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METI's Investigation Results on Previous Accidents of Hydrogen Refueling Station

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1. Governmental Measures

(1) METI

The Ministry of Economy, Trade and Industry (METI) has publicized accidents involving hydrogen refueling stations. A total of 27 accidents occurred at hydrogen refueling stations during the period from FY 2002 when the first experimental hydrogen refueling station started to operate to FY 2014. Although the majority of the accidents were hydrogen leaks from equipment or piping, one of the leaks led to an explosion. Because hydrogen gas is extremely light and quickly diffuses in the air once it leaks, a risk of large-scale explosion or fire is low. However, there are risks that drivers may accidently move fuel cell vehicles (FCVs) during refueling or crash into refueling facilities. Because the risks may increase as the vehicles become popular, METI will keep working on safety measures. The accident report was submitted at a committee meeting on high pressure gas of the Industrial Structure Council. The details are zero to three accidents until FY 2011, six accidents for the two consecutive years from FY 2012, and four accidents in FY 2014. Already three accidents were reported for this year. The number of hydrogen refueling stations is low, but the total accident rate of all the stations is about 30%. This rate is higher than 5 to 10% for compressed natural gas (CNG) refueling stations or 1% or less for liquefied petroleum gas (LPG) refueling stations. The major causes are gas leaks from piping accidently loosened during inspections or due to degradation of sealing materials at connections. When a worker was clearing foreign matter from a hydrogen tank with a vacuum cleaner, hydrogen gas was unintentionally sucked into the vacuum cleaner at a hydrogen refueling station in Osaka last year. The gas exploded in the vacuum cleaner, which caused burns. The reason behind these accidents is that hydrogen naturally goes deep into a metal structure, and hydrogen storage tanks, accumulators, and piping are also exposed to high temperatures and pressures. The standard pressure of hydrogen refueling equipment is 82 MPa, and the internal temperature of hydrogen gas is 180 °C. On the other hand, CNG refueling equipment uses 25 MPa and the gas temperature is 140 °C. LPG one is only 1.6 MPa and 35 °C. The nature of hydrogen led accidents was reported in Japan. Hydrogen gas leaked from a tank in only eight days after the first operation in Japan. Scratches were made inside the tank in the production process, and they enlarged in a short period. The High Pressure Gas Safety Office of METI expects the accident rate to rise caused by metal fatigue as more hydrogen refueling facilities are installed because hydrogen refueling stations operate under more severe condition, and the ministry will keep working on safety measures such as imposing thorough equipment management and securing product quality as well as measures to stop cars crashing into equipment. (Nikkan Jidosha Shimbun, March 17, 2015)

(2) METI & MLIT

51 countries and regions including Japan, Europe and South Korea will prepare an easy environment for FCVs to be imported and exported. Safety standards and inspection methods will be compiled by this June to be shared among them, and the qualified FCVs can be sold without another safety inspection at an export destination. Because each country currently has own safety standards and inspection methods, even a FCV which fits in the regulations and passes the inspections in Japan has to have another inspection in export destinations at the moment. The inspection procedure takes six months to one year, and changing

design and parts may cost a lot to accommodate the regulations of the export destinations. The UNECE World Forum for Harmonization of Vehicle Regulations (WP.29), a group of voluntary countries, has worked on unifying automobile standards. The participants include European countries, South Korea, Thailand, Australia and Russia as well as Japan. The new standards are expected to come out in June, and METI and Ministry of Land, Infrastructure, Transport and Tourism (MLIT) plan to revise related ministerial ordinances of the High Pressure Gas Safety Act and Road Trucking Vehicle Act by next spring to accommodate the unified standards in Japan. The new standards will include the material of tanks to store hydrogen, the figure of the pressure for dispensing hydrogen, and a method to safely release hydrogen when hydrogen leaks and a method of a collision test. The hydrogen dispensing pressure will be increased from current 70 to 87.5 MPa in Japan. Once the safety inspections are set for the new pressure, the certified FCVs can be exported to the other 50 nations and region without another inspection at the other end. Japan and Europe will encourage China and the US, non-members of the forum, to join the unified standard making scheme. (The Nikkei, April 3, 2015)

(3) MOE

A project has started to examine a system to produce hydrogen by splitting water using wind power in Kabashima, one of the Goto Islands of Nagasaki Prefecture. The Ministry of the Environment (MOE) and Toda Corporation had an open demonstration on site on April 6th. This project uses a hydrogen production method without creating CO_2, and will be a preparation for the hydrogen society that the Japanese government expects to realize by 2040. A giant wind turbine of 80 m across outputs 2 MW and floats 1 km off the coast of Kabashima. Power goes to the island through an underwater cable, and the 1,000 households of the island are supplied with power through the Kyushu Electric Power Co.'s grid. The project uses excess power to produce hydrogen which is then reacted with toluene to produce methylcyclohexane (MCH) for liquid form storage. Hydrogen is extracted from MCH by using heat and catalyst. As a demonstration, a ship transported MCH between remote islands, and hydrogen extraction and power generation were carried out on the day. The project will last until next March. (The Asahi Shimbun, April 7, 2015)

(4) Japanese Government

On April 10th, the Japanese government decided on a plan to put new technologies into practice for the 2020 Tokyo Olympics and Paralympics at a meeting of the Council for Science, Technology and Innovation (Prime Minister Shinzo Abe as the chairman). An advertisement will start to encourage business participants into the plan this month. Because the new technologies use a system which widely relates to social infrastructure, the development will be carried out in cooperation with the Japanese government, Tokyo Metropolitan Government and businesses from an extensive range of industries to make commercialization faster. The target technologies contain nine areas including an automatic driving system, a specialty of Japanese businesses, and machine translation. The plan also includes a model of hydrogen society which gives less impact to the environment. Electricity will be produced by renewable energy such as solar and wind power throughout Japan, and sent to the greater Tokyo area by large tankers. Hydrogen will be stored in Tokyo and used for the venues, the Olympic village and FCVs. The issues are the development of a cell and technology for safe transport at a large-scale. The developed technologies are more likely to be used for the Tokyo Olympics, and the business participants have higher opportunities to sell their products and technologies for the event. The Japanese government will allocate responsibilities to ministries related to the technologies, and they will calculate budgets for next fiscal year. These technologies are planned to be commercialized before the rest of the world, and promoted as the international standards. (The Nikkei, April 9 & 10, 2015)

On the morning of April 13th, Prime Minister Shinzo Abe attended an opening ceremony of a newly installed hydrogen refueling station to supply hydrogen to FCVs, and expressed governmental commitment to support business installation of hydrogen refueling stations to promote FCVs with the words of "foot down further to the floor on the accelerator pedal". The Japanese government aims at hydrogen refueling stations at 100 locations by FY

2015 throughout Japan. (The Nikkei, April 13, 2015)

2. Local Governmental Measures

(1) Muroran City

Muroran City will drive faster to realize a society using hydrogen by compiling "Muroran Green Energy Town Concept". They will use green energy such as hydrogen which has the commercial potential to revive local economy by creating a new growth base as a city of the established environmental industry. FCV "MIRAI" will be purchased as an official car in this fiscal year, and the number of vehicles is planned to be increased to 15 by 2020. Green energy town is to be established by making an energy network of electricity, gas and hydrogen, installing FCs at facilities and factories, using waste heat from FCs in the community and to promote FCVs and fuel cell (FC) buses. (Nikkan Jidosha Shimbun, March 18, 2015)

(2) Kanagawa Prefecture

Kanagawa Next Generation Promotion Conference has compiled "Kanagawa's Roadmap to Realize Hydrogen Society". Their targets are 5,000 FCVs and hydrogen refueling stations including mobile facilities at 25 locations. The conference consists of automakers, battery manufacturers, hydrogen/electricity provider and governmental bodies. The roadmap contains mid-term targets by FY 2020 for FCVs and hydrogen refueling stations as well as long-term targets by FY 2025. They expect the FCV price range to become competitive with that of hybrid vehicles (HVs) by FY 2025, and anticipate 20,000 to 100,000 FCVs in uses. To accommodate the number of the vehicles, stationary hydrogen refueling station are targeted to be installed at 25 to 50 locations by then. (Nikkan Jidosha Shimbun, March 27, 2015)

(3) Tokushima Prefecture

Tokushima Prefecture will promote preparation of hydrogen refueling stations for FCV growth. Their estimation is 1,700 FCVs in use by 2025 and 3,600 FCVs by 2030. They target hydrogen refueling stations at four locations by 2025 and nine locations by 2030. The prefecture aims to be "Environmental Capital Tokushima" by promoting hydrogen refueling infrastructure with the advantage of being an entrance connecting the Kansai area and Shikoku prefectures. These objectives were announced at the Conference of Tokushima Prefecture Hydrogen Grid Liaison held on March 20th. (Nikkan Jidosha Shimbun, March 31, 2015)

(4) Tokyo

The Bureau of Environment of Tokyo Metropolitan Government has chosen JX Nippon Oil & Energy Corporation to construct and operate a gasoline refueling station with a hydrogen filling facility. They will sign the agreement in April, and the land for the station will be transferred in the late July. The construction is planned to complete by the end of March 2016. (Architectures, Constructions & Engineerings News (Daily), April 6, 2015)

(5) Saitama Prefecture

Saitama Prefecture has revealed a plan to increase the number of FCVs used in the prefecture to 6,000 by 2020. Their plan is to raise the figure to 60,000 by 2025. On April 7th, they started taking applications for a subsidy scheme for FCV purchase. The scheme supports ¥1 million per vehicle, and with governmental subsidy of ¥2.02 million residents will have a total support of ¥3.02 million. Additionally, preparation of hydrogen refueling station will be accelerated. There are three hydrogen refueling stations are in operation, and another six stations will be prepared. The plan contains targets of 17 locations by 2020 and 30 locations by 2025. Being keen on the hydrogen business, the prefecture is cooperating with Honda and Iwatani for an experimental hydrogen refueling station operating on a photovoltaic generator at the prefectural office. (The Nikkan Kogyo Shimbun, April 8, 2015; The Nikkei Business Daily, April 10, 2015)

(6) Kyoto City

On April 13th, Kyoto City announced that a hydrogen refueling station for FCVs would be invited to the city. Osaka Gas will prepare a mobile hydrogen refueling station in FY 2015, which is expected to be the first one in the city. In this year, the city will prepare a hydrogen supply facility for FCV hire for consumers as a part of a project to promote new energy use which has less impact on the environment. "Kamitoba Hydrogen Station (provisional name)" will be prepared in Minami-ku, Kyoto City. The installation costs are between ¥200 to 300 million. The facility can supply three FCVs with fuel at the same time, and it takes about three minutes to fully fill a FCV. A hydrogen consumer price of about ¥1,100/kg is under

consideration, and the fuel will be transported from another hydrogen refueling station in Ibaraki City, Osaka Prefecture, which has a production facility. Kyoto City is working on realizing low carbon society, and will purchase FCV MIRAI in this year to lend them to its residents and tourists by the hour. (The Nikkei, April 14, 2015)

3. Development and Business Plans of FC Element Technology & System

(1) Iwatani & Others

On March 21st, a FC system was installed to experiment supply of electricity and hot water by directly injecting hydrogen at Tokuyama Zoo in Shunan City. The system will be used for lighting and a shower of the elephant enclosure to investigate generation efficiency and durability over two years. The enclosure was equipped with 700 W output FCs and a tank to store hot water using heat during generation. The system provides power for lighting of the elephant enclosure with two Sri Lankan elephants and hot water for the elephant shower and a hot bath dedicated to capybaras. This is the first cogeneration system to supply heat and power solely using hydrogen. Four firms including Iwatani have developed the system, and are testing it with a subsidy of Yamaguchi Prefecture. (The Chugoku Shimbun, March 22, 2015)

(2) FCO Power

FCO Power, Nagoya City, has developed a prototype of a stack of solid oxide fuel cells (SOFCs) which is specifically made thinner for home FC systems. This stack enables a reduction in the volume of hot modules which contain converters and insulation to less than a quarter that of conventional products. The firm aims to commercialize this product which leads to the development of a small system for apartments with limited installation areas by 2020. Cells which consist of sets of anodes and cathodes are stacked together, and the system uses a SOFC stack which was developed by sintering to join. Four of 70 W stacks are placed in three layers to constitute a 700 W stack which is commonly used for home FC system to achieve a thin stack with a cooling structure to keep temperature distribution even in the whole stack. The generation performance will be evaluated. The firm is a venture specialized in research and development of SOFC stacks previously operating as FCO which started development of a next generation SOFC stack in collaboration with a research institute of ceramics in 2005. (The Nikkan Kogyo Shimbun, April 3, 2015)

4. Development and Business Plans Hydrogen Infrastructure Element Technology

(1) Toshiba

Toshiba will test a highly efficient hydrogen production system. A SOEC requires less power than other electrolysis cells and also eliminates the need of expensive platinum catalyst. The basic development has been completed, and the firm will test a scaled-up system in FY 2015 for commercialization. Their plan is to combine the hydrogen production system and SOFCs to commercialize a hydrogen storage and power generation system of large-capacity. Having researched SOFCs for eight years, the firm has already developed a SOFC using scandia stabilized zirconia (ScSZ) for the solid electrolyte and a nickel oxide/gadolinium doped cerium material for the anode, and has worked on commercializing the system as a part of the "Hydrogen Use Research and Development Projects" of New Energy and Industrial Technology Development Organization (NEDO9 since FY 2014. (The Chemical Daily, March 17, 2015)

On March 18th, Toshiba announced that an experiment to adjust electricity supply to the demand using hydrogen would start in the UK. The system will store hydrogen produced by solar and wind power, and generate electricity using hydrogen as demanded in a community. Hydrogen has an advantage for long-term storage, and the firm aims to develop an energy system for the community to be energy self-sufficient. (The Nikkei & The Nikkei Business Daily, March 19, 2015)

Toshiba will work on the development of energy system which consists of renewable energy and hydrogen to eliminate CO_2 emissions. In April, an experiment will start to test a hydrogen storage system combined with a photovoltaic generator in cooperation of Kawasaki City in the city. (The Nikkei Business Daily, March 19, 2015)

On April 6th, Toshiba announced that a research and development center was opened dedicated to the hydrogen energy field which can reduce CO_2 emissions. A large-scale system to produce hydrogen

and generate power is planned to be commercialized FY 2020 before other firms. The new lab is located in the Fuchu Complex. Currently hydrogen is produced from oil which creates CO_2. The firm aims to build a system which emits no CO_2. The system uses photovoltaic generator for electricity to split water to produce hydrogen to be stored in a special tank. Then a large-scale power generator centrally produces electricity using hydrogen in order to supply households with power through the grid. The firm aims to develop a large system to generate power for 10,000 households by FY 2020, and to sell it to new power suppliers. This will be the world's first unified hydrogen energy system from production to generation. The hydrogen related industry is anticipated to grow into a ¥160 trillion global market by 2050. Global major manufacturers including US-based General Electric (GE) are likely to start fighting over global leadership in the market. Toshiba's sales of hydrogen related products are currently about ¥20 billion, and are planned to be increased to ¥100 billion by FY 2020. (The Nikkei & The Nikkan Kogyo Shimbun, April 7, 2015)

(2) Honda

On March 16th, Honda delivered the first Honda Power Manager, HEH55, which is V2H direct current normal charger, and supplies household with electricity from electric vehicles (EVs) or FCVs, to Ohta Elementary School of Saitama City. Saitama City is preparing photovoltaic generators and storage batteries at its all elementary and junior high schools as evacuation centers. The charger can top up electricity once an EV or FCV arrives during disasters, and can also manage systems including photovoltaic generators to optimize power. The city already has a small hydrogen production facility and FCs, which allow a complete hydrogen chain in the area. (The Nikkan Kogyo Shimbun, March 17, 2015)

(3) Hydrogenics

Canadian-based Hydrogenics will accelerate its deployment of a FC business in the Japanese market. Mobility related products will be sold to businesses, and the firm will work on more evaluation of 33 kW level FCs by users which it has already introduced into the market. Additionally, a combined system with a hydrogen filling facility will be offered to bus operators. As well as a demonstrational experiment in Kitakyushu, they will offer a megawatt level power generation for commercial power suppliers and stationary FCs for base stations which have already been used oversea. Their full-scale operation is expected to be in a few years to take an opportunity of growing hydrogen society. (The Chemical Daily, March 19, 2015)

(4) Tohoku University

A team of Assistant Prof. Shigeyuki Takagi and Prof. Shin-ichi Orimo at Tohoku University has developed a technology to bond seven hydrogen atoms to a chromium atom which is previously known to be hard to bond with hydrogen. This achievement can be used for a material to store large amounts of hydrogen on FCVs, and contribute to a superconductive material which zero electrical resistance at low temperature. The research was carried out in cooperation of the Japan Atomic Energy Agency, High Energy Accelerator Research Organization and Toyota Central R&D Labs. Chromium is used for plating and stainless steel. Some metals are easily bonded with hydrogen, and others combined with non-metals tend to bonds to hydrogen better. However, chromium was believed to be hard to bond with hydrogen. The research team calculated how many hydrogen atoms a chromium atom can theoretically take. The calculation shows a possibility that magnesium added chromium bonds with seven, eight or nine hydrogen atoms. Chromium powder was added to a compound of magnesium and hydrogen. The mixture was reacted with hydrogen gas at 50,000 atm and 700 $^{\circ}C$ for four hours. The compound contained a chromium atom bonded with seven hydrogen atoms. The team will try to make a chromium compound bonded with eight or nine hydrogen atoms, and synthesize a compound with other metals. (The Nikkei Business Daily, March 30, 2015)

(5) Kyushu University, Mitsubishi Kakoki & Toyota Tsusho

A research group of Mitsubishi Kakoki, Toyota Tsusho, Kyushu University and Fukuoka City has developed a technology to produce hydrogen from sewage sludge. The technology removes CO_2 by a membrane separator from sewage biogas produced during the sewage treatment process to make a highly concentrated methane gas. Methane is reacted with water vapor, and an adsorbent captures CO_2 to refine

it to highly concentrated hydrogen. An experimental facility will be built in Fukuoka Central Sewage Treatment Center as a commissioned research of the National Institute for Land and Infrastructure Management (NILIM). The experimental facility will fully operate from March 31st. The group will investigate the amount and quality of hydrogen production and profitability. The facility will process 2,400 m^3 of sewage biogas and 3,300 m^3 of hydrogen each day. (The Nikkan Kogyo Shimbun, March 31, 2015)

(6) Tokyo University & Mitsubishi Chemical

On April 1st, a research group of Tokyo University & Mitsubishi Chemical announced that a technology to efficiently produce hydrogen using photosynthesis of plants was developed. A sunlight conversion rate of 2.2 %, the highest ever, was achieved with a catalyst containing copper. The team aims at a 10% conversion rate which is an indication for commercial use by the end of FY 2021. Plants produce oxygen using sunlight and water and energy such as sugar from CO_2. The team combined copper and bismuth to make the catalyst. The catalyst in water with light shone split water into hydrogen and oxygen. They used a membrane which only let hydrogen go through to separate the gas. Previously the highest conversion rate was 0.2% of the research group. The research was carried out as a NEDO project. The team plans to produce hydrogen at a large-scale which is to be reacted with CO_2 from fossil fuel power plant to produce something useful in an equatorial area. (The Nikkei, The Tokyo Shimbun & The Chunichi Shimbun, April 1, 2015)

(7) JFE Steel

On April 2nd, JFE Steel announced that a gas permeability test facility of the world's highest pressure hydrogen gas was developed for steels for hydrogen infrastructure. The maximum pressure is 100 MPa, approximately over 100 times that of a conventional product. The product can contribute to the development of surface processing technology of steels which can stand more hydrogen. (Japan Metal Daily, April 3, 2015)

(8) MHPS, KHI & GE

Mitsubishi Hitachi Power Systems (MHPS) plans to commercialize a hydrogen turbine which emits less greenhouse gases by FY 2017. At the same time, Kawasaki Heavy Industries (KHI) will start working on transporting cheaper hydrogen from oversea. Also, GE is testing hydrogen power generation for 30,000 households in cooperation with the major power supplier in Italy. (The Nikkei, April 7, 2015)

(9) Yachiyo Industry

Yachiyo Industry plans to increase the capacity of accumulators of hydrogen refueling stations and bring the cost down. Development of a resin composite using carbon fiber has been carried out since FY 2013. The firm gained expertize on suitable resin materials for accumulators from the development, and created an inlet structure which prevents hydrogen leaks and is easily serviced. Using experimental results with a small container, the usage and suitability of composite containers will be examined for accumulators of 300 L soon. The firm aims to contribute to the society and environment using its technologies gained from fuel tanks for automobiles, and has worked on the development of compressed natural gas tanks and FCV hydrogen tanks. Their current development is a type 4 composite container which uses a resin liner as an inner container wound by carbon fiber. Accumulators take a large portion of the building cost of a hydrogen refueling station. Type 4 containers can cut down the building cost more than using steel containers. The firm started the development in 2006, and has commercialized containers for liquefied petroleum gas (LPG). This development has been carried out as a part of the "Research Projects on Technologies to Use Hydrogen" of NEDO since FY 2013, and the firm worked on the structure and production method of resin liners and chose suitable resin materials and inlet structures. To make the resin liner, parts are formed by injection and then joined by welding. The inlet structure uses a combination of an O-ring and self-sealing which seals a joint surface by internal pressure of the container for easy maintenance. The manufacturer confirmed that the small container exhibited sufficient sealing ability at a low temperature of -35 °C and a high temperature of 85 °C in the experiment. (The Chemical Daily, April 9, 2015)

5. Ene-Farm Business Plans

(1) Panasonic

On March 25th, Panasonic announced that a smart

city would be developed at a former factory premise in Kita-ku, Yokohama City. The development will use the most advanced energy-saving technologies for residential and commercial facilities, and fully function by FY 2018. Panasonic determined housing business as a growing market, and aims to expand it. The development uses land formally worked as cell phone factory which was closed in 2011 as "Tsunashima Sustainable Smart Town". The development area is approximately 38,000 m^2. This is the second for Panasonic to develop start city using idle land after one in Fujisawa City, Kanagawa Prefecture. Panasonic plans to create a community which reduces energy use and is friendly to the environment by signing agreements with Apple and Nomura Real Estate Development. The development will be equipped with hydrogen refueling station for vehicles, FCs and surveillance cameras using a face recognition technology. The construction will start in FY 2015. The total cost has not been disclosed. Panasonic plans to develop more smart cities using idle land in Japan. (The Nikkei, March 26, 2015)

(2) Tokyo Tatemono

Tokyo Tatemono is developing "Brillia Higashikoganei" which is to be an environmentally friendly condominium to be equipped with Ene-Farm for all the 46 units in Nakacho, Koganei City, Tokyo. The first sales of the first phase have started, and all 39 units were sold out on the day with 1.64 of the competition rate on average and 4 at the most. This 10-story condominium is four-minute walk from the JR Chuo line Higashi-Koganei Station. Ene-Farm will allow a saving of approximately ¥42,000 on utility bills and CO_2 emissions of approximately 1,000 kg each year. The delivery is planned in early December. (Jutaku Shimpo, March 31, 2015)

6. Cutting Edge Technology of FCV & EV

(1) Tesla Motors

On March 19th, US-based EV manufacturer Tesla Motors announced that an application would be available to prevent the loss of power supply by communicating with quick chargers from the end of March. This should encourage more consumers with less worry about a flat battery. The software collects the state of chargers through the internet all the time, and informs users of the risk of running out of power by calculating the distance between EVs and chargers. Working with navigation software, the application automatically chooses routes to pass available chargers at suitable timing on the way. This function will negate the trouble of planning a route with chargers to destinations for a long-distance journey. The application can also tell when the batteries have been charged enough for the destinies to those who do not have much time using smart phones. Tesla will install chargers at possible resting places such as hotels and restaurants for long-distance driving as requested. Their charging network will expand to regional cities, and the number of chargers is planned to be double that of the current figure in order to bring it to over 4,000. (The Nikkei, March 20, 2015)

Tesla Motor has revealed that its sales ended the highest as quarterly results with global shipping of 10,030 EVs from January to March, 2015, a 55% increase of that of the previous term. Their luxury sedan "Model S" has sold well. A lot of orders were placed specifically in the US, which unexpectedly helped the high number of shipping. Although sales are struggling in China, the firm plans to introduce a sport utility vehicle (SUV) "Model X" this summer, and aims at about 55,000 vehicles, over 70% that of the previous year, to ship for the whole 2015. They revealed the sales results for 2014 which is $3.19835 billion (approximately ¥380 billion), a 59% increase that of the previous year. Because the development of the next model has costed at lot, the final loss ended $0.29404 billion, an increasing loss from the previous figure of $0.07401 billion. (The Nikkei, April 7, 2015)

(2) Toray, Asahi Kasei & Sumitomo Chemical

Toray will increase the production of key materials for batteries of EVs. Their key plant in South Korea will be invested with approximately ¥10 billion to increase its production capacity by 50% in 2016. The firm is the global leader of battery materials for eco cars. In this area, Japanese manufacturers take a 70% of the global share. Due to tightening regulations on emissions, the eco car market is expected to expand, and Japanese firms are keen to invest to raise their production capacity. Material production at a larger-scale is likely to reduce eco car price, which would encourage more consumers to buy these cars. "Toray Battery Separator Film", a subsidiary to produce battery materials in Tochigi Prefecture, will

increase the production lines from four to six in its plant in Gumi, North Gyeongsang, South Korea. They will strengthen the production capacity of separators, a material of lithium-ion battery (LIB) for EVs and HVs. Separators stop fires, and also affect the performance of batteries. A separator takes 10 to 15% of the LIB material cost. Toray had a 21.5% share in the global separator market in FY 2013. Japanese firms have started racing for investment in the separator area. Asahi Kasei has the largest share of 34.9% in the global market, and made a decision to acquire US-based Polypore International in the third place for ¥260 billion in February. Sumitomo Chemical in the sixth place will also triple its global production capacity by 2020. (The Nikkei, March 24, 2015)

(3) Toyota & Other Automakers

Toyota Motor plans to increase the sales ratio of HVs to 50% in Japan by FY 2016. The criteria of a preferential tax scheme on eco cars will be tightened from April, 2015, and the firm aims at 760,000 HV sales from the current percentage of around 45% by introducing new models and increasing production. Their plug-in hybrid vehicle (PHV) plans to be able to drive 60 km, double of that of the current product, solely on battery, and will be introduced into the market by FY 2016. Fuji Heavy Industries and Honda will add an HV to their range, and foreign automakers will introduce PHVs and clean diesel cars into the Japanese market. German automakers of VW, Audi and Mercedes-Benz will release PHVs, diesel cars and EVs as their key products. (The Nikkei, March 26, 2015)

(4) Hon Hai

Hon Hai Precision Industry, a Taiwanese electronics contract manufacturing company, has signed agreement on the research and development of a "smart EV" which is to have improved safety and driving performance with two firms including Tencent, a major Chinese internet company. Hon Hai is trying to start an electronics contract manufacturing business of EVs, and this agreement is a part of the movement. Their expectation is that the combination of internet technology of Tencent and the designing and production technologies of Hon Hai would produce an energy-saving, environmentally friendly and safe smart EV. Hon Hai started providing components and service for automobiles in 2014. With this experience, the firm aims to get contracts to manufacturing EVs. (The Nikkei, March 27, 2015)

(5) Nissan

March 27th, Nissan Motor announced that the price of its EV "LEAF" was uniformly reduced by ¥ 140,000. Because the governmental subsidy will be brought down from ¥530,000 to ¥270,000, the firm will compensate the reduction in subsidy by lowering and leveling the price for consumers. The price with the subsidy will be approximately ¥2,390,000, which is a ¥120,000 rise comparing to the previous price plus subsidy. (The Nikkei, March 28, 2015)

(6) LG Chem

On March 30th, South Korean-based LG Chem announced that a long-term agreement was signed with German-based Daimler for supplying EV batteries. To begin with the batteries will be used for the 2016 model of a small EV "smart". This is the 13th user for LG Chem to supply products out of 20 globally major car brands. (The Nikkei, March 31, 2015)

(7) Park 24 & Toyota

A major carsharing provider will improve convenience for users. On April 10th, the major carsharing provider Park 24 started a drop-off service for the central Tokyo area. In cooperation with Toyota Motor, the firm deploys a single-seater electric tricycle "i-ROAD". Other service providers use a variety of facilities such as train stations and condominiums as their service centers, and the carsharing market looks like taking off. The service of Park 24 and Toyota Motor is offered for a limited period of time until the end of September to start with. During the period, they will investigate the booking system, car distribution and the operation including the call center to commercialize the service fully by 2017. This service is offered exclusively to selected individual members and corporate members, and allows them to drop the EVs off at five service centers in a 10 km area which has Yurakucho in the center and includes Asakusa/Kaminarimon and Odaiba. The fee is ¥412 per 15 minutes, and the maximum period for one use is two hours and thirty minutes. Toyota intends to investigate the social needs of a small EV which is different from normal cars. (The Nikkei, April 11, 2015)

(8) Toyota

On April 13th, Toyota Motor announced that an information center of FCV "MIRAI" would be open in Minato-ku Tokyo. Iwatani installed a hydrogen refueling station, and this was revealed on the same day. The refueling facility will be available from 17th. Displaying actual MIRAI, the information center will introduce the concept of the development and advantages of hydrogen fuel in videos, and offer test drive for visitors to feel FCVs and hydrogen closer to them. The center is called "TOYOTA MIRAI Showroom" which has two stories with a total floor area of 165 m^2. The first floor will display the actual vehicle, and show a video to explain the outlook of the vehicle in a large screen. The opening hours are from 9 am to 5 pm, closed on Tuesdays. The facility will operate until the end of the March 2021. Also a dedicated test car will be facilitated to offer the general public to have a test ride around the showroom with a member of staff on board by booking through the website. (The Nikkei, April 14, 2015)

7. Development and Business Plan of FCV Component

Mizuno will increase the production of carbon fiber for Toyota's FCV "MIRAI". MIRAI uses "tow prepreg" which is a sheet material of carbon or glass fiber soaked in an epoxy resin. The material is in a tape form and used to wind around tanks to improve strength. The firm developed a dedicated production facility for MIRAI, and installed the facility at Mizuno Technics, a subsidiary for production in Gifu Prefecture. The facility precisely controls the width of fibers and the ratio of resin in the material to stabilize the quality. Since Toyota plans to increase the production of the FCVs, Mizuno will triple the production capacity of the reinforcement material for high pressure tanks at the plant in Gifu Prefecture by this autumn. Mizuno has developed technologies for the precise process of carbon fiber for golf clubs since 1970s, and aims to grow a new business by expanding the range outside the sport area such as automobiles. Their targets are tanks for hydrogen refueling stations and industrial robot as well as FCV. For sales, the firm will also cooperate with Nagase & Co. which supplies resin as a material for the FCV. The sales target of their non-sport products will be increased to annual ¥3 billion, triple that of the current figure, over the mid-term period to bring them as a core business. (The Nikkei, March 21, 2015)

8. Hydrogen Refueling Station Business Plans

(1) JX Nippon Oil & Energy

On March 17th, JX Nippon Oil & Energy announced that its first on-site commercial hydrogen refueling station was opened in Okazaki City, Aichi Prefecture. The refueling station can supply five to six FCVs with hydrogen in an hour. (The Chemical Daily, March 18, 2015)

(2) Nippon Mobile Hydrogen Station Service

"Nippon Mobile Hydrogen Station Service" was launched in cooperation of Toyota Tsusho, Iwatani Taiyo Nippon Sanso Corporation, and started an operation of commercial mobile hydrogen refueling stations on March 24th. Since FCV MIRAI started its commercial sales, the venture will quickly deploy mobile refueling stations which are cheaper than stationary facilities. "Nimohyss Hydrogen Station Kudan" will be open by the Yasukuni Shrine in Chiyoda-ku Tokyo. The hydrogen refueling facility in a trailer developed by Nippon Sanso Corporation and will stay and supply hydrogen from 9 am to 1 pm on weekdays. The hydrogen price with tax is ¥1,200/kg. (The Nikkei, March 24, 2015)

9. Development & Business Plan of FC & Hydrogen Related Measuring & Observation Technology

A team of Associate Prof. Ogawa Takeo of Keio University has developed a technology to measure real-time water distribution in a cell which is a factor to reduce generation efficiency of FCs. FCs generate power by a chemical reaction to create water from hydrogen and oxygen, but water coming from the reaction sometimes stays in a groove to supply oxygen to the catalyst layers or on polymer membrane surfaces connecting electrodes. This is an issue which reduces generation efficiency. Although researchers and FC related manufacturers are studying materials and a structure to prevent water staying these places, it was difficult to point out exact locations where water is staying in an operating cell on a real-time basis. The team invented a technology of attaching very small coils to a cell and using nuclear magnetic resonance (NMR) which analyzes structures. In the new method, a couple of tens of 0.3 to 0.5 mm

diameter small measuring coils are attached to grooves and the membrane surface in a FC. The FC is placed for analysis in a NMR which creates a strong magnetic field to analyze. Electromagnetic waves give different signal strength depending on the amount of water around the coils. The amount of water is calculated using the different strength in signals. This method can measure the current generated around coils by signal frequencies, which gives localized generation amounts at the same time. In the experiment, a FC with 32 coils attached was tested, and water behavior was analyzed in 6 mm intervals in the cell. The observation found out that water tended to stay downstream of the grooves, and also generation amount was reduced in these spots. The team plans to increase the number of coils to 128 to have a more detailed analysis. They will make a 3 dimensional image of water and generation distribution inside cell for easy understanding. This method is planned to be commercialized as an analyzer in two years in cooperation with a business. (The Nikkei Business Daily, March 19, 2015)

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