Road Map to Realize Hydrogen Society

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1. Governmental Measure

(1) METI

The Ministry of Economy, Trade and Industry (METI) will revise related safety ordinances within FY 2013, so that a tanker truck can transport a larger amount of hydrogen for hydrogen filling stations to supply fuel cell vehicles (FCVs). Currently the maximum legitimate pressure to fill a tank with hydrogen is 35 MPa, and the pressure will be increased to 45 MPa. The ministry will support the industry by this revision which will allow a tank to take more hydrogen at a time than it can under the current regulations. The amendment will be made on the Cylinder Safety Ordinance of the High Pressure Gas Safety Act to increase the pressure to 45 MPa for tanker truck transportation. On the other hand, the standards will be stricter for the leakage inspection for cylinders and pipes in order to secure safety. The Japanese government appoints this change as a key economy growth strategy. (The Nikkan Kogyo Shimbun, November 26, 2013)

The ministry will create a road map to form a hydrogen society in the future. Based on a new "Energy Basic Plan" to come out shortly after new year, the road map will explain how hydrogen is to be used as energy, and will show milestones of technological developments and diffusion rates of technologies. This may be a noteworthy plan to know the future of FCV and hydrogen filling stations. An investigative commission along with the industries and experts will be established soon to make the road map. (Nikkan Jidosha Shimbun, December 2, 2013)

METI revealed major subjects for the supplementary budget for FY 2013 on December 10th. Already being announced, ¥48 billion is allocated for reactor decommissioning and solving problems concerning contaminated water of Tokyo Electric Power Company's Fukushima Daiich Power Station. The budget also includes a total of ¥93 billion for a measure for energy cost reduction and ¥50 billion for energy saving facility installation. Allocations for commercial products are ¥35 billion for energy saving support, ¥20 billion for Ene-Farm, ¥10 billion for stationary lithium-ion batteries (LIBs) and ¥5 billion for energy management system (EMS) installations for houses and other buildings. (The Denki Shimbun, December 11 & 13, 2013; The Chemical Daily, December 13, 2013)

On December 12th, the Agency for Natural Resources and Energy of METI announced that a "Council for Strategy on Hydrogen and FCs (fuel cells)" would be established. The first conference will be held on December 19th, and they will be working on making a road map of hydrogen production, storage, transport and usage. Setting 2030 as a time of an increased growth phase, the road map will contain time scales and the introduction period and penetration targets of products including FCVs as well as clear roles for the industry and government. (The Denki Shimbun, December 13, 2013; Nikkan Jidosha Shimbun, December 16, 2013; The Nikkan Kensetsu Kogyo Shimbun, December 17, 2013; Nikkan Kensetsu Sangyo Shimbun, December 18, 2013; The Chemical Daily, December 19 & 20, 2013; The Yomiuri Shimbun, The Nikkei, The Sankei Shimbun, The Denki Shimbun, The Nikkan Kogyo Shimbun & Architectures, Constructions & Engineerings News (Daily), December 20, 2013)

(2) Japanese Government & Ruling Party

On November 28th, the Liberal Democratic Party of Japan, the ruling party, has been considering establishing a tax exemption scheme of the Gift Tax when parents or grandparents buy environmentally friendly and energy saving facilities, such as photovoltaic generators and FCs for their children or grandchildren. However the government, or the party, intends to exclude the scheme from the tax reform for FY 2014. Calling the "Green Gift Scheme", New Komeito, the coalition, promised to introduce the

scheme at last election of the House of Councilors, and has been strongly supporting it. Both parties will keep up discussing in order to make a final decision. (The Sankei Shimbun & Fuji Sankei Business i, November 29, 2013; The Nikkei, December 2, 2013)

On November 30th, the Japanese government revealed its basic idea of preparation for large disasters "Land Fortification Policy Outline". The outline includes a target to be an independent, distributed and cooperative nation by avoiding overconcentration. The government shows its strong intention to work on contingency plans. In the transport field, alternative routes will be quickly prepared for railways and highways in case the transportation network is destroyed. In that case, the energy supply may stop. The government will encourage stocking piling oil in places, and aims to make an independent and distributed energy system with FCs and renewable energy. (Osaka Nichinichi Shimbun, Kanagawa Shimbun, The Chugoku Shimbun, The Kyoto Shimbun, Nara newspaper, Gifu Shimbun, The Shizuoka Shimbun, The Sanyo Shimbun, The Saitama Shimbun, The Yamanashi Nichinichi Shimbun, The Shinano Mainichi Shimbun, Shimotsuke Shimbun, The Shikoku Shimbun, The Kochi Shimbun, The Hokkoku Shimbun, Nihonkai Shimbun, The Yamaguchi Shimbun, The Tokushima Shimbun, Kumamoto Nichinichi Shimbun, The Nagasaki Shimbun, Oita Godo Shimbun, The Ibaraki Shimbun, Ise Shimbun, Jomo Shinbun, The San-in Chuo Shimpo, The Ryukyu Shimpo, Fukushima-Minpo, Chiba Nippo, The Niigata Nippo, The To-o Nippo & The Fukushima Minyu Shimbun, December 1, 2013)

2. Local Governmental Measures

(1) Fukui Prefecture

The Wakasa Wan Energy Research Center has chosen two subjects for the "New Industry Creation Model Project for Reinan Area" and the "Promotion for Forming Research and Development Base Project" for the second subsidy for FY 2013. They are parts of the energy development base plan of Fukui Prefecture. The maximum subsidies are an annual ¥6 million for the model project, and an annual ¥20 million for the development base project including developing a prototype. (Fukui Shimbun, November 27, 2013)

(2) 3 Prefectures in Tokai Region

On November 28th, the first conference of the "Tokai Council for Industrial Competitiveness" was held to discuss growth strategies for the region in the Nagoya City with local governments of Aichi, Gifu, Mie, Shizuoka and Nagano Prefectures and heads of business. Quite a few members suggested that human development and deregulation were needed to promote the aerospace industry which is considered to be a next generation growing business. The governor of Nagoya, Hideaki Omura brought up infrastructure preparation for next generation vehicles such as chargers for electric vehicles (EVs) and hydrogen filling stations for FCVs, and requested deregulation for these vehicles to be tested on actual public roads. (Ise Shimbun, November 29, 2013)

(3) Niigata Prefecture

On December 18th, Niigata Prefecture established "Niigata Prefecture Promotion Association for Next Generation Vehicle Industry". The association consists of academic and governmental organizations, businesses and banks, and aims to gather businesses specializing in advanced technologies of energy source, operation support and powertrains, a core component of next generation cars such as FCs. (Japan Metal Daily & The Niigata Nippo, December 19, 2013)

3. Technology Developments and Business Plans of FC Elements

(1) Zeon Corporation

Zeon Corporation will start the commercial production of next generation carbon material, single wall carbon nanotubes (CNTs). A plant will operate from 2015 for the production, and the annual production is expected to be a couple of tons for a while. The product will sell for about one thousandth that of conventional CNTs. Being strong, CNTs conduct heat and electricity efficiently, and are expected to be used for a wide range of products including capacitors and FCs. As well as the CNT commercial production, the firm aims to increase sales by combining them with existing products such as elastomer and films to sell the product as components. (The Nikkan Kogyo Shimbun, December 2, 2013)

(2) University of Tsukuba & Kyoto University

The study team of Mutsumasa Kyotani, a guest researcher at the Tsukuba Research Center for

Interdisciplinary Materials Science (TIMS), and Kyoto University has developed a porous carbon sheet derived from cellulose. Raw materials for rayon, paper and cotton cloth were directly carbonized, without pyrolysis, using sulfonic acid to give the materials a shape retention function at a nano level as well as flexural strength. Before carbonization, the material was processed in methanesulfonic (MS) acid solution, a dehydration catalyst, and then heated in argon gas at 800°C . The process to make the carbon sheets was confirmed to bring the carbonization yield of the material close to its theoretical value. Also conductivity can increase by controlling crystallinity, and the product was found to be effective for a diffusion layer of FC. The team aims to commercialize the process of highly functional carbon sheets. (The Chemical Daily, December 9, 2013)

(3) Stanford University

The study team of Hirohito Ogasawara, a staff researcher at Stanford Synchrotron Radiation Lightsource of SLAC National Accelerator Laboratory discovered that water molecules near the platinum catalyst in a cathode play an important role in increasing the performance of FCs. Photoemission spectroscopy using X-rays, focused on the cathode was used to observe the oxidation in situ. The team found that hydration on the platinum catalyst surface determined the efficiency of the redox reaction at a molecule level. (The Nikkan Kogyo Shimbun, December 20, 2013)

4. Developments of Next Generation FCs and Related Products

(1) Evernew

Evernew, which produces and imports sports equipment in Tokyo, has started selling portable FC chargers which can supply mobile devices, such as smartphones, with electricity. They aim the product to be used for outdoor activities and as an emergency power source. The charger consists of a FC to generate electricity and a LIB with 1500mAh capacity to store the power. A charger cable and connector come with the product to charge cell phones and smartphones. The tank in the lower part of the charger holds water, and hydrogen is generated by setting a fuel pack, sold separately, in the charger. Being named “my FC Power Charger”, the charger, will sell for ¥25,200. (The Nikkei Business Daily, December 4, 2013)

(2) Kyoto University & Aquafairy

Prof. Kazuyuki Hirao of Kyoto University developed a stationary solid hydrogen FC with cooperation of Aquafairy. An improved solid fuel cartridge can supply the FC with hydrogen for a continuous 24 hours. Because the improvement extended the fuel replacement interval to once a day, they expect the FC to be used in mountains where power is difficult to secure. Powdered metallic aluminum and calcium hydroxide are compacted for the fuel of the newly developed stationary FC, and produce hydrogen by the corrosion reaction of aluminum. Their current portable product uses calcium hydride for its fuel, but the stationary FC uses the cheaper chemical calcium hydroxide for considerable reduction in the fuel cost. By using a nano technology, fuel is made into a special shape in the solidifying process, which can release hydrogen slowly over 24 hours. Also the reaction rate is over 95%, which is a practical level. Their current product generates electricity by simply inserting the fuel cartridge into the FC system; however, the new FC requires several minutes for hydrogen to actually come out after inserting the fuel. For this time lag, the group plans to integrate a small storage battery in the system which allows for the supplying of power while waiting for the hydrogen. Also a technology has been developed to process the reacted compound of the fuel, in order to use it again to produce hydrogen, with cooperation of Hitachi Zosen. The calcium and aluminum compound after the corrosion reaction was processed at high temperature, and then exposed to ultraviolet light. Hydrogen production was confirmed by adding water to the processed compound. (The Nikkan Kogyo Shimbun, December 5, 2013, Nikkei Marketing Journal, December 6, 2013)

(3) Nihon Nokyo Denshi (Aqua Power System Japan)

Aqua Power System Japan, Tokyo, will start a new light emitting diode lighting brand “Akupa” with a magnesium-air FC which generates electricity from salt water. The series has a torch and a lamp for home, and will be sold as zero environmental impact lighting. The FC uses a membrane to let only air through but no liquid, for the cathode. The anode is a magnesium pole, and salt water is the electrolyte. A release system of hydrogen gas was improved for the series. Also, the ion exchange rate was enhanced by revising the

arrangement of the magnesium pole and adjusting the air flow. For 1.5 V, the amount of current is increased to triple, about 1.5 A, that of conventional products. Also the FC has an easier access to refill salt water. (The Nikkan Kogyo Shimbun, December 10, 2013)

5. Business Plans for Industrial FCs

(1) Softbank

On November 25th, Softbank revealed its plan to import and sell a total of 30MW worth of US-based Bloom Energy's industrial FCs in Japan over three years. They aim to install the products at large firms and public offices. Their 20 story office building in Fukuoka City is already equipped with about a 9 m wide, 2 m high and 3 m deep FC which outputs approximately 200 kW and provides approximately 75% of the electricity consumption. This solid oxide fuel cell (SOFC) system extracts hydrogen from natural gas or methane gas. The electricity rate is a maximum of ¥28/kWh. A reduction in gas price through importing shale gas may bring the rate down to around ¥20/kWh. (The Asahi Shimbun, The Nikkei, The Denki Shimbun, Dempa Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, The Kyoto Shimbun, The Nishinippon Shimbun, Miyazaki Nichinichi Shimbun, Kumamoto Nichinichi Shimbun, The Saga Shimbun & The Yamaguchi Shimbun, November 26, 2013; The Nikkan Kensetsu Kogyo Shimbun, November 27, 2013)

On November 25th, Bloom Energy Japan, a fifty-fifty joint venture of Softbank and US-based Bloom Energy, started its first industrial FC "Bloom Energy Server" in Japan. The electricity price is up to ¥28kWh. (Fuji Sankei Business i, December 11, 2013)

(2) GE

US-based GE has started a new business related to generators in Japan, and aims to sell its key components such as turbines to thermal power plants in Japan by proposing generation ability improvement. They also plan to enter the FC market by 2016, and a SOFC is already under development. Visiting Japan, John Rice, a vice president of GE mentioned the plan to commercialize FC by 2016 and to move into the global market using experiences in Japan. He also indicated a possibility to cooperate with a Japanese firm for the FC development. (The Nikkei December 5, 2013)

6. Business Plans for Ene-Farm

(1) Daiwa House

Daiwa House will develop a total of 175 houses for sale "SMA × ECO CITY Tsukuba Science City" in Tsukuba City, Ibaraki Prefecture. Each house will be equipped with a home LIB, photovoltaic generator and Ene-Farm. With an EMS to produce the energy system statement of the town, the whole development will be the largest smart city for the firm. A ceremony making start of construction was held at site on December 14th. (Daily Construction Newspaper, December 17, 2013)

(2) Osaka Gas

On December 18th, Osaka Gas announced that the lowest priced Ene-Farm in Japan would be available from April 1st, 2014. The suggested retail price is ¥1.944 million including 8% tax. The FC uses fewer parts and cheaper material for the core components. Tokyo Gas released Ene-Farm in April which is currently the cheapest product with the price of ¥1.995 million including 5% tax. Some of Osaka Gas's Ene-Farm can be remotely controlled by a smartphone to switch on the water heater and underfloor heating. Also the generation status can be checked on a smartphone. The development was jointly conducted with Toshiba Fuel Cell Systems, Chofu Seisakusho and Noritz. (The Asahi Shimbun, The Mainichi Newspapers, The Nikkei, The Sankei Shimbun, The Denki Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, The Kobe Shimbun & The Kyoto Shimbun, December 19, 2013)

(3) Hokuriku Gas

Hokuriku Gas has announced that the total number of its domestic cogeneration systems in use had reached 1,000 by the end of November. The detailed figures of the total 1,043 are 696 units of Ecowill using a gas engine and 347 units of Ene-Farm. (The Denki Shimbun, December 19, 20139

7. Cutting Edge Technologies of FCVs and EVs

(1) Fuji Heavy Industries

In June, Fuji Heavy Industries revealed its first hybrid vehicle developed with cooperation of Toyota Motor, and now plans to expand the range of hybrid vehicles with technical support of Toyota for FCV.

(Japan Metal Daily, November 26, 2013)

(2) KEPCO, Takenaka Corporation & Others

On November 26th, a group of Kansai Electric Power Company (KEPCO), Takenaka Corporation and others announced that an experiment would start to supply a building with power from EVs and plug-in hybrid vehicles (PHVs) in Osaka City. The experiment aims to develop a system to provide energy during power cuts and to moderate the demand peak. Including MID Urban Development, a subsidiary of KEPCO, six firms and organizations will participate in the experiment. A car park of an office building will have five EVs and PHVs in total as well as a facility which can charge and discharge the cars simultaneously. The experiment includes approximately 30 minutes of elevator operation only on the car batteries and effective power supply from batteries during high demands. The group will start it from FY 2014 and capitalize about ¥300 million over the period to FY 2015. (The Nikkei, November 27, 2013)

(2) Panasonic

On November 26th, Panasonic announced that a new EV charger would be available from January 21st, 2014. With its wall mount, the charger is expected to be installed in underground car parks and public facilities, and will sell for from ¥170,000. The manufacture aims for ¥10 billion sales, four times that of 2012, by FY 2018. (The Nikkei, November 27, 2013)

(4) Daihen

On November 27th, Daihen, Osaka City, announced that a wireless power charging system had been developed for compatible EVs. The power source can produce a higher frequency than conventional power sources, which makes the transmission range wider. With a high frequency, an EV can be automatically charged even if it is parked 50 cm off the position. The power source uses inverters with improved conversion efficiency and a current regulator for semiconductor handling systems in order to supply power without much loss at the high frequency of 13 MHz. The transmission rate at high frequency was 50%, but improved to 85% which is the level at low frequency. Starting the sales from April, 2014, the firm plans to cooperate with automakers to expand sales. (The Nikkei, November 28, 2013)

(5) SoftBank

SoftBank will fully bring its charger management system for EVs into the Asian market. The system is to be incorporated in EV chargers, and flexibly bills customers depending on how much electricity they have put in their cars. With local firms there, Softbank has started its sales activity in Brunei and the Philippines where EVs' are expected to grow. (The Nikkei, November 28, 2013)

(6) Sekisui Chemical

Sekisui Chemical has developed a new material for LIBs for EVs. The material can store triple the amount of electricity of conventional products, which allows an EV to drive about 600 km on a full battery. The firm also developed a material which can simplify the production process. With these developments, a 60% reduction is targeted in the battery production cost. Storing electricity, the developed material uses silicon, which takes more electrons, instead of conventional carbon materials. The manufacturer made an alloy by combining the material and a metal to improve durability which was the issue for commercialization of the product. Also, a new electrolyte was developed to allow a smoother current flow. The product only requires to be applied on a material such as silicon, which eliminates the need of facility to inject fluid into batteries. The battery production rate is currently three units per an hour, and can be increased to 10 times. The production cost per kWh is estimated to go down to just over ¥30,000 from about ¥100,000. Automakers think that the EV price can come down to gasoline car levels if the battery cost per kWh get to ¥30,000 or below. Sekisui Chemical plans to ship samples of the new materials to battery manufacturers in summer of 2014 as a sales activity, to start commercial production by 2015. (The Nikkei, December 3, 2013)

(7) Osaka Motor Show

The largest automobile exhibition in the western part of Japan "Osaka Motor Show" was held at Intex Osaka, Osaka City, from December 20th to 23rd. Toyota Motor brought its FCV concept which had caught visitors' eyes at Tokyo Motor Show. Nissan Motor displayed its three-seater EV concept "BladeGlider". Because Osaka Motor Show is largely run by car dears, its exhibition tends to show more practical vehicles, including eco cars, and technologies. BMW

exhibited its first commercial EV "i3". Mitsubishi Motors showed two sport utility PHV which can be charged from a domestic socket. A computer in the car automatically chooses to run only on electricity or use both gasoline and electricity based on battery level. Osaka Institute of Technology brought a solar car. An EV of the Osaka Prefectural Sano Technical High School attracted visitors with an original display style. Using a small class truck as its base, the EV can be charged with a small domestic solar panel or a wall socket at home. Six hours of charging gives a 50 km driving range. Seven members of the school's automobile club spent three months of their after-hours to build the car for. (The Yomiuri Shimbun, December 3, 10, 14 & 20, 2013; Nikkan Jidosha Shimbun, December 4, 2013; The Sankei Shimbun & The Kobe Shimbun, December 12, 2013; The Nikkei, December 20 & 21, 2013; Osaka Nichinich Shimbun, The Kyoto Shimbun, Nara newspaper, The Nishinippon Shimbun, Nihonkai Shimbun, The Shikoku Shimbun, The Tokushima Shimbun, The Yamaguchi Shimbun, Miyazaki Nichinichi Shimbun, Saga Shimbun & etc, December 21, 2013)

(8) Sumitomo Electric Industries

Sumitomo Electric Industries will start shipping samples of its sodium-ion battery by next spring, and plans to begin production on a large scale by FY 2016 aiming to sell them for energy saving houses and EVs. A dedicated clean room was prepared with ¥1 billion. Plates of the sodium-ion battery (approximately 11 cm by 14 by 4 cm) will be produced and delivered to electronics manufacturers. The capacity of each plate is 125 Wh, and connecting batteries gives a wide range of applications. Sodium is dissolved in the electrolyte of sodium-ion batteries to transfer electrons, and there is a plentiful of sodium in sea water. This makes it easier to secure the supply than of lithium, of which South America dominates the production. Although, sodium-ion batteries have disadvantageously needed over 57 °C for their operations, Sumitomo Electric succeeded in operating its battery at 20°C this summer. The product is one of the promising next generation batteries, and the firm plans to sell it for the same price level or less of LIB (¥100,000 to ¥200,000/kWh). (The Nikkei, December 5, 2013)

(9) Honda

On December 6th, Honda Motor revealed that its PHVs would be lease for consumers. Planning on full sales later, the firm will start the lease at 170 dealers, largely in the Tokyo area, from December 22nd, and the number of PHVs is limited to 400. (Fuji Sankei Business i, December 7, 2013)

(10) Toyota

Toyota Motor has started an experiment to improve recyclability of FCVs which aims to be introduced into the market in FY 2015. Technologies are being tested to collect and reuse platinum in FC stacks and disassemble and reuse high pressure tanks for hydrogen storage. Also the automaker aims to make the maintenance of FCVs the same level as that of gasoline cars. (Nikkan Jidosha Shimbun, December 11, 2013)

(11) Nagoya Motor Show

Nagoya Motor Show, organized by the Mid-Japan Economist, will start at the Nagoya International Exhibition Hall in Minatoku, Nagoya City from December 12th. Toyota Motor will display its FCV to be commercialized in FY 2015. Nissan will exhibit a new small EV and a business use EV to be available from next year. (The Chunichi Shimbun, December 12, 2013)

(12) Kyoto University

On December 16th, Associate Prof. Masaharu Komori at Kyoto University announced that a transmission system had been developed to extend the driving range of EVs by 10%. The new system avoids power loss at gear shift in order to maintain speed as much as possible. In the conventional system, power is disconnected from a gear to change into another. The new system uses another gear wheel during gear changes in order to minimize loss of power from the engine. This time the team succeeded in changing into two gears with a commercial EV as an experiment, and aims to commercialize the transmission system in five years with cooperation of an automaker. (The Nikkei, December 17, 2013)

(13) Nissan

Automakers are putting more effort into the development and sales of cars which are easy to use for elderly and disabled people. Nissan Motor has developed an EV which has a self-driving system and is driven only by both hands, but no feet. The EV accelerates more smoothly than gasoline cars, which

gives more stress free driving for the elderly. (The Nikkei, December 18, 2013)

(14) Mazda

On December 19th, Mazda Motor revealed a prototype of its EV (PHV) which is equipped with a rotary engine to generate electricity in order to extend its driving range. The EV use Mazda's "Demio EV" as its base, and gasoline in its 9 L tank is combusted in the rotary engine to charge the battery. Demio EV drives approximately 200 km on a fully charged battery, and the rotary engine realizes double the driving range. The rotary engine is characteristically easily made small. (The Nikkei, December 20, 2013)

(15) Tokyo Institute of Technology

The study team of Prof. Takashi Yabe of the Tokyo Institute of Technology developed a new battery using magnesium, which is plentiful in sea water, for the electrodes. Although magnesium batteries are non-rechargeable, they can theoretically provide approximately seven times the power of LIB. The large capacity allows an EV to drive 500 km. Magnesium is light metal and can work as electrodes to go in salt water which makes up to battery. Currently magnesium batteries have had a difficulty in practicality that they require a large amount of salt water to be replaced every several hours. Studying with Fujikura Rubber, Prof. Yabe developed a thin film of magnesium and rolled it up. The film is fed slowly like a tape recorder to act with salt water continually, which eliminates the need to replace salt water and makes the battery work longer. On December 20th, the team demonstrated a test car powered by the battery. The dimensions of the battery are 34 cm long, 17 cm wide and 2 cm thick, and the product weights 800 g. 40 batteries were combined to make the 560 W power source to drive the 200 kg test car smoothly. (The Nikkei, December 22, 2013)

8. Development, Experiment & Business Plans of Hydrogen Filling Stations

(1) Aich Steel

Aich Steel will start to sell its brand new stainless steel for high pressure hydrogen tanks"AUS316L-H2" which was developed last year as a material for valves. The product keeps its strength better with hydrogen which makes normal steel brittle, and withstands high pressures of 70 MPa. To reduce hydrogen embrittlemen, the new steel was made by adjusting the compositions of stainless steel "SUS316" and "SUS316L". On November 27th, the firm announced that the sales target of steel for hydrogen filling stations for FCVs was increased to ¥100 million for FY 2015, triple that of the estimated sales for FY 2013. Demands for the steel are expected to increase due to the market entry of FCVs in 2015. The manufacture plans to sell the product widely for valves, pipe fittings and dispenser nozzles which are used under a high pressure. (The Nikkan Kogyo Shimbun, November 28, 2013; Japan Metal Daily, November 29, 2013)

(2) Chugoku Kogyo

Chugoku Kogyo plans to develop a composite accumulator hydrogen storage cylinder, for hydrogen filling stations which are the infrastructure for FCVs with the New Energy and Industrial Technology Development Organization (NEDO). A 12 L cylinder has already been developed with a carbon fiber fortified resin liner. By upsizing the cylinder, the manufacture aims to develop a 300 L cylinder, and to commercialize it by 2018. The price is expected to be about ¥10 million. The burst pressure of the 12 L cylinder is 360MPa. The governmental guidelines require the designed pressure of 106 MPa for commercial products and a repeated use of over 100,000 times for a large high pressure hydrogen cylinder accommodating 300 L. NEDO will financially support the manufacture a half the development cost of approximately ¥120 million over three years. (The Nikkan Kogyo Shimbun, December 2, 2013)

(3) Tatsuno

Tatsuno, Tokyo, has established a cross departmental project team to strengthen its hydrogen filling station business. The manufacturer developed a dispenser to fill FCVs with hydrogen gas at a high pressure, and is trying to reduce the cost of the product to expand the sales. The developed dispenser has a "coriolis flowmeter" with the world's highest precision, and supplies hydrogen gas pressurized at 70 MPa. Tatsuno manufacture measuring instruments for gasoline filling stations, and has over 60% share in the Japanese market. This spring, they built a hydrogen filling facility including dispensers at the Ebina Chuo Hydrogen Station which now supplies gasoline and hydrogen on the same premise. (The Nikkan Kogyo Shimbun, December 3, 2013)

9. Developments & Business Plans of Hydrogen Production & Refining Technologies

(1) Osaka City University

A team of Prof. Kamiya Nobuo and Prof. Yutaka Amao at the Advanced Research Institute for Natural Science and Technology of Osaka City University aims to develop an efficient hydrogen production system and a light driven catalyst to produce hydrogen to lead next generation hydrogen energy as an industry and academia cooperative research. In FY 2014, they plan to create a hydrogen production system to produce about 1.5 V, the common battery level, using artificial photosynthesis. Osaka City University will work together with University of Hyogo, and business participants of the development are Fuji Chemical Industry of Toyama Prefecture, Daiwa House Industry, Sharp, Espec and Glory. (The Nikkan Kogyo Shimbun, December 11, 2013)

(2) University of Hyogo

On December 26th, University of Hyogo will establish a "Next Generation Hydrogen Catalyst Cooperative Research Center". The research center plans to develop an electrode using hydrogenase which is a biological enzyme within FY 2014. With good conditions, hydrogenase can produce hydrogen an over of 10 thousand times more efficiently than platinum. They aim to develop an electrode using hydrogenase within 2014, and to commercialize a next generation hydrogen production system and FC by 2024. (The Nikkan Kogyo Shimbun, December 20, 2013)

10. Developments of FC & Hydrogen Related Evaluation Facilities

(1) Panasonic

On December 6th, Panasonic announced that an evaluation facility of automobile short stack FCs and a facility to analyze single cells for fundamental research were developed. The evaluation technologies built from domestic FC developments was used, and high precision pressure, temperature and current control functions were added to the new products. They comply with high power output for automobile FCs which is100 times higher than domestic FCs. These products can contribute to earlier commercialization which should reduce the cost of automobile FCs by improving the efficiency of the developments of FC and FC material manufacturers. Measurement results of the FC evaluation equipment are highly reproducible, which can shorten evaluation periods. The equipment has highly accurate pressure control of hydrogen gas, an automatic program for evaluations and a temperature adjustment system of FC stack. Panasonic previously introduced evaluation for 660 W single cells. Accommodating 2 to 100 kW, the new equipment can evaluate FC stacks for vehicles. (The Nikkan Kogyo Shimbun, December 6, 2013; The Chemical Daily, December 9, 2013)

(2) Kyowa Electronic Instruments

Kyowa Electronic Instruments developed a foil strain gage for a hydrogen gas environment "KFV-2-350-CI" and has started sell it for research and development of hydrogen energy systems. Using iron alloy in its construction, the product can measure tensile and fatigue strength of metal materials in high pressure hydrogen gas. The strain gage is a sensor that is glued on a structure to detect microscopic change in size using electrical signals. Hydrogen affects metal, and metal resistance foils of more conventional products become brittle in high pressure hydrogen gas, which changes electric resistance. This prevents stable strain measurement. The manufacturer worked on materials for the new instrument in order to reduce electrical resistance changes by the hydrogen. The development was carried out with technical support of the Research Center for Hydrogen Industrial Use and Storage of Kyushu University. The manufacturer sells the product for hydrogen filling stations and FCVs to develop safer hydrogen systems. The gage will sell for ¥50,000. The sales target is 1,000 units for the first year, and 2,000 each for later years. (The Nikkan Kogyo Shimbun, December 17, 2013)

— This edition is made up as of December 22, 2013 —

A POSTER COLUMN

Development of Effective Artificial Photosynthesis Fuel Production for FC

Panasonic has developed an artificial photosynthesis system to synthesize methane using water and CO_2 as materials and sunlight. Toyota Central R&D Labs, a research firm of the Toyota Motor group, and

Panasonic succeeded synthesizing formic acid, an organic material, at the efficiency level of plants. However, the new development is the first system to produce a compound which can be directly used as a fuel.

This time, Panasonic uses gallium nitride and a semiconductor which is combined with silicon photovoltaic generator in order to convert sunlight and water into electricity. Then, the energy is fed to a catalyst containing copper to produce methane from CO_2. The energy conversion efficiency is 0.04% which is low. However, methane can be produced continuously on sunny days by using a highly efficient photovoltaic generator. The manufacturer plans to develop a technology to synthesize alcohol, and to investigate applications of methane and alcohol as fuels of FC.

This should be the first step towards artificial photosynthesis to produce useful fuels using an inexhaustible supply of material and renewable energy. (The Nikkei, December 6, 2013)