steel announced that the US model was added to the core component package system including compressor and chiller for hydrogen refueling stations. This model is to catch demand of hydrogen refueling station that California, USA, is leading in the preparation. The price is equivalent of under ¥200 million. This model reduced the installation area by 10% compared to the Japan model released in 2014, and is provided with a dispenser by Tatsuno. The filling pressure can rise to 87.5 MPa, and the hydrogen supply capacity is 340 Nm<sup>3</sup>/hr. The manufacturer introduced the US model on the evaluation that they saw better opportunity in the US market than the European market which has many competitors. (Nikkan Jidosha Shimbun, February 23, 2017)

### (6) Yachiyo Industry

Yachiyo Industry has developed a new prototype of accumulator for 82 MPa as standard pressure for hydrogen refueling stations. This prototype is made of a resin lined composite container of "type 4 with wrapped with carbon fiber. The external dimensions are 400 mm by 1,200 mm, and the capacity is 70 ℓ. The designed pressure is 105 MPa. The manufacturer can produce up to 700 mm diameter and 5,000 mm long to make 500 ℓ capacity. An automobile tank is also planned to be developed. (The Chemical Daily, March 7, 2017)

### (7) Shizuoka Gas

Shizuoka Gas has opened the first stationary hydrogen refueling station for Shizuoka Prefecture in Shizuoka City

using subsidies of the government, prefecture and city. The city has set up the Shizuoka Hydrogen Town Concept that Shizuoka Railway Group and Suzuyo Shoji support. Although the number of Toyota's MIRAI registered in the prefecture stays under 30, the gas supplier went ahead for the upfront investment to take opportunities of FCV sales growth and transport demand between Tokyo and Nagoya. The station can also refuel Suzuki's FC motorbike under development, and an experiment of pure hydrogen FCs will start in the facility in cooperation with Panasonic. (The Nikkei Business Daily, March 9, 2017)

#### (8) AIST & NOK

On March 9<sup>th</sup>, AIST and NOK announced that highly functional carbon membrane module at a large-scale of 1 m<sup>3</sup>/hr level, for hydrogen separation. This seems to be a groundbreaking technology to lead to reduction in costs of organic hydride type hydrogen refueling stations using methylcyclohexane as the energy carrier. The research group ensured that the membrane sustained the high selectivity when mixed gas of hydrogen and toluene was supplied at 90 °C. The module is self-supporting hollow-fiber membrane, which makes the separation equipment compact. Without any defects, the new product also allows improvement in membrane production method, development of sealing method and increase in scale by optimizing module structure. The group also made sure steady hydrogen production met ISO standards for FCVs by a test of separation into hydrogen and toluene at JX Energy in actual operation conditions. (The Chemical Daily, March 10, 2017)

#### (9) Air Liquide Japan

On March 30<sup>th</sup>, Air Liquide Japan will open its fourth hydrogen refueling station, off-site production system, in Kobe. This is the second hydrogen refueling station in Hyogo Prefecture after Iwatani's station in Amagasaki City, and the first one for Kobe City. A gasoline refueling station stands nearby. Because the firm has roots in Kobe, it supports "Hydrogen Smart City Kobe Concept" and was given subsidy for construction from the city. Hyogo Prefecture started using Toyota's FCV MIRAI for its operation in this March. (Nikkan Jidosha Shimbun, March 15, 2017)

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