THE LATEST NEWS NUMBER 240, 2016 FCDIC

Experiment of Smart Community Connecting FCV and Home with Power

Arranged by T. HOMMA

1. Governmental Measures

(1) MLIT

The Ministry of Land, Infrastructure, Transport and Tourism, MLIT, will set safety standards for motorbikes using a next generation powertrain such as an electric motor and hydrogen. Standards for hydrogen gas containers for fuel cell (FC) motorbikes and safety for electric motorbikes will be implemented from January, 2017. In the Tokyo Motor Show, "EV Cub" of Honda and a FC unit of Suzuki were displayed. The ministry will support the next generation motor bike sales by establishing safety standards in Japan to preempt international standards. As hydrogen gas container requirements, the motorbikes have to be designed to avoid the containers contacting other parts of the motorbikes or the road during accidents including falling over, and the fixture of the container must withstand expected impacts from accidents. Also the motorbikes must release hydrogen gas outside the vehicle in emergency circumstances, so that fire fighters and emergency service can trace the gas movement for safety. The standards will be implemented from January 2017. (Nikkan Jidosha Shimbun, December 3, 2015)

(2) NEDO

The New Energy and Industrial Technology Development Organization, NEDO, will start development of stationary FCs for commercial facilities and plants. This development will try to commercialize a solid oxide fuel cell system by 2020. In the project, FCs of 5 kW output and a 250 kW generation system combining FCs and gas turbines will be developed, and tested for their performance and durability. (The Nikkei Business Daily & The Chemical Daily, December 4, 2015)

(3) Japanese Government/Ruling Party

On December 9th, the Japanese government/ruling party decided on a new tax scheme for cars to replace the automobile acquisition tax, a local tax. The tax revenue will decrease by approximately ¥20 billion to reduce tax on eco cars. The current automobile acquisition tax will be abolished when the sales tax is increased to 10% in April, 2017 reducing the impact of car purchasers. In the new tax scheme, residents will pay extra to the automobile tax when they buy cars. The automobile tax is to be paid every year. The extra tax applies to consumers who keep the purchased cars past the year, and only applies to first year of the purchase. The tax will go to local governments. As well as new car sales, used cars are subject to the scheme. The tariff of the tax will be from 0 to 3% of the purchase price depending on fuel efficiency, an indication of environmental performance. The tax rate will be in four tiers, and drop as fuel efficiency goes up to promote eco cars. Although the current automobile acquisition tax also gives a better rate as cars get more environmentally-friendly, the requirements for a lower rate will be more relaxed in the new scheme than the current one. This revision of the tax scheme is for the automobile industry which is worried about falling sales. The current automobile acquisition tax is set in six tiers each for Kei Class, of which engine is 660 cc or less, and the rest depending on fuel efficiency. The new scheme will be made simpler to four tiers, three tiers for Kei Class, by 1% steps, and the zero (0%) tax range will be expanded. In the current scheme, the zero-tax range will be applied to gasoline cars with 20% better fuel efficiency than the latest target of fuel efficiency standards, currently for FY2020, set by MLIT as well as electric vehicles, EVs, and FCVs. The zero-tax range in the new scheme will include gasoline cars with 10% better fuel efficiency than the latest target of fuel efficiency standards. (The

Mainichi Newspapers, December 10, 2015)

(4) MOE

On December 10th, the Ministry of the Environment, MOE, and the Ministry of Ecology, Sustainable Development and Energy of France signed a memorandum of agreement on cooperation to develop a low-carbon society for the environment. With this agreement, the two countries will jointly support developing countries, and exchange information for the development and promotion of geothermal, hydrogen and low-carbon technologies and liaison between Japanese and French cities for a low-carbon society. Other cooperative areas are controlling air pollution, securing bio diversity and waste management. (The Nikkei, December 11, 2015)

2. Local Governmental Measures

(1) Fukuoka City

On December 11th, Fukuoka City started providing hydrogen to FCV users at the hydrogen refueling station in Fukuoka City Central Sewage Treatment Center. Users will sign up the memorandum of agreement for this experimental hydrogen supply operation, and the refueling station is open every Tuesday. This current operation will last for a while. The refueling station supplied a total of 15 FCVs with hydrogen on 11th and 18th. Fukuoka City has promoted the "Leader City Project in Hydrogen" which tackles innovative measures to explore a hydrogen society to be a pioneer. As a part of this project, an experiment is being carried out to produce hydrogen from sewage biogas by a research consortium formed by Kyushu University, Mitsubishi Kakoki, Toyota Tsusho and the city. The production is world's first on a commercial level. This project supplies FCVs with hydrogen produced from biogas which emitted during sewage treatment. The city advertise this as "green hydrogen from sewage to reduce environmental impacts" to save CO_2 emissions. The station has supplied official cars of the city with hydrogen as an evaluation since its open in March, 2015. Because the supply system of the facility in the city was prepared for larger operation, the refueling station has started to open to the public. However, users need to exchange memorandums with the research consortium before using the facility. They pay for hydrogen as a cooperation fee, and provide FCV driving data including driving distance and numbers of passengers. The cooperation fee is ¥1,100/kg. Users are required to book for hydrogen supply, and the station opens from 10 am to 3 pm. The facility started its first operation for the public on 11th, and provided six FC taxis with hydrogen. On 18th, nine vehicles were supplied with hydrogen. According to the city, the station is capable of supplying 65 vehicles each day. In Fukuoka Prefecture, there is a commercial hydrogen refueling station already operating in Kitakyushu City, and the infrastructure for FCVs is improving for users since the station in Fukuoka City started operation for the public. (Nikkan Jidosha Shimbun, November 26, 2015)

(2) Tokyo

On November 26th, Governor Yoichi Masuzoe had a meeting with Minister of METI Motoo Hayashi at the ministry office, and they agreed to cooperate for realizing hydrogen society and smart city. "The Japanese economy needs to be sound to successfully host of the 2020 Tokyo Olympics and Paralympics and Rugby World Cup in 2019. We absolutely want to revive Japan." Mr. Masuzoe emphasized. He thinks what we leave after the Olympics is the issue. "After previous Olympics, the bullet train was a legacy. This time, we want to establish hydrogen society." he said. Hydrogen refueling stations are planned for 80 locations. This was explained to the minister, and the governor requested deregulation to the government. Also, Mr. Masuzoe introduced smart city projects under development in major European cities, and pointed out the importance of cooperation between the Japanese and Tokyo governments. (The Denki Shimbun, November 27, 2015)

(3) Toyama Prefecture

In January, 2016, "Toyama Hydrogen Energy Promotion Committee" will be launched to establish hydrogen society in Toyama Prefecture, and it will aim to install a hydrogen refueling station for FCVs by 2020. Toyama Toyota will join the project as one of three proposers to promote hydrogen society from the automobile industry selling FCVs. The committee will ask governmental bodies, universities and businesses to join the project in order to solve issues for hydrogen energy to be used more. The committee consists of organizations from industry, academia and government, which is unusual in Japan. They aim to

install the first hydrogen refueling station in the Hokuriku area. (Nikkan Jidosha Shimbun, November 27, 2015)

(4) Asahi-ku, Yokohama City

Asahi-ku, Yokohama City, has bought FCV "MIRAI" as an official car. Kanagawa Toyota Motor Sales delivered the vehicle, and a delivery ceremony was held at the local government office. The head of the local government and Mr. Watanabe, an executive officer of Kanagawa Toyota attended the ceremony. (Nikkan Jidosha Shimbun, December 7, 2015)

3. FC Element Technology Development & Business Plans

(1) Kyushu University

A team of Prof. Naotoshi Nakashima at the Faculty of Engineering, Department of Applied Chemistry of Kyushu University has improved the durability of a catalyst by over 120 times for polymer electrolyte fuel cells, PEFCs operate under an humidified environment at low temperature. Uniform sized platinum particles were highly dispersed and attached on surfaces of carbon nanotubes, CNTs, to be the catalyst, and this catalyst made the improvement. This technology allows a significant reduction in FC costs, and the team aims to commercialize it in five years. CNTs have good conductivity and durability; on the other hand, it is hard to attach platinum nanoparticles on them. The team previously found "polybenzimidazole" which is a resin to easily fix on surfaces of carbon materials. CNTs were thinly coated with this resin to successfully attach platinum nanoparticles. Then, a catalyst was made with other special materials and a resin to transfer protons. This catalyst exhibited high durability under a high temperature of 120°C and non-humidified environment which are considered as operating conditions of next generation FCs. In the research, the catalyst was created with this special material instead of "Nafion", a resin used in commercial FCs. The team repeatedly applied 1 to 1.5 V to the catalyst under low temperature of 80°C and low humidity which are common generation conditions. After 600,000 cycles, the catalyst barely lost it electromotive force. On the other hand, a conventional catalyst reduced its electromotive force to half in 5,000 cycles. (The Chemical Daily, November 25, 2015; The Nikkan Kogyo Shimbun, November 26, 2015)

(2) Mitsubishi Gas Chemical

Mitsubishi Gas Chemical aims for early commercialization of direct methanol fuel cells, DMFCs. The demand of these cells has been increasing for wireless base stations including backup power supply for broadcasting as well as emergency power source at offices as business continuity planning for disasters. The producer is developing improved portable generators in smaller size to deploy full-scale sales activity. Their DMFCs use a lithium-ion battery, LIB, to stabiles output, and have an advantage of quiet operation. The manufacturer will offer portable and stationary types. Their generators get more attention for a wide range of use including broadcasting equipment and observational instrument, and the firm aims for orders to fully build this business. (The Chemical Daily, December 7, 2015)

(3) Denso

Denso will start an experiment of FCs for business use. The product will be solid oxide fuel cells, SOFCs, and the firm will improve the generation performance to 5 kW to better suit business use. The technology is planned to be established for commercialization in FY2017. SOFCs generate power efficiently, and the heat produced during power generation can be used to heat water. This makes the system energy efficient. "Ene-Farm" also uses this system, and the technology is expanding its use. The firm will test FCs to be able to sell the product for commercial use. The targets of the product are restaurants/cafes, hairdressers/barbers and welfare facilities. (The Nikkei Business Daily, December 10, 2015)

(4) Aquafairy

Aquafairy, Kyoto City, will develop a FC system which continuously operates at low-output. They will introduce standard specifications in January 2016, and sent the product to some businesses for free to explore usage in disasters, leisure, and the internet of things, IoT. The firm was previously targeting mobile products for its FC usage. Since rechargeable batteries have gone down in price, they have changed the target area. They will seek usage for FCs to be more advantageous. The standard specification which outputs 30W will be available from January. This can takes two fuel cartridges of calcium hydride which produces hydrogen by reacting it with water, and

operates continuously by replacing cartridges. The maximum capacity is 1200 Wh. The product weighs 6.5 kg; 7.3 to 8.1 kg with fuel. The generator is portable and lighter than a rechargeable battery at the same capacity level which is 20 to 30 kg. The portable generator will sell for ¥500,000 excluding sales tax. (The Nikkan Kogyo Shimbun, December 17, 2015)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) Honda

Honda is participating in "La Galerie by We" which is a related event of the 21st Conference of the parties (COP21) of the United Nations Framework Convention on Climate Change held in Paris, France, to introduce energy management technology focusing on hydrogen. La Galerie by We is a place to propose and show measures for saving energy and CO_2 emissions as solutions for the global issue of climate change. The automaker started an experiment on reduction in fuel consumption using charging technology of EV in the Republic of the Marshall Islands which has a large problem of sea-level rise caused by global warming. They present suggestions to combat environmental issues by introducing their global actions for reduction in CO_2 emissions and energy consumption. Their presentation is an original smart hydrogen refueling station using "Power Creator", a high pressure water electrolysis system, and "Power Exporter 9000", an inverter to supply power from FCVs and EVs, to introduce their suggestion of smart community. (The Denki Shimbun, December 9, 2015)

(2) Chiyoda Corporation

Chiyoda Corporation and Asahi Kasei together will develop a large-scale production and storage system of hydrogen using wind turbines. An experimental facility will be built in the research center of Chiyoda in Yokohama City. In the system, wind turbines will generate power to split water, and produced hydrogen will be stored in a liquid form under normal temperature and pressure. Hydrogen will be used in SOFCs to generate power. Because hydrogen can be stored and transported on a large-scale, it is better to convert energy from wind turbines into hydrogen rather than using the energy directly as electricity. This system allows a stable supply of wind power. The firms aims for efficient use of renewable and hydrogen energy. (The Nikkan Kogyo Shimbun, December 21, 2015)

5. Ene-Farm Business Plans

(1) Consumer Affairs Agency

On November 28th, the investigation board for consumer safety, the accident investigation board, decided to investigate the relationship between operation noise and vibration of "Ene-Farm" and "Ecowill" which both provide electricity and hot water for homes using gas, since some consumers claimed that these products caused their sleeping problems and dizziness. "These products are expected to be more popular for saving energy, and we need to take notice of health problems possibly caused by the products in an early stage" Dr. Yotaro Hatamura, the chairperson of the board, explained. Ene-Farm and Ecowill have been sold over 100,000 units each. The board received 32 health problem reports from consumers over four years by this October. (The Asahi Shimbun, The Nikkei, The Sankei Shimbun & The Tokyo Shimbun, November 28, 2015)

(2) JPA

Japan Prefabricated Construction Suppliers and Manufacturers Association, JPA, has published a result for FY2014 of the "Eco Action 2020", an environmental action plan. The report reveals that CO_2 emissions from each home decreased by 9.9% from the previous year since photovoltaic generation and FC cogeneration systems are becoming popular. Eco Action 2020 targets to reduce CO_2 emissions at home by half that of FY2010. Compared to FY2010, the emissions for FY2014 went down by 25.7%, 1.734 tons. (Fuji Sankei Business i, November 30, 2015)

(5) Osaka Gas

Osaka Gas will introduce a new Ene-Farm of which the generation efficiency is over 50% in the spring of 2016. This system uses next generation SOFCs, and the price level will be under ¥ 1 million including sales tax. Although the gas supplier focused on houses rather than apartments for the sales of the product, it will try more for apartment units with the compact system. Their accumulated sales result is 40,000 units up to July, 2015, and 200,000 units are targeted by 2020. The new system has improved generation

efficiency, which allows using a smaller hot water tank because of less heat production. The existing model requires a large capacity tank, and it is not suitable for apartment units due to limited space. Kyocera produces stacks of SOFC for the Osaka Gas, and the new system is under development in cooperation with Aisin Seiki and Chofu Seisakusho. The gas supplier started Ene-Farm sales in 2013, and the system was improved in 2014. The current model operates at a generation efficiency of 46.5%, and sells for ¥2.322 million including sales tax. (The Nikkan Kogyo Shimbun, December 15, 2015)

6. Cutting Edge Technology of FCVs and EVs

(1) LIXIL Housing Research Institute & Honda

In Katsushika-ku, Tokyo, Honda and LIXIL Housing Research Institute, a member of LIXIL Group, have finished building a show house of "Next Generation Resilience Home Ie Plus X Powered by Honda", which combines a house, car and energy. They will carry out experiments to commercialize the first consumer product house for FCVs in Japan. LIXIL Housing Research Institute has built a variety of concept houses for new products with a feeling of the near future, and this one is the sixth. By connecting home, car and energy, this new show house allows significant energy saving at normal times, and gives its residents independence for a long period during emergency situations such as disasters. As the key feature, the firms are trying to connect home and EV or FCV, which uses hydrogen for its fuel, as a "mobile power source". When the power grid is shut down due to disaster or power cut, a FCV can provide the house with electricity for seven days for residents to have a normal life. FCV or EV can bring power to houses short in electricity, which is another expected feature. The second side is "home plus energy". In addition to FCV/EV, the photovoltaic generator is to work together with the gas engine cogeneration system which can provide power using liquefied petroleum gas, LPG, as well as hot water. Honda is developing "Power Manager" to control power demand and supply, and this is to optimize energy use at home. (The Mainichi Newspapers, November 26, 2015)

(2) Nissan

On December 3rd, Nissan revealed that it has received pre-sales orders for over 3,000 vehicles of "LEAF" its improved EV and to be released on 24th. The new model offers 24 kWh used in the existing model or newly developed 30 kWh driving battery. (The Nikkei, December 4, 2015)

(3) Osaka Motor Show

On December 4th, the 9th Osaka Motor Show, the largest automobile fair in the western Japan, started at Intex Osaka in Suminoe-ku, Osaka City. Automakers brought concept cars pursuing "driving fun". They also offer test ride of latest available cars in the market on public roads, which is the first time in the event. Nissan introduced a small sports utility vehicle, SUV, with engine exclusively for electricity production. 11 cars including Toyota's FCV "MIRAI" are provided for test ride on the public roads around the venue. The exhibition ends on 7th. (The Nikkei, December 5, 2015)

(4) Tesla Motors

On December 4th, Tesla Motors announced that its EV "Model S" sold in Japan would be installed with driving assistant function from this year. Once MLIT certifies the function, the software to control the driving assistant function will be distributed via the internet. This function will control the wheel to keep in a lane on express roads. Since October 2014, Model S has come with camera and ultrasound sensor which are essential for the driving assistance. However, the function is disabled because the software is missing. From December, the software can be installed by following the instructions on the screen in the car, which operates the camera and sensor. As well as driving on express roads, the function assists in parking the car in parallel. The software will be updated periodically, and the updates will be distributed via internet. (The Nikkei, December 5, 2015)

(5) Porsche

On December 4th, German-based Porsche, which is a member of German-based VW Group and produces luxury range cars, announced that €1 billion (approximately ¥134 billion) would be invested in development of a new EV which is to be introduced into the market by 2020. Since the emission fraud came out in October, VW chose to focus on the development of electric cars. This is the first decision made for major investment since then. Porsche tries

to compete with US-based Tesla which is an increasing presence in the EV market. The EV will be developed using "Mission E" of which a concept car was revealed in the International Motor Show Germany in September as its base. The automaker will spend €0.7 billion in the main plant near Stuttgart, southern Germany, to add assembly and paint work facility, and estimates to employ 1,000 new workers. Mission E drives over 500 km on a single charge. The battery can be charged to 80% in 15 minutes, and also be compatible with wireless charging. The EV can reach 100 km/h in 3.5 seconds from the start, which is faster than its signature sports car "911". VW has strategically let the affiliating luxury range use the most advanced technology, and then gradually spread the technology in popular cars. Although the total investment of the group will shrink due to the emission fraud, the group will keep focusing on shifting to electric driven cars in its luxury range to compete with others and to accommodate tightening environmental regulations. German-based Audi, another member, also plans to introduce an electric SUV which drives 500 km on a single charge by 2018. The new EVs of Porsche and Audi are expected to be expensive, but to have better driving range by improving the weakness. This should contribute to cars becoming more electric driven. (The Nikkei, December 5, 2015)

(6) Toyota

Since Toyota released FCV "MIRAI" in December 2014, it has received orders for over 3,300 vehicles in one year after the introduction. The initial target is an annual 400 vehicles in Japan, and the actual orders are over eight times the target. A FCV drives on electricity generated by the reaction of hydrogen and oxygen, and water is the only waste that comes out from the vehicle. Due to this nature, FCV gets more attention as next generation eco car. Toyota sold 359 vehicles of MIRAI until October in Japan. Because their production capacity is limited, delivery is expected to take three years. The production plan including oversea sales is about 700 vehicles for 2015, because the components exclusive for the FCV require longer time to produce. The automaker is improving production facility to increase capacity gradually to 2,000 vehicles by 2016 then 3,000 vehicles by 2017. (The Nikkei, December 15, 2015)

(7) Ford

US-based Ford Motors will invest ¥4.5 billion (¥540 billion) intensively in EV developments up to 2020. Since the regulations on fuel efficiency is tightening up in Europe and the US, the automaker aims to bring up the level of technology for cars which use electric motors rather than engines. Their target is to increase the sales ratio of motor driven cars including hybrid vehicles, HV, to 40% by 2020. This is the largest investment in EV for Ford. The first introduction will be the next model of EV "Focus" to be released in the second half of 2016. This EV drives approximately 160 km, and is compatible with quick chargers allowing charging 80% in 30 minutes. Additionally, the automaker plans to bring out 13 new vehicles of plug-in hybrid vehicle, PHV, and EVs by 2020. Their targets are the US, Europe and the Asian region including Taiwan, South Korea and China where the EV market is expected to grow. Air pollution is especially a big problem in China and the Chinese government largely subsidizes EVs which emit no exhaust gas. Although Ford was developing a hybrid system for pickup truck with Toyota Motor until 2013, the EV development will be sole work. GM, another American major automaker, is strengthening EV business in cooperation with South Korean-based LG group. (The Nikkei, December 15, 2015)

(8) The Ministry of Industry and Information Technology of China

In China, the production of "new energy cars" which are EVs and PHVs was approximately 72,300 vehicles in November, 2015, which is 7.4 times of that of the term in the previous year. This is the highest monthly production record. (The Nikkei, December 16, 2015)

7. FCV Parts/Components Development & Business Plans

(1) NGK Spark Plug

NGK Spark Plug has been taken orders of the thermal conductive hydrogen detecting sensor for automobiles. This product is expected to be used in FCVs and hydrogen refueling stations. The sensor does not use a platinum catalyst, and is more durable than existing products. The manufacturer prepared the production facility in its Komaki Plant. The product detects the slight temperature change which is caused by a hydrogen leak to send the information

to cars. The detecting range is hydrogen concentration of 0.2 to 2%. The sensor can operate in two seconds after turning it on and in an environment of -30 to +100 °C. Hydrogen has much higher heat conductivity than other gas, and the manufacturer use this property. The sensor detects the phenomena that hydrogen takes heat from the heater inside the sensor. The manufacturer aims to sell the product to be used around hydrogen tanks of FCVs, and plans to sell it for hydrogen refueling stations and home FCs by using the same technology. (The Nikkan Kogyo Shimbun, December 16, 2015)

8. Hydrogen Refueling Station Development & Business Plans

(1) JFE Group

On November 30th, JFE Steel and JFE Container announced that an accumulator which is to achieve a significant cost saving for hydrogen refueling station would be commercialized by 2018. With Mitsubishi Rayon, three firms are preparing the development of the accumulator combining high-strength low-alloy steel and carbon fiber as a "Research Project on Technologies to Use Hydrogen" by New Energy and Industrial Technology Development Organization, NEDO, and have estimated that their accumulator could reduce the cost while achieving higher strength than current steel accumulators. According to the Fuel Cell Commercialization Conference of Japan, the period from 2016 to 2025 is determined as the first growing phase, and hydrogen refueling stations are expected to be prepared at 1,000 locations. However, the current cost for a hydrogen refueling station is about ¥500 million, which is expensive. To solve this cost issue, a lot of changes are essential in the regulations, design and materials. NEDO aims at an accumulator cost of ¥200 million or less and for durability of over 300,000 times of hydrogen dispensing. (The Chemical Daily, December 1, 2015)

(2) AIST

On December 11th, the National Institute of Advanced Industrial Science and Technology, AIST, announced that a technology was developed to continuously produce high pressure hydrogen without using a compressor. This technology allows dispensing hydrogen at high pressure of 70 MPa, which is expected to contribute to a significant reduction in construction costs of hydrogen refueling station. In the technology, formic acid, a hydrogen carrier, is broken down into hydrogen and CO_2 at 80°C using an iridium complex as a catalyst, which continuously produces high pressure hydrogen at over 40 MPa easily without a compressor. Also, the speed of pressure increase is over double of that of ruthenium complex catalyst. The hydrogen production technology using the conventional hydrogen carrier requires multiple processes of refining to remove impurities including leftover medium. Hydrogen and CO_2 are highly pressurized, when breaking down from formic acid in the new technology. In this environment, CO_2 is liquid, but hydrogen is gas. The new technology uses this status difference of the two materials to separate hydrogen gas from liquid CO_2 for high pressure hydrogen production. Theoretically, the chemical reaction itself can produce high pressure hydrogen of over 200 MPa, which allows hydrogen dispensing for FCV at 70 MPa. Formic acid is the simplest carboxylic acid, and comes out as a by-product in the production process of acetic acid. There are two competitive reactions of decomposing formic acid; decarboxylation breaks down to hydrogen and CO_2, and dehydration breaks down to water and CO. This new technology allows choosing decarboxylation, and hydrogen gas production containing no CO. This technology can eliminate the need for a compressor for hydrogen refueling stations which are needed with conventional technologies, and is planned to be commercialized. The team targets at 99.999% purity of hydrogen at 70 MPa by further technological development. They will work on building an ideal hydrogen carrier system also including highly pressurized liquid CO_2 which comes out from the process. (The Chemical Daily, December 14, 2015)

(3) Air Liquide Japan

On December 15th, Air Liquide Japan announced that its hydrogen refueling station would be open in the center of Saga City. This is to be the first commercial hydrogen refueling station in Saga Prefecture which is planned to start its operation in March 2016. The refueling station can supply a FCV with hydrogen in three minutes, and 5 FCVs in an hour. Hydrogen will be produced and compressed offsite, and transported to the station by trailers. (The Nikkei Business Daily, December 16, 2015)

9. Hydrogen Detection & Safety System Development

(1) University of Toyama

A team of Associate Prof. Satoshi Akamaru has developed a switch element plate which operates by detecting hydrogen at low concentration. This element only shuts down a circuit when sensing hydrogen, and can work as a hydrogen leak detector or safety device to stop motors which may give off sparks. The team thinks the product can be used as a safety measure for gas leaks in an enclosed space once FCs get more common, and aims to commercialize the product with the cooperation of business. Powdered alloy of palladium and cobalt is attached on a thin copper film as a switch for a circuit, and a permanent magnet is placed close to the film. In an environment without hydrogen, the film connects the circuit by being pulled by the magnet. When hydrogen is in air, the film cuts off the circuit by pushing itself away. Palladium and cobalt exhibit magnetic property in room temperature, but the force becomes weak when they absorb hydrogen. The switch element uses this nature. The magnet can attract the film to bend while the magnetic force of those materials is strong. Once the film absorbs hydrogen, the film goes back straight by losing the force. The team observed the film's behavior in various concentrations of hydrogen in air. The film's bending force changed with minimum 1% of hydrogen concentration. They also made a test switch element, and ensured that a circuit is cut off in 2% hydrogen in argon gas after 10 minutes. Hydrogen concentration of 4% or higher in air may cause an explosion. Hydrogen is very light, and diffuses in outdoor environment in a short period. However, a sensor is needed in an enclosed space for safety. There are hydrogen sensors in the market for industrial use, and they use temperature changes on catalyst or resistance change of semiconductor to detect hydrogen. These products require a system to measure heat or resistance. On the other hand, the film's characteristic property of the new element is used as a passive switch in a circuit, which is a simple mechanical system. Although the element cannot measure hydrogen concentration, it disconnects a circuit in a certain concentration. The team thinks the element is a good low cost device for use in environment of potentially high hydrogen concentration where there is a risk of using other hydrogen alarms. Currently the element takes minutes to react with hydrogen. The improvement plan is to shorten this period, and to more accurately react to hydrogen without reacting to other gas such as methane. The team will keep studying the distance between the magnet and the film and the ratio of the alloy for further performance improvement. (The Nikkei Business Daily, November 25, 2015)

(2) Kochi University of Technology

A team of Prof. Tetsuya Yamamoto has developed a highly sensitive sensor which can detect slight hydrogen leak in a short period in cooperation with the National Institute of Technology, Kochi College. This sensor uses zinc oxide which is cheap and used in cosmetic products. Conventional sensors need platinum which is an expensive material. The production costs of the new sensor are expected to be a tenth of that of the conventional ones. The team aims to commercialize the sensor for hydrogen refueling stations in cooperation with electronic part producers in five years. The sensor measures the current produced by zinc oxide capturing hydrogen. Excess oxygen ions in crystal structure of zinc oxide react with hydrogen, which forms water. In this reaction, electrons leave negatively charged oxygen ions behind, and create current. The sensor can detect 0.5% of hydrogen in air in one second. Hydrogen can explode at approximately 4% concentration. The product detects this level and prevents accidents. The highly sensitive hydrogen sensors for FCVs in the market use a catalyst made of platinum and rhodium and platinum coils. The temperature of catalyst surface goes up as hydrogen burns the surface. Those conventional sensors measure changes of electric resistance of the coils, and can detect a very low hydrogen concentration of 0.01%. However, platinum price is ¥4,000/g, which pushes up catalyst price. The new sensor uses zinc which is low cost of ¥0.2/g, and the production cost is estimated to be reduced to a tenth at the least. The current sensitivity is 0.5%, but can be improved to 0.01% which is the level of those conventional sensors. There are cheaper sensors using the same system with tin oxide. However, they take about 20 seconds to detect hydrogen. The detection speed is not suitable for sudden leak, which is a problem. (The Nikkei Business Daily, December 11, 2016)

10. Eco-Products 2015

On December 10th, "Eco-Products 2015", the largest exhibition of environmentally-friendly products, started with a number of technologies to reduce carbon emissions and store electricity at Tokyo Big Sight in Ariake, Tokyo. Visitors are very interested in the latest environmental technologies which are expected to be introduced into the oversea market in near future, since the "21st United Nations Conference on Climate Change, COP21" is being held in Paris at the same time. Eye-catching products are vehicles which run on hydrogen and emit no CO_2 such as Honda's FCV to be released in the spring of 2016 and a FC forklift being developed by Toyota Industries. Panasonic brought out home FCs of high generation efficiency under development. There are parts for hydrogen related products such as a durable steel pipe for high pressure hydrogen by Nippon Steel & Sumitomo Metal. For the power storage area, Sekisui Chemical displays home power supply systems combining EVs and photovoltaic generators. Furukawa Battery and Toppan Printing together developed an emergency power source which starts electricity production by adding water. Nikkei and Japan Environmental Management Association for industry sponsor the exhibition, and this is the 17th event. It will be open until 12th, and expects 165,000 visitors. (The Nikkei, December 11, 2016)

—This edition is made up as of December 21, 2015—

A POSTER COLUMN

Opening Rich Field of Hydrogen Society

It is said that 2015 is the "first year of hydrogen" to start growing as energy largely led by FCVs. Preparation of hydrogen refueling station is progressing in the Kansai area as well as other areas. Iwatani opened the first commercial station in Amagasaki City, Hyogo Prefecture, July, 2014, and plans to open at 21 locations in whole of Japan by March, 2016. This will increase the number of stations to six in the Kansai area. Osaka Gas will open one in Ibaraki City, Osaka Prefecture, in April. The preparation is also outside the centers. The Kansai International Airport is testing a FC forklift which is powered by hydrogen.

The construction cost which is ¥400 to 500 million per station and location make it difficult for hydrogen refueling facilities to be more common. The current law does not expect the facility to be used in urban areas, and the standards for parts and locations are stricter than oversea. The government aims to bring the cost down to half by 2020 by deregulation.

Expecting the deregulation, Iwatani is already working on reduction in the costs by developing a system to pressurize liquid hydrogen without gasifying, and having its subsidiary A-Tec in Akashi City to produce core components.

Kawasaki Heavy Industries developed a facility to liquefy hydrogen, and has installed a testing facility in Harima Works in Hyogo Prefecture. The product is planned to be commercialized to be used for hydrogen supply for FCVs in FY2016.

Hydrogen business is not only the construction and operation of refueling stations. Takaishi-industry, a rubber packing producer in Ibaraki City, and Samtech, a manufacturer of high pressure tanks in Kashiwara City, Osaka Prefecture, are putting more effort on research and development aiming their products to be used in hydrogen related products. More businesses will enter the hydrogen related market as the regulations are eased. (The Nikkei, December 4 & 9, 2015)