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Demonstration on Technology to Store Solar Power as Hydrogen Energy in Alloy

Arranged by T. HOMMA

1. Governmental Measures

(1) MLIT

On February 1st, the Ministry of Land, Infrastructure, Transport and Tourism decided to put an obligation on automakers to install "pedestrian alarms" to give pedestrians a warning noise of approaching quiet cars, such as hybrid vehicles (HVs). A UN organization will establish international standards including the volume of the alarm by December. Based on the international standards, the ministry will set standards on alarm systems for new motor driven cars such as HVs, electric vehicles (EVs) and fuel cell vehicles (FCVs) by 2018. The goal is to improve safety of pedestrians and cyclists. The safety standards of the Road Trucking Vehicle Act will be revised, and new electric motor cars must to be installed with alarms fit in the international standards to be sold in Japan. Japan and Europe are leading establishing the international standards, and will attach primary importance to easy hearing for pedestrians by indicating the volume of alarm and frequency. (The Mainichi Newspapers & The Sankei Shimbun, February 2, 2016)

(2) Agency for Natural Resources and Energy

The Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, METI has estimated how much energy facilities and systems are to increase among users for virtual power plants, VPP, and negawatt power trading by FY2030. "Energy producing facilities" including domestic photovoltaic generators, ENE-FARMs and cogenerations are to be 24.5 GW, which is the equivalent of 24 large-scale thermal power plants, and this is about a 35% increase of that of current figure. Home/business/industrial energy management systems and EVs can be used for demand response, and are considered as "energy storage facilities". The report says that the power of these facilities can reach 13 GW, an equivalent of 13 large-scale thermal power plants. The estimation was calculated based on the long-term forecast on energy demand for FY2030 published last year. The estimation for each facility and system are also indicated. Home photovoltaic generators are to increase from current 7.6 to 9 GW in 2030, and the majority of them are to be used for households to be more energy independent after feed-in tariff, FIT, finishes. ENE-FARMs are to significantly expand from 0.105 to 3.71 GW in 2030. Cogeneration is to go up from 10.2 to 13.2 GW in 2030. (The Denki Shimbun, February 10, 2016)

The Agency for Natural Resources and Energy will compile actual measures for reduction in costs of home fuel cells (FCs) and hydrogen refueling stations. They have determine that ENE-FARM needs to hit a cost target by FY2020, and needs cooperation of product producers, gas suppliers and construction firms for promotion in slow growing areas of the market. A project to reduce the size of product and maintenance cost will be included as an example. For hydrogen refueling stations, measures to improve materials and to reduce personnel and repair costs will be covered to aim for a cutting down of maintenance and operation costs by 2020. The agency compiled promotion strategy for FCs for home and business, FCVs and hydrogen production from renewable energy in June 2014, and it is considering revising the strategy this spring. The measures will be produced as an action plan in parallel. The promotion strategy indicates an objective to reduce the cost by 2020, so that ENE-FARM users can recover their investment in seven to eight years. Additionally, actual target prices are set to be hit for polymer

electrolyte fuel cell s, PEFCs, and solid oxide fuel cells, SOFCs. They are ¥0.8 million for PEFCs, over 40% reduction of that of current price, by 2019 and ¥1 million for SOFCs, over 40% reduction of that of current price, by 2021. ENE-FARMs are mainly sold for newly built houses at the moment, but are expected to expand the application to new and established apartment units by cutting down the size. (The Denki Shimbun, February 17, 2016)

2. Local Governmental Measures

(1) Tottori Prefecture

On January 25th, Tottori Prefecture signed a partnership to carry out preparation of a hydrogen energy experiment center in cooperation of Honda, Sekisui House and Tottori Gas. These four organizations will prepare a center for smart house, FCV and a refueling station to supply hydrogen produced by electricity generated from photovoltaic generator to work together in Tottori City. The facility will offer the public experience as an environmental education. The photovoltaic generator will be installed in land owned by Tottori Gas. In adjacent land, Honda will prepare a refueling station which produces hydrogen on-site and is developed in cooperation with Iwatani. (The Nikkan Kogyo Shimbun & The Nikkei Business Daily, January 26, 2016)

(2) Osaka Prefecture

Osaka Prefecture will work on the promotion of EVs and FCVs and infrastructure for them at a faster speed. Previously organizations operated individually for EV and FCV, and "Osaka Promotion Committee for Next Generation Cars" was launched to unite them. Since both EV and FCV have reached a commercial sales phase, the local government will combine the promotion for next generation cars. Under the new promotional organization, industry, academia and governmental bodies together aim for the promotion and establishment a center for next generation car industry as well as expanding employment. The prefecture previously ran "Osaka EV Action Conference" and "Osaka FCV Promotion Conference" to promote EVs and FCVs. The EV Action Conference was established in June 2009, and provided a subsidy for the purchase of 50 EVs for taxi operators. As a measure, a research and development center was launched at Osaka Prefecture University to promote EVs and increase demand in related industries. Osaka FCV Promotion Conference used a FCV, which was in the demonstrational phase at the time, as an official car to help commercialization of hydrogen refueling stations, since its establishment in March 2009. Nissan's EV "LEAF" was released six years ago. Last year, Toyota introduced the world's first commercial FCV into the market. The market of next generation cars has fully started. The prefecture launched the new organization to provide unified promotion for EVs and FCVs on January 12th by combining the old organizations. The conference consists of automakers including Toyota Motor, Nissan Motor and Honda and infrastructure related firms such as Kansai Electric Power Company (KEPCO), Osaka Gas and Iwatani. Individual study groups for EV and FCV will be established to investigate measures for each car to expand and preparation of their infrastructure. The first meeting was held on January 20th to discuss previous projects taken by the old organizations, current issues on EV and FCV and future actions. Mr. Tsu, the chairperson, greeted in the meeting. "As promotion of new energy industry, the prefecture is working on developing business and industrial complex for both storage battery and hydrogen/FC areas which are expected to grow into large markets. Especially, EV and FCV are the key technologies for the two areas. The new organization will carry out combined measures to work well to expand use of next generation cars.", he said. (Nikkan Jidosha Shimbun, January 26, 2016)

(3) Tokyo

On February 2nd, the Tokyo Metropolitan Government Bureau of Waterworks announced that an experiment would be carried out to use hydrogen derived from chlorine production process for chlorination of water as recycled energy in the new financial year at Asaka Water Purification Plant. The project will supply FCV with hydrogen to reduce CO_2 emissions, and this kind of project is the first in Japan. Also, if a truck running on hydrogen is developed in the future, the bureau plans to use it to provide water for emergencies. A system will be organized to be able to supply areas damaged by disasters with drinking water, even if the fuel supply is cut off. According to the bureau, the plant has a facility to produce sodium hypochlorite, chlorine, by electrolyzing salt water, and

a large amount of hydrogen is produced during the process. However, hydrogen has been unused and released in air. In this project, a facility is planned be built to compress hydrogen for storage, and hydrogen will be supplied to refueling stations in Tokyo. The estimated amount of hydrogen is an equivalent energy for 3,000 vehicles each year. The bureau specifically focuses on fuel supply function for truck and emergency vehicles, and "wants to expand the system to other waterworks once it ensures the feasibility". (The Sankei Shimbun, February 3, 2016)

The Tokyo Metropolitan Government will start a subsidy scheme for the purchase of external electricity feeder from FCVs from FY2016. Since Honda will release commercial FCV and an external power feeder in March, the local government will start the subsidy scheme for sole purchase of external power feeder. However, they already have a subsidy scheme for FCV purchase. The subsidy can be applied from both individuals and businesses. When a FCV is connected to the power feeder, it turns in to supply mode, and can be used as a power source for emergency and leisure. With a full tank of fuel, a FCV can supply an average household with power for about seven days. The power feeder is expected to sell for ¥1.2 million, and the maximum subsidy is set at ¥0.4 million. The local government plans to subsidize 700 to 800 applications at the most. For FCVs to expand their use, the number of hydrogen refueling stations needs to grow. Nevertheless, refueling stations solely supplying hydrogen are difficult to be financially viable. Due to this circumstance, the local government determines that hydrogen filling facilities should be attached to gasoline refueling stations for efficiency, and a support project will be organized to assist in opening hydrogen refueling facilities for smaller operators of gasoline refueling stations. The project will provide a consultation service for technical support and training. At the same time, the project will investigate deregulation of installation standards for hydrogen refueling stations. (The Nikkei, February 5, 2016)

(4) Toyama Prefecture

Projects have started to use hydrogen energy in the Hokuriku area. In Toyama Prefecture, a committee has been set up to promote the energy use with the cooperation of industry, academia and governmental organizations. It will encourage installation of hydrogen refueling station and FCV use. There is a cross-prefectural boarder project. Being environmentally conscious, Hokuriku uses a lot of small-scale hydroelectric power, and aims to realize hydrogen society. In Toyama Prefecture, "Toyama Hydrogen Energy Introduction Promotion Council" has been recently launched, and the members are about 40 organizations including Hokusan Corporation, Nihonkai Gas and Toyama Toyota Sales. The council aims to open the first hydrogen refueling station in the area apart from large urban areas by 2020. A roadmap will be published to show the process in this year. "Hokuriku Green Energy System Society" consists of businesses, university and local governments from three prefectures in the Hokuriku area. It is researching a technology to produce hydrogen from aluminum waste in general garbage, and to use the gas for power generation. Alhytech has been established by cooperation of members of the study group to produce power plant. In April, the plant will start trial operation at a plant of a financing firm. (The Nikkei Business Daily, February 10, 2016)

(5) Aichi Prefecture

Aichi Prefecture and Toyota Motor will carry out an experiment to supply hydrogen produced by waste heat to FCVs from FY2017. Although FCV emits no CO_2 during driving, common hydrogen production uses fossil fuel. By using unused energy, these two organizations aim to develop environmentally-friendly hydrogen society from its production to use. The prefecture allocated ¥20 million for investigation for commercialization in the initial budget bill for FY2016. At a waste disposal site in Aichi Prefecture, heat from waste treatment process will be used for hydrogen production by electrolyzing water. Hydrogen will be stored, and then transported to various hydrogen refueling stations as a fuel supply for vehicles. Toyota will evaluate combustion and power generation technologies using hydrogen as an energy source, and also test hydrogen use for car production process. The firm already produces and sells FCV MIRAI, and also its group member Toyota Industries is developing a FC forklift. (The Nikkei, February 16, 2016)

(6) Kyoto City

On February 19th, Times Mobility Networks, a member of Park 24 in Hiroshima City, announced

that a car-sharing experiment would be carried out using Toyota Motor's FCV "MIRAI" in cooperation with Kyoto City. The city will lend its three vehicles of MIRAI to Times Mobility Networks. The experiment period is from March 7th to 31st. This project will advertise the city's environmentally-friendliness and investigate user demand. According to the service provider, carsharing of MIRAI is the first in Japan. This service will be operated at "Times Car Rental Kyoto Station" by the JR Kyoto Station. The cars will be rented to residents of the city with a driver's license, and the city office will take booking from February 22nd to 29th by phone. The rental period for each user is six hours from 9 am to 3 pm at the most. The service is free of charge, but the users will pay the fuel cost. The service provider will tell users the nearest hydrogen refueling stations, when the cars are picked up. The insurance will be paid by the city. Users will pay the excess of ¥50,000 for actual accidents. (The Nikkei, February 20, 2016)

3. FC Element Technology Development & Business Plans

(1) FC-R&D

FC-R&D, FC developer in Sagamihara City, has developed a portable FC power system in a handy suitcase size. The system has a small, lightweight hydrogen cylinder, and outputs direct and alternating current. The weight is 2 to 3 kg. The product will sell for ¥0.5 to 1.5 million. The developer targets outdoor leisure and emergency use. With "Micro FC M Series", users can choose either 5 or 12 V in direct current or 100 V in alternating current, and the product range offers output from 200 W to 1,000 W allowing users to operate a wide range of appliances. The power generator includes a cylinder made of a hydrogen storage alloy, plugs for power supply and USB sockets. The continuous operation is five times of that of a lead–acid storage battery. The generator stably supplies current without noise, heat and CO_2 emissions. This small suit case size generator can be installed with solar panels enabling efficient operation for a long period by using hydrogen and sunlight. The product can be simply composed to be a small size of batteries for cell phones or PCs. The firm also offers a system which extracts hydrogen from methanol. This product can supply power to measuring equipment of wind power and direction or CCTV which are used in places without power source continuously for one to three months. (The Nikkei Business Daily, January 28, 2016)

(2) Toshiba FC

Toshiba Fuel Cell Power Systems has developed a next generation pure hydrogen FC system achieving the world's highest level of power generation efficiency, and will test it at "Iwatani Hydrogen Station Tokyo Ikegami" which was opened in Ota-ku, Tokyo, on February 10th. The system outputs 700 W, and was developed using the model developed in FY2014 as its base. The highly efficient power generation of 55% was achieved by improving hydrogen use rate and battery voltage property by advancing battery parts. Because the product uses hydrogen as it is, it produces power with no CO_2 emissions. Also, it can start generation in a short period of one to two minutes. The test will collect operation data by FY2017, and investigate operation methods and application benefit. (Dempa Shimbun, February 12, 2016)

4. Hydrogen Infrastructure Development & Business Plans

(1) SMFL & Tokuyama

Sumitomo Mitsui Finance and Leasing, SMFL, and Tokuyama have signed a lease agreement for facilities of hydrogen use experiment. Tokuyama produces sodium hydroxide in its plant in Yamaguchi Prefecture, and hydrogen comes out during the process. The experiment will use unused hydrogen produced as a by-product. SMFL will lease facilities for hydrogen storage and supply pipe. Tokuyama will install a facility "buffer drum" to collect and store hydrogen to improve the hydrogen recovery rate. Collected hydrogen will be supplied to a FC system (100 kW output) to be installed at a private swimming club in Shunan City, Yamaguchi Prefecture. Tokuyama plans to install a hydrogen pipe to connect Tosoh's plant on the premises for joint production in FY2017, although this is not included in the lease agreement. The experiment will also investigate how hydrogen use contributes to CO_2 emissions. Tokuyama applied to "FY2015 Community Collaboration Project for Technological Evaluation of Hydrogen with Low-carbon Emission" of the Ministry of the Environment, MOE, as the representation of

this experiment, and won the contract. The project period is from FY2015 to FY2019. The budget is approximately ¥1.5 billion. (The Nikkan Kogyo Shimbun & The Chemical Daily, January 25, 2016)

(2) Toyota

Toyota Motor will use hydrogen as energy source for its plant from this year. An experiment will start with the cooperation of Fukuoka Prefecture and Kyushu University for full use of the technology by 2020. The car producer is working hard on hydrogen use including commercial sales of the world's first FCV "MIRAI". However, their plants are producing more CO_2. The manufacturer wants to reduce the emissions by expanding hydrogen use for both cars and plants as fast as possible. Toyota Motor Kyushu, a group member in Fukuoka Prefecture, will use the gas as energy for forklifts moving parts around and air conditioning. Hydrogen will be produced by electrolyzing water using electricity from photovoltaic generators and wind turbines in Fukuoka City, and be stored. Then FCs will be supplied with hydrogen for power generation as required. In the car assembly process in the plant, 60% of whole CO_2 emissions are from heating instruments and air conditioners. The experiment aims to use hydrogen for paint drying processes as well as air conditioners. Hydrogen can be used as fuel for MIRAI, if the production goes over demand for the plant facilities. Fukuoka Prefecture and Kyushu University have already started testing the economic feasibility of hydrogen on the premises of the university. Toyota will use the expertise for full use of hydrogen at the plant for MIRAI in Toyota City, Aichi Prefecture by 2020. As well as the FCV, they sell a number of hybrid vehicles, HVs, to significantly reduce CO_2 emissions from cars. However, the emissions from their global plants have increased by about 10% of that of 2001 since production growth. "The Paris Agreement" setting reduction target in greenhouse gases was adopted in last December. Japan has decided to cut down the emissions by 26% of that of FY2013 by FY2030. Businesses also need to decrease the emissions, and hydrogen use can possibly expand to other plants of other business operators. (The Nikkei, February 10, 2016)

(3) Hiroshima University

Hiroshima University has announced that it established a technology to increase the pressure of hydrogen gas to the high level for hydrogen refueling stations using the properties of an alloy to storage hydrogen. Hydrogen refueling stations require mechanically driven systems to increase hydrogen pressure. Maintenance costs and safety have been issues. The hydrogen releasing pressure of the hydrogen storage alloy in this study exponentially increases as temperature goes up. By using this property, the alloy can store low pressure hydrogen at low temperatures, and release high pressure hydrogen by raising temperature. This technology likely allows increasing pressure only by heat. This may achieve a safer hydrogen refueling station at a lower cost. The study team will develop a small trial compressor for further testing. Hydrogen storage alloy enables rising hydrogen pressure at lower temperatures. Further reduction in running costs of stations is possibly made by using exhaust heat from waste incinerators or modules of photovoltaic generators. (The Denki Shimbun, February 16, 2016)

(4) Shimizu Corporation

Shimizu Corporation and the National Institute of Advanced Industrial Science and Technology, AIST, will start an experiment to store electricity from photovoltaic generator as hydrogen energy this autumn. Hydrogen will be produced by splitting water, and stored in a special alloy before use. Then, FCs can produce electricity, the original form of energy, using hydrogen. Exhaust heat from water electrolysis and FC operation will be used for air conditioners of a building for efficiency. An apartment building with 50 units can reduce electricity consumption by approximately 15%. The firm aims to install the system to new apartment and office buildings by 2020. Storage batteries loose power by almost 90% in a month by self-discharges without connecting any devices. The production cost increases as a capacity of battery becomes bigger. However, hydrogen stored in the alloy can stay for very long time, and a large amount of the alloy does not significantly affect the production cost. With about a ¥250 million investment, the experiment facility of houses will be built to demonstrate 10 common households at the Fukushima Renewable Energy Institute of AIST in Koriyama City, Fukushima Prefecture. The project will research a method to efficiently control electricity generated by the photovoltaic generator, and develop

a cheaper material with fewer fire risks for hydrogen storage alloy. There is a previous study on storing electricity in the form of ammonia. The issue is that more safety measures are required due to the chemical properties. (The Nikkei, February 22, 2016)

(5) AIST

AIST has developed a photocatalyst which mimics the photosynthesis of plants. Water is split using sunlight, and energy is stored in ions in a liquid. Using ions for the chemical reaction enables hydrogen production at low cost. The energy conversion rate is 0.65% which is close to the rate of 0.8 % by which corn produces sugar by sunlight. The team plans to increase the rate to 1% in two to three years, and then start an artificial photosynthesis experiment at a small-scale plant. Chloroplasts in plants convert the energy of sunlight into chemical energy through oxidation and reduction of substances. The main material of this powder catalyst developed in the research is bismuth, a metal. By applying light to a solution, a mixture of the catalyst and iron ions, electrons are stored in iron ions acting like chloroplast. Previous researches on artificial photosynthesis produced hydrogen and formic acid by reaction on electrode surfaces. The larger the electrodes, the higher the costs. This has made development of a large-scale plant difficult. (The Nikkei, February 22, 2016)

5. ENE-FARM Business Plans

Toray Industries has started sales of "Chalier Nagaizumi Grand Marks" which is to be installed with an energy sharing system for condominiums using ENE-FARM in Nagaizumi-cho, Shizuoka Prefecture. This is the first condominium having the energy sharing system in Japan. The system is named "T-Grid System", and its patent is jointly held by Shizuoka Gas and Panasonic. The power supply of the building will be a combination of a single power contract of the grid for the whole condominium and ENE-FARM installed in each unit. Shizuoka Gas buys excess electricity from households which produce power more than their consumption. Households using more power than their FCs' production will buy electricity through the sharing system at a cheaper rate than the normal rate from the grid. This system is beneficial for both sides. Also, the construction firm will build an independent power system which consists of photovoltaic generator and storage battery to supply common areas with electricity during power cuts. (Jutaku Shimpo, February 2, 2016)

6. Cutting Edge Technology of FCV & EV

(1) Honda

Honda will release a new FCV "Clarity Fuel Cell" in the US on lease deal by the end of 2016. The car will be available only in places which have prepared refueling infrastructure. This means California is the only sales area for a while. The FCV will sell for approximately $60,000 (approximately ¥7.2 million). The monthly lease fee is planned to be $500 (approximately ¥60,000) or less. Based on the US standards, the vehicle has achieved over 300 miles, 480 km, on a single charge. (The Nikkan Kogyo Shimbun, January 28, 2016)

(2) Mitsubishi Motors

On February 3rd, Mitsubishi Motors announced that an EV version of small sport utility vehicle (SUV) "RVR" was planned to be introduced by FY2019. This is to be the second EV for the firm. Mr. Tetsuro Aikawa, the president, revealed a development plan for FY2020 to release 14 types of vehicles in the period from FY2017 to FY2020. In FY2017, they will bring out a new small SUV as well as PHV version rechargeable through a domestic wall socket. The new PHV is to be the second for them after the medium size "Outlander". The manufacturer is considering development of a successor of i-MiEV, an EV currently available in the market, using a small car with an engine under 660 cc as the base in cooperation of Nissan. (The Nikkei, February 4, 2016)

Mitsubishi has developed a next generation EV with in-wheel motors with the cooperation of a component producer in Okayama Prefecture. This motor gives more space for the trunk and battery than a motor installed in the back of the car, and contributes to a reduction in size and extension of driving range. The commercial production is undecided, but the technology will be used for enhancing EV performance. This development was carried out using the commercial EV "i-MiEV" as the base in cooperation of 16 component producers including Asteer and Timec both in Soja City, Okayama Prefecture. In this system, a round motor is

installed inside a wheel to directly drive the wheel. This is globally uncommon. Common commercial EVs have motors at their rear. If a motor is installed in wheels, a larger battery can be installed in the space, which will improve EV performance. However, the production cost may become higher. (The Nikkei, February 6, 2016)

(3) Tata Motors

On February 5th, "Auto Expo", a motor show, will open to the public near New Delhi, the capital of India. Also, environmental technologies can be found in the exhibition. Tata Motors which is in fifth place for the passenger car market has place its FCV concept using hydrogen in a corner of its booth. "This concept was developed for tightening regulations in India at the Pune plant in cooperation with our group members." their executive for sales said. As well as the EV shown at the 2014 Auto Expo, the manufacturer is strategically preparing by developing environmentally-friendly cars for stricter regulations. Mahindra & Mahindra, has brought out an EV "e2o" produced by Mahindra Reva Electric Vehicles, a subsidiary. With a normal charger, it takes five hours to recharge the lithium-ion battery, LIB, but an "optional charger can recharge only in 75 minutes", according to the CEO of Mahindra Reva Electric Vehicles. They are getting ready for more competition caused by increasing demand on environmentally-friendly cars. (The Nikkei Business Daily, February 5, 2016)

(4) Panasonic

On February 5th, Panasonic made an official announcement that a battery plant will be constructed for EVs in China. The new plant will be built in Dalian in Liaoning aiming for start of production in 2017. Dalian Levear Electric, a local manufacturer of industrial electric appliances, will invest half, and a joint venture was launched to produce and sell batteries. The investment amount is closed, but estimated at a couple of ¥10 billion level. (The Nikkei, February 6, 2016)

(5) Nissan

Nissan will increase the number of EV chargers in North America. In cooperation of German-based BMW, quick chargers which can take EVs of both firms will be installed at over 270 locations in the US and Mexico. Nissan has determined EV as its key product of next generation eco cars, and will prepare the infrastructure for promotion of the cars in the region. In May 2015, Nissan and BMW signed an agreement for joint preparation of EV chargers in South Africa. The cooperation has extended to North America. The quick chargers to be installed can recharge the batteries of Nissan "LEAF" and BMW "i3" to 80% in 30 minutes. In November 2015, Nissan released a new model of "LEAF" which has extend the driving range by increasing battery capacity by 20% from the previous one into the North American market before Japanese and European markets. By preparing more charging points, Nissan aims for sales growth of the new car. In the US, new installation will be at 120 locations in 19 states including California, Florida and New York. In Mexico, rechargers will be installed in more than 150 locations including Mexico City. The accumulated sales of LEAF in the US are 90,000 vehicles at the end of 2015 which goes over the sales of 58,000 vehicles in Japan. On the other hand, 6,000 quick chargers have been installed in Japan, but the figure in the US is 1,500, which is slow. Toyota Motor and Honda determine FCV as their key for next generation eco cars. In contrast to this, EV is the key for Nissan. Nissan plans to take a lead in competition over eco car standards by strengthening the tie between BMW which is also working on promoting EVs. (The Nikkei, February 14, 2016)

(6) Toyota Industries

On February 18th, Toyota Industries revealed that its FC forklift would be introduced into the market in the second half of FY2016. The core components are shared with FCV MIRAI by Toyota Motor. The forklift can operate eight hours on a single charge, which is highly efficient working performance. Two new FC forklifts will be used in the international cargo area of the Kansai International Airport from March as a test. In this evaluation period, the firm research on reduction effect in CO_2 emissions and improvement of work efficiency before commercialization. The forklift is planned to sell for about ¥10 million, but the purchases are expected to be assisted by governmental and local governmental subsidies to reduce the actual financial impact. (The Nikkei, February 19, 2016)

(7) Hitachi Zosen

On February 18th, Hitachi Zosen announced that it

developed a LIB which charges and discharges in an environment of -40 to +100°C. The battery uses a powder form electrolyte instead of an electrolytic solution which is vulnerable to temperature change. The manufacturer plans to commercialize the product by FY2020 targeting EV and space satellite use. Their plan is to supply battery manufacturers with the product in a cell form as a core component. The cells have been sent to a Honda's research and development center for performance evaluation. A common cell consists of an anode, a cathode and an electrolytic solution. Electrolytic solutions freeze in low temperatures, and have a risk of fire in high temperatures due chemical reaction. The operating temperature is limited from 0 to 40°C for common cells. Hitachi Zosen uses sulfide electrolyte to stack with anode and cathode in a powder form. The capacity is similar to that of common cells. This new cell has fewer risks of leak, which reduces chances of fire. It sustains good performance after recharging and discharging cycles. Cell cases are required to be pressurized by screws as particles of solid electrolyte have to closely contact each other. Previously, this was difficult to develop as a production technology. (The Nikkei, February 19, 2016)

(8) SK innovation

SK Innovation, a major South Korean petrochemical producer, has signed a contract to supply German-based Daimler with LIB cells. The cells are planned to be used in EV to be released by Daimler in 2017 as well as in other ranges. SK getting the contract from Daimler, a major global automaker, causes more competition among battery manufacturers. This producer provides battery cells to the Hyundai Group including Kia Motors and Chinese-based Beijing Automobile Works. Their plant in the central area of South Korea doubled its production capacity in last October. Because more orders are expected now, another capacity improvement is under consideration. The current size of the global EV market is about 2.20 million vehicles. SK estimates the market to grow into a 6.00 million vehicle level due to tightening environmental regulations. (The Nikkei, February 20, 2016)

7. FCV Part Development

Nisshinbo will accelerate development of parts for next generation cars. For robot cars driving autonomously, wireless technology will be used to produce a new device. For FCVs which have just started their commercial sales, the firm will explore the FC area for vehicles at full speed by strengthening the partnership with Ballard Power, a FC producer. Their carbon separator is in production, and carbon alloy catalyst is under development. These products are targeted for FCVs. Nisshinbo has an overwhelming share of separators for domestic FCs, but FCVs use a metal separator. Because automakers concerns about strength to prevent cracks and fractures, they use metal separator. However, Nisshinbo "has worked out on strength, and has faith in the quality". Their experience on domestic FCs will be used to step up to larger stationary FCs. The manufacturer expects this experience to lead to FCVs. Also, carbon alloy catalyst can achieve a reduction in production cost of FCV, and is being developed at faster speed. The catalyst is estimated to take about 45% in FC cost. Common catalysts use expensive platinum. On the other hand, a carbon alloy catalyst allows reducing the material cost to between a sixth and tenth. Nisshinbo aims for its catalyst to be in a successor of next generation FCV which is to be platinum free. (The Chemical Daily, January 29, 2016)

8. Hydrogen Refueling Station Development & Business Plans

(1) Iwatani

On January 29th, Iwatani opened a hydrogen refueling station for FCVs including FC buses at the Kansai International Airport. This is the first one installed at an airport in Japan, and the 13th commercial station for the firm. The facility can fully fill six FCVs in an hour. Also, space for seminars and fairs are attached to the facility. (Fuji Sankei Business i, January 30, 2016)

Hydrogen refueling stations for FCVs are being installed outside the four urban areas. Iwatani has revealed its plan to build a hydrogen refueling station in Miyagi Prefecture. This is to be the first commercial station in the Hokkaido and Tohoku area. Additionally, there is a preparation plan in the Chugoku and Shikoku area. The firm announced the construction plan at "Miyagi FCV Promotion Committee"

consisting of private and governmental organizations. This is to be the first commercial hydrogen refueling station in the whole of Hokkaido and Tohoku. The prefecture decided to submit a budget bill of FCV related projects including subsidy for the construction and FCV purchase to its assembly. Toyota Motor and Honda are now considering selling FCVs in the area. (Nikkan Jidosha Shimbun, February 2, 2016)

(2) Kanayama Precision

Kanayama Precision Co., Ltd., Kyoto City, will develop a lubricator for compressors for hydrogen storage equipment in hydrogen refueling stations. They aim for a lubricator to supply lubricant at a high pressure of over 100 MPa at a fifth the price of conventional ones. A trial product is planned to be made by this summer for use in hydrogen refueling stations of which construction and installation are in progress towards 2020. The firm will also seek new usage such as chemical plants. The parts and design are being entirely reviewed to minimize the amount of materials withstanding high pressures. In their plant newly finished in 2014 in Otsu City, the air conditioning system keeps a certain temperature in the whole facility round the clock, which allows stable and precise process of parts needed for high pressure environment. This is another advantage. (The Nikkan Kogyo Shimbun, February 3, 2016)

(3) JX Energy

On February 5th, JX Nippon Oil & Energy made the announcement of opening of a hydrogen refueling station in Sagamihara City, Kanagawa Prefecture. This mobile station supplies hydrogen in a large lorry from noon to 2 pm on Wednesdays and Fridays. Including this, the firm operates 17 hydrogen refueling stations in Tokyo and five prefectures. Their plan is to increase the number to 40 locations. (The Nikkei Business Daily, February 8, 2016)

(4) Tokyo Gas

On February 8th, Tokyo Gas started the operation of "Urawa Hydrogen Station" a hydrogen filling facility for FCVs. This is the third hydrogen refueling station after one in Tokyo, and the first for Saitama Prefecture. The new station produces hydrogen from natural gas on site. As well as refueling FCVs, this facility can also supply hydrogen to other refueling stations without production equipment. The site area is about 1500 m^2 and its refueling ability is 300 Nm^3/h. It takes about three minutes to fill a FCV, and seven minutes to prepare for the next refuel. One session of refueling and preparation is carried out in 10 minutes. The facility is installed in "Urawa Eco Station", an established natural gas refueling station. By attaching to the established station, operation and management costs are reduced and the land is more efficiently used. (The Denki Shimbun, February 9, 2016)

(5) Osaka Gas

Osaka Gas had been building a hydrogen filling facility in Kyoto City, and made an announcement of completion of the facility on February 19th. This mobile filling facility uses trailers to store and supply hydrogen, and this type is the first in the Kansai area. As the investment, the building cost was kept low to approximately ¥300 million which is half that of conventional one. "This is a suitable system for the spreading period of hydrogen." Mr. Takehiro Honjo, the president, said at the press conference. The facility was built in Minami-ku, Kyoto City, next to a natural gas refueling station operated by the gas supplier, and this is the second hydrogen facility for the firm. Hydrogen is transported from the station opened in Ibaraki City, Osaka Prefecture, in April 2015. The firm aims to increase the operation rate of the facility which is slumping. (The Nikkei, February 20, 2016)

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