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Kyocera Starts to Sell Its Own SOFC System

Reported by K. Onda

1. Governmental Measures

(1) METI

The Ministry of Economy, Trade and Industry (METI) will invite applications of the subsidy scheme for clean energy cars for FY2017 from May 29. The subject is clean energy cars registered for the first time from April 28. The scheme aims to promote next generation cars which contribute to energy and CO_2 emissions saving. The subsidy for fuel cell vehicles (FCVs) is ¥2.02 million for MIRAI and ¥2.08 for CLARITY FUEL CELL, and the amount for electric vehicles (EVs) is ¥0.228 to 0.28 million for Nissan LEAF. The total budget is ¥12,300 million. If the ministry notice that the prospective subsidy amount is likely to exceed the budget, the ministry will close the invitation. Valid applications must arrive by the day before the closure. The details are found on the website of the Next Generation Vehicle Promotion Center. (Nikkan Jidosha Shimbun, May 17, 2017)

(2) Reconstruction Agency & Tokyo

On May 31st, the Governor of Tokyo had a meeting with the Minister for Reconstruction at the Tokyo Metropolitan Buildings, and she said that the local government wanted to advertise the "2020 Olympics and Paralympic to use hydrogen" by running fuel cell (FC) buses on hydrogen produced at Fukushima Prefecture. She has been selling the "Tokyo Olympics is a symbol of recovery to the International Olympic Committee. Tokyo and Fukushima Prefecture signed an agreement for joint research and development of hydrogen production using renewable energy such as wind and solar power. She said that the Olympics using hydrogen energy would be a symbol of cooperation of Fukushima, Tokyo and the Japanese government. (The Tokyo Shimbun, June 1, 2017)

(3) Japanese Government

On June 2nd, the Cabinet approved the energy white paper. The white paper introduces a new movement to establish interest while the price of crude oil stays low. Also, it shows issues and the direction of energy policy such as policy making for a more flexible pricing of liquefied natural gas (LNG) and revising the feed-in tariffs (FIT). The government aims to achieve short-term and spot contracts by reviewing previous long-term contract of LNG through revision of the Law Concerning the Japan Oil, Gas and Metals National Corporation to enable investing in oversea state-run oil companies. As domestic consumption, they plan to accelerate energy saving by fortifying the top runner program. As an action to combine economy and environment, the white paper indicates a target price of storage batteries and full use of negawatt trading to diversify energy source. The government continues measures of commercialization of large-scale hydrogen power generation facilities for realizing hydrogen society and increasing hydrogen refueling stations for FCVs as well as achieving expansion of renewable energy use and reducing financial impacts on users by revising the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities. The white paper shows that powerline fortification work will start from this fiscal year for wind power generation and the construction of large-scale hydrogen production base at 10 MW output level is planned to operate in 2020 based on the Innovation Coast Framework. To go with the global trend, it suggests that firms of the Japanese energy industry should diversify their businesses, and use open innovation which employs technology and human resources from outside (Nikkan Jidosha Shimbun June 3, 2017)

(4) Minister-level meeting of 25 countries in Beijing

On June 7th, two minister-level meetings were held on research, development and promotion of clean energy in Beijing, China. The ministers all agreed to progress plans to achieve double the budgets for research and development of renewable energy as well as expanding the share of electric vehicle (EV) in the new car sales. In the meeting of ministers of clean energy, EV30@30 was set up to increase the share of EVs, plug-in hybrid vehicles (PHVs) and FCVs in new car sales to 30% in all the participating countries by 2030 as a tool to solve political issues such as a measure for air pollution,

energy security and economic growth. On the other hand, plans to double the budgets of research and development in five years were discussed in Mission Innovation which was decided to launch to focus mainly on research and development of clean energy in COP21. (The Denki Shimbun, June 9, 2017)

(5) MLIT

On June 9th, the Environment Working Group of the Panel on Infrastructure Development and the Environment Working Group of the Transport System Subcommittee of the Council for Transport Policy held the 31st joint conference in Tokyo to check progress on measures listed in the Environment Action Plan of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The following seven points were checked; 1) progress on measures of counter and moderate global warming, 2) renewable energy use by using social infrastructure, 3) progress on adaptation measure of global warming, 4) measure to form a society symbiotic with nature, 5) measure to form a recycling society, 6) measure to encourage people to select better environmental behavior and 7) advancement of contribution to the environment using technology. For 2), members appraised steady progress on preparation of standards for FCVs, safety measures for realizing hydrogen society and establishment of marine transport of liquid hydrogen. In 2014, the ministry decided an environment action plan for 2014 to 2020, and has been working on reduction in emissions of greenhouse gasses by thoroughly using renewable energy and fortifying measures to adapt effects of climate change as priority issues. (The Denki Shimbun, June 13, 2017)

(6) METI

The Ministry of Economy, Trade and Industry (METI) worked on deregulation for hydrogen refueling stations by reviewing regulations to lead to reductions in costs focusing on construction including hydrogen containers. Now, they are re-accelerating to relax regulations for reduction in operation and maintenance costs of hydrogen refueling stations by reviewing safety inspection and approving remote monitoring. The basic plan will be compiled by the end of year to be included in the Strategic Road Map for Hydrogen and FCs which is to be revised next spring. The ministry expects 2025 to be the earliest timing for the operation of hydrogen refueling stations to be financially viable. To make the timing for the business turn positive, they will focus on deregulation to contribute to reduction in operation costs. Their plan is to eliminate the need of a safety book and to change to visual inspection for the facilities using materials which are not affected by hydrogen in the subject facilities only for hydrogen refueling stations. They will investigate operation of these stations to be monitored remotely as the fuel industry requested and possible measures to refuel hydrogen during road services which are currently not permitted by law. (Nikkan Jidosha Shimbun, June 13, 2017)

2. Local Governmental Measures

(1) Hokkaido, Sapporo City & Air Water

Hokkaido and Sapporo City have announced that they selected Air Water for the subsidy for opening a hydrogen refueling station. Air Water will install the first commercial hydrogen refueling station, a mobile system, in Sapporo City in FY2017. This will be the third station for Hokkaido following ones in Muroran City and Shikaoi-cho. The station will be installed in Toyohira-ku, and the installation will be completed in March 2018. The filling pressure is 82MPa, and two FCVs can be refueled in one hour. The total installation cost is about ¥260 million which includes a subsidy of ¥160 million from the Japanese government and ¥2.65 million from local government. Sapporo City compiled Sapporo City FCV Promotion Plan in March 2017, and aims to have four hydrogen refueling stations and 3,000 FCVs in use by FY2030. For now, the local government is working on preparation of a hydrogen refueling station in one location, and will see growth of FCVs for further action. One FCV will be purchased by the city as an official car in this fiscal year. Air Water installed a stationary hydrogen refueling station Shikaoi-cho in January, and is already working on an experiment to develop a supply chain from hydrogen production, storage, transport and use. They will invest ¥9,000 million in facilities in Hokkaido, and the Tomakomai Hydrogen Plant expects ¥500 million investment. (Nikkan Jidosha Shimbun, May 31, 2017; The Nikkan Kogyo Shimbun, June 2, 2017)

(2) Nagoya & Toyota;

On June 5th, Nagoya City announced an agreement was signed with Toyota Motor to research a next generation transport system including FC buses on 1st. The city is considering a new public transport system on roads, and will exchange information on high speed transport systems and automated driving as well as FC buses. Toyota plans over 100 FCVs to be used nationwide by 2020. (The Nikkan Kogyo Shimbun, June 6, 2017)

(3) Miyagi Prefecture

On June 1st, Miyagi Prefecture started a car hiring service of Toyota MIRAI and Honda CLARITY by contacting out to Toyota Rent-A-Lease Miyagi, Toyota Rent-A-Lease Sendai and Honda Cars Sendaichuo. This is the first operation to offer the general public to hire the latest FCVs in Japan. To use the

first hydrogen refueling station for the Tohoku region, the prefecture will advertise its hydrogen related measures by encouraging residents to use FCVs. The rental plans are all same at three operators, and ¥4,000 for four hours and ¥5,000 for six hours. FCVs must be fully refueled at Iwatani Hydrogen Station at return. (Nikkan Jidosha Shimbun June 6, 2017)

(4) Tokyo

Tokyo has started subsidizing FC buses with up to ¥50 million, about half of FC bus price which is about ¥100 and double of that of normal buses. Although they aim for 100 FC buses by 2020 when the Olympics are to be held, the number of FC bus currently stays at two due to the high price. (The Nikkei, June 9, 2017)

3. FC Element Technology Development & Business Plans

(1) Seikei University

Seikei University has developed zeolite catalyst containing hydrogen ions to efficiently remove sulfur which are added in natural gas to lead to a reduction in costs including ENE-FARM. The study results will be published at the conference of the Japan Petroleum Institute on May 24th, and the research team aims to commercialize the technology in five to ten years by working with businesses. Because fossil fuel contains various sulfuric compounds, the compounds are removed to make natural gas. However, a tiny amount of sulfuric compounds is added to natural gas as an odorant, because odorless gas leaks are dangerous. Although a tiny amount of sulfuric compounds is toxic to anode catalyst of FCs, they are removed for fuel for ENE-RARM. This zeolite catalyst containing hydrogen ions converts sulfuric compounds, an odorant, into more neutral compounds. In the experiment, zeolite was added to an odorant mixed with nitrogen in a container which was operated at 150 ℃, and the team assessed the compounds removed at a commercial level. Because the desulfurization temperature of current ENE-FARM is higher than that, the technology can lead to a reduction in costs. (The Nikkei Business Daily, May 17, 2017)

(2) Tokyo Gas

On May 23rd, Tokyo Gas announced that 5 kW output level solid oxide fuel cells (SOFCs) exhibited a 65% equivalent of efficiency rating for alternate current end in lower healing value (LHV) for the first time in the world. Although SOFCs for home and business use using natural gas as its fuel already achieved 45 to 60% of generation efficiency, further improvement of efficiency is wanted for realizing low-carbon society. CO_2 and H_2O, reaction products, are removed from unused fuel, and sent back to SOFCs to use up fuel to a total of 91% in order to reduce waste fuel. Additionally, the system efficiently uses high-temperature gas to reduce heat loss to achieve a 73% efficiency rating for direct current, 65% for alternate current. The details will be announced at the 24th FC Symposium organized by FCDIC. (The Denki Shimbun, May 24, 2017)

(3) Kyocera

Kyocera has announced that 3 kW FOFCs for business use would be available as a small-scale power station for buildings through Osaka Gas from July. They already produce and supply components for ENE-FARM of Osaka Gas through Aisin Seiki, but will produce the final product of this business use system. The system uses natural gas as its fuel, and generates power at 52% efficiency rating which is 20% higher than competing systems. The dimensions are 1.2 m x 1.7 m x 0.68 m. The price has not been set yet, but is expected to be ¥5 million or less. The system is eligible for subsidy making installation costs reduced by up to one third or ¥1.35 million. The manufacturer aims for 500 units for the first year and 35% to be business use system in its FC business sales. Their FC business aims to increase by 50% of that of previous year in its sales including components for FY2017. The firm plans its FC business to be a twin core with its photovoltaic generation business in its energy business by growing FC business to ¥50,000 million, seven times of that of sales target of FY2017, by 2021. They are the second Japanese firm to produce FC systems for business use following Fuji Electric. The 3kW SOFCs for business use provide electricity and hot water equivalent of four units of ENE-FARM Type S, and are available in the supply areas of Tokyo Gas and Osaka Gas. The firm is considering expanding the sales area to Europe and the US. With Tokyo gas, they had experimental operation from FY2016. Apart from Fuji Electric, a subsidiary of Softbank Group imports American FCs for business use to sell in Japan in the same field. Also, Miura and Hitachi Zosen are working on development of system for business use. (The Nikkan Kogyo Shimbun, May 25, 2017; The Nikkei, June 13, 2017)

(4) 58th Fujiwara Award

Prof. Susumu Kitagawa at the Kyoto University Institute for Advanced Study has won the 58th Fujiwara Award for development of the world's first porous metal complex which is used for separating or storing gas and electrode catalyst in FCs. (The Yomiuri Shimbun, May 29, 2017)

(5) Toyota Motor

Toyota Motor aims for zero CO_2 emissions at its plants by 2050 by expanding use of FCs. They started experimental operation of a hybrid power generation system of 250kW and

55% efficiency rating combining SOFCs and small gas turbine using natural gas as its fuel with Mitsubishi Hitachi Power Systems (MHPS) as a project of New Energy and Industrial Technology Development Organization (NEDO) in their Motomachi Plant in April. The system is planned to be an independent power source, and will be evaluated for practicality including efficiency and durability. The automaker has already reduced CO_2 emissions since it brought two FC forklifts using hydrogen as the fuel to the plant in January; It takes about three minutes which is short to fill the tank. The plan is to expand the number of FC forklifts to 20 by 2018, and to replace 90% of current 200 engine forklifts in the plant with FC ones by 2020. To achieve a reduction in CO_2 emissions globally, the emissions at plants needs to be cut down as well as emissions from cars. The automaker targets reduction in CO_2 emissions to half of that of 2001 and one third by 2030. (Fuji Sankei Business i, May 29, 2017)

(6) Tanaka Kikinzoku

Tanaka Kikinzoku has improved reaction activity of catalyst of FC electrodes per surface area by 10% by using alloy of platinum, cobalt and manganese in nano-size particles while keeping durability. This can lead to a reduction in the price of FCV by increasing amount of generation per unit mass of catalyst to reduce the amount of catalyst used in FCVs. A conventional catalyst of 1 g of alloy of platinum and cobalt produces 120 amp, whereas 1 g of the new catalyst made of alloy of platinum, cobalt manganese gives 130 amp, a 10% increase. As well as production technology of the alloy, the manufacture uses processing technology to evenly disperse and fix alloy on a carbon surface. Their catalysts for electrodes are used in CLARITY, and will be proposed for FC busses which are expected to expand in the Chinese market, as well as selling to other manufacturers in Japan. (The Nikkei Business Daily, June 2, 2017)

(7) Toyota Tsusho

On June 2nd, Toyota Tsusho announced that a sales contract on reformed methanol fuel cells (RMFCs) in Japan with Chung-Hsin Electric and Machinery Manufacturing (CHEM) of Taiwan. CHEM will build a power generation system by assembling reformer and FCs, and Toyota Tsusho will carry out sales, installation and maintenance. They will sell the system for base stations of cell phones and water treatment. (The Chemical Daily, June 5, 2017)

(8) Panasonic

On June 5th, Panasonic announced that the "Panasonic Environment Vision 2050", a long-term environmental management of the group was compiled. This vision focuses on energy creation and storage by reducing the energy use of their product. They will specifically work on efficient usage of storage batteries to lead to the development of smart living space and transport system to increase clean energy usage. By this means, they will try reducing impacts to the global environment. Green Plan 2018, their environmental action plan is currently being carried out. It is in progress as a principle of CO_2 reduction in production and use of their product. Since their measure is getting close to the goal of the plan, they indicated the new direction for the environmental management. The targets of the vision are "reduction in energy use and energy creation and storage exceeding use". An actual measure is efficient use of batteries. The firm will fortify technological development of next generation photovoltaic generator, FC, hydrogen storage, dispersed power source at a small scale and smart house. Furthermore, their effort will be made to recycle parts, components and final products (The Chemical Daily, June 6, 2017)

(9) Kyushu University & JNC

Kyushu University and JNC have jointly developed a catalyst for FC anode which is a combination of nickel and iridium, and the result is published in Angewandte Chemie website, German chemistry journal. Common electrode catalysts use platinum which reduces its function by CO poisoning. The research team focuses on a group of enzymes containing hydrogenase and CO dehydrogenase. They exist in microbes in soil, and produce CO_2 from CO. The team developed a catalyst of metal complex using this function as the model. They ensured that a cell using the new catalyst worked even with fuel which contains H_2 and CO 50% each. A catalyst which withstands CO poisoning eliminates the need for platinum and high purity hydrogen. These improve the cost efficiency and significantly contribute to growth of FCs. However, the new catalyst is less efficient as an anode catalyst than platinum, and the team is looking into further research. (The Nikkei Business Daily, June 8, 2017; The Chemical Daily, June 13, 2017)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) Chiyoda Corporation

Chiyoda Corporation is researching a system to electrolyze water by using surplus production of wind power generation to create and refine hydrogen, and this research is in the final stage. They are carrying out a demonstration project of elemental technology with subcontractors for four years until February 2019. Yokohama National University is simulating electricity

for hydrogen production using three wind power stations in the Tohoku area as a model. Asahi Kasei is working on an electrolyser which produces hydrogen stably using electricity supply at a fluctuating production level, and is collecting test data by the end of September for analysis. Chiyoda is carrying out production of high purity hydrogen by washing out impurities using a special shower and removing oxygen using alumina catalyst at the experimental plant in its Koyasu Office & Research Park in Kawasaki City. The collected data from May 2016 will be analyzed by the end of this financial year. Chiyoda already completed technological development of hydrogen to react with toluene to form a methylcyclohexane solution for storage and transport. The Japanese government is trying to achieve a project to transport hydrogen from abroad to Japan by 2020 when the Tokyo Olympics are to be held. Kawasaki Heavy Industries (KHI) is developing a tanker ship for liquid hydrogen, and IHI is working on a gas turbine using ammonia which contains a large amount of hydrogen as fuel. Successful technology from these areas will be used for the project. (The Nikkei Business Daily, May 26, 2017)

(2) Fuji Keizai

Fuji Keizai has published the survey report that hydrogen fuel related market is expected to be ¥590.3 billion, 32.1 times of that of FY2015 by FY2030. Recently, the large part of the market is taken by hydrogen refueling stations. The research firm, however, expects the market to prevail from FY2020 because of hydrogen import at a large-scale and hydrogen power generation use. The market of hydrogen refueling stations is estimated ¥38.7 billion, 2.2 times of that of FY2015, for FY2030. Hereafter, FC forklifts and buses are expected to be sold at a full-scale. The FCV range is expected to increase, and Fuji Keizai estimates over 200,000 FCVs for annual sales and nearly 900,000 FCVs in use by FY2030. By this, hydrogen refueling stations are expected to increase rapidly, and about 220 stations are estimated to be open for FY2030. The scale of hydrogen fuel market is expected to increase from ¥50 million for FY2015 to ¥147,200 million for FY2030. In FY2020, a 90 MW output level hydrogen power station is planned to start an experimental operation. The estimation for the market scale of hydrogen fuel is ¥19,500 million. The hydrogen market is anticipated to expand to ¥87,000 million exceeding the market of hydrogen for industrial use such as FCVs and semiconductors. Considering that Japan aims to reduce greenhouse gasses emissions by 26% that of FY2013 by FY2030, they predict the market scale of hydrogen power generation systems to be ¥196,100 million for FY2030. They point out that import and export costs need to achieve the fossil fuel level as well as preparation of the supply chain. (The Denki Shimbun, May 12, 2017; The Nikkan Kogyo Shimbun, June 12, 2017)

(3) Showa Denko & Toshiba

Showa Denko will supply Tokyu REI Hotel which is to be open in the spring of 2018 in KING SkyFront, the global strategic center of Kawasaki City, with hydrogen made from plastic waste at its Kawasaki Plant. The plan is to supply hydrogen from the plant through pipeline to produce electricity and hot water using 100kW pure hydrogen FCs of Toshiba which can start generating power in a short period of five minutes in order to provide about 30% of electricity and heat of the hotel. The center is about 10 minute drive away from the Haneda Airport, and has businesses and research institutes for life science and environment. (The Denki Shimbun, May 31, 2017; The Chemical Daily, June 6, 2017)

(4) Shimizu Corporation & AIST

On June 1st, Shimizu Corporation and the National Institute of Advanced Industrial Science and Technology (AIST) announced that a hydrogen energy system attached to a building constructed in the Fukushima Renewable Energy Institute started full-scale experimental operation. This project aims to develop a compact and safe system to attach to building by using a hydrogen storage alloy which is AIST's specialty. The two organizations started the joint research in February 2016, and the experimental operation will be carried out until March 2018 in order to establish controlling technology to optimize the smart building energy management system (BEMS) developed by Shimizu. The energy system uses excess production of solar power to electrolyze water, and the produced hydrogen is stored in hydrogen storage alloy. Hydrogen is supplied to FCs to produce electricity and heat as needed. This system consists of a photovoltaic generator of 20kW output, an electrolyser of 5Nm3/hr, hydrogen storage units of 40 Nm^3, FCs of 3.5 kW output and storage batteries of 10kW output. It is specifically designed for a building of about 100m^2 floor area. In the experimental operation, the team monitors and controls hydrogen production, storage and supply in order to develop optimal controlling technology while watching power production status of the photovoltaic generator. The project aims for the system to be used for buildings or housing areas by 2020. (The Chemical Daily, June 2, 2017)

(5) Netsushin & AIST

Netsushin and AIST have jointly developed a standard platinum resistance thermometer to precisely measure liquid hydrogen of ultra-low temperatures. The product will be available in July for ¥500,000 to 600,000. The measuring error

is ±0.005 ºC at 20K, -253 ºC, or lower which is the temperature to liquefy hydrogen, which makes the product compliant with the international scale. The firm makes fine 12 holes in high purity ceramic tubes of 1.8 mm diameter and 15 mm, and inserts platinum wire coils of 0.25 mm diameter in each hole. The length of platinum wire is 1 m in total. By this process, the thermometer archives a high resistance of 1000Ω, 0 ºC, which is 10 times of that of the conventional product. The resistance is 4.5Ω at the liquefying temperature, which allows measurement to be highly precise. This new product enables accurate temperature management of liquid hydrogen infrastructure, and can contribute to safety operation. (The Nikkan Kogyo Shimbun, June 5, 2017)

5. FCVs

(1) Honda

On May 18th, Honda announced that taxi operation using CLARITY FUEL CELL planned to start in the end of June. They will lease eight FCVs to Teito Motor Transport, Sendai Taxi, Omiya Jidousya and Hino Kotsu for three years to expand FCV use in the future. Driving data and information to choose a suitable operation area will be collected from the taxi operation, which are to be used for further performance improvement. These taxis will use hydrogen refueling stations in each operation area of the firm. Honda started the sales of FCV in March 2016, and delivered 145 vehicles as of March 2017. (The Nikkan Kogyo Shimbun, May 19, 2017)

(2) The Tokyo Shimbun

1,370 of Toyota's FCV MIRAI have been registered as of the end of last year since its sales started in 2014. Honda started leasing CLARITY FUEL CELL last year, and 110 were registered. The Japanese government targets at 40,000 FCVs by 2020, but this seems to be tough to hit. These vehicles sell for high price of over ¥7.2 million. Furthermore, hydrogen refueling stations have been prepared at 90 locations against the target of 160 locations by FY2020. A hydrogen refueling station costs ¥400 million to build, and require about a couple of thousand FCVs as users. The Agency for Natural Resources and Energy of METI thinks that. FCVs are in demand, and expect manufacturers are able to increase production, and, although these targets numbers for hydrogen refueling stations and FCV are ambitious, they are realistic. (The Tokyo Shimbun, May 22, 2017)

(3) JSAE

The Society of Automotive Engineers of Japan (JSAE) announced the winners of 67th Society of Automotive Engineers of Japan Awards. A total of eight products won the Engineer & Researcher Awards which includes "new small FC stack for automobiles" of Honda R&D, "FC stack frame using stampable carbon fiber reinforced thermoplastic material" and "lithium-ion battery (LIB) for hybrid vehicles (HVs)" of Toyota Motor. Also, the Awards for Contributions to the Field of Engineering were given to three people who include Mr. Yoshihiko Masuda of Toyota Central R&D Labs for devotion in automobile technology through the development of engine and FC. (Nikkan Jidosha Shimbun, May 27, 2017)

(4) The Tokyo Shimbun

The total number of FCV sales in Japan is over 1,800. Toyota sold 1,682 FCVs by the end of April, and Honda sold 145 FCVs by the end of March this year. On the other hand, the governmental target of METI for FY2020 is 40,000 FCVs to be used. Toyota will be able to produce 3,000 FCVs each year, 12 FCVs each day, from this year, which allows the delivery period to be one to two months. They aim at 30,000 FCVs to be sold globally by 2020, and half of the figure is expected to be sold in Japan. The current subsidized price of FCVs is ¥5 million level which is same as the luxury class. The agenda is to reduce production cost. Because hydrogen refueling stations currently cost in maintenance four to five times of that of gasoline ones, the facility number stays about 90 locations. Toyota, Honda and energy firms will jointly launch a venture to accelerate preparation of hydrogen. Using renewable electricity to produce hydrogen will expand the use of hydrogen from automobile to residential. A hydrogen plant at the world's largest level is planned to be built in Fukushima Prefecture, and the Japanese government has started making the basic strategy having related ministries to work together. Bold supports are wanted for hydrogen energy including FCV which is leading the use. (The Tokyo Shimbun, June 2, 2017)

6. FCV Component Development & Business Plan

(1) Bosch

On June 8th, the Japanese arm of German-based Bosch held a press conference on its business strategy. They expect growth of 3 to 5% of that of the previous financial year for FY2017, and will fortify investment in artificial intelligence (AI) and three important areas of electrification, automated driving and connected car technology for mid- and long- term. As the electrification, 48V mild hybrid system for automobiles will be produced at a commercial level. Their experts on FCV components which were newly launched in January have taken a main role on technological proposals for sales at full scale. The firm plans to get more opportunity to pick up needs as early as possible in Japan where FCV development is in

progress. (The Nikkan Kogyo Shimbun, June 9, 2017)

(2) Nisshinbo

Nisshinbo Holdings has moved on to cross border development system among its group members for carbon separator for automobile FCs. Previously Nisshinbo Chemical was playing the leading roll, but a new organization will set up in the Business Development Division soon to accelerate development with all the group members to aim products to be used for next generation FCVs which are to be sold from 2020's. Metal separators are used for automobiles, because of their reliable properties for cracks. However, this is not a fixed choice. The group judges that it is a critical stage now for the product to be used for FCVs from 2020. The new department will focus on carbon separator development for FCVs. As well as human resources, advanced technologies including AI are considered to be use. They can easily form flowing channels on both sides of their separator, and will work on reducing thickness to a level compatible with metal separators. Their separator exhibited high durability to survive all the legs of a round the world driving test in FCV by European carmakers in the past. They plan to develop sales packages combined with carbon alloy catalyst as a FC related product in the future. (The Chemical Daily, June 9, 2017)

7. Hydrogen Refueling Station Technology Development & Business Plans

(1) Toyota & JXTG

Toyota Motor and JXTG Holdings along with others will launch a venture for hydrogen refueling station business to prepare new hydrogen refueling stations at about 300 locations in 10 years from 2018. The venture will be invested by 11 organizations including Tokyo Gas, Idemitsu, Iwatani, Nissan, Honda, Toho Gas, Air Liquide Japan, Toyota Tsusho and Development Bank of Japan as well as the two firms. The capital is expected to be a couple of ¥10 billion level. Currently, hydrogen refueling stations are open in about 90 locations, and about 1700 FCVs are in use. This makes hydrogen refueling stations difficult to be financially viable due to a large amount of operation costs. When the number of these stations extends to 400 locations, four times, the construction costs of each station will be reduced; The current construction costs of each station is between ¥400 to 600 million, over double of that of gasoline ones. JXTG and Iwatani plan to transfer the existing stations to the venture. As of the end of FY2016, around 100,000 EVs are in use, and the number of accumulated sales including plug-in hybrid vehicles (PHVs) are nearly 200,000 vehicles. The preparation of quick chargers has been progressed, and the number of the chargers in operation is about 7,100 units as of February 2017 according to a promotional organization. There is a plan to install a quick charger which can reduce charging time to a third of that of current one in this year. On the other hand, FCV has short hydrogen refueling time of three minutes and longer driving range of 700 to 800 km. The organizations are trying to make FCVs popular in the market, and expect 2020 Tokyo Olympics to be a good opportunity to advertise the product. (The Nikkei, May 18, 2017; Fuji Sankei Business i, May 20, 2017)

(2) Toyota & Iwatani

Kansai Airports, the operator of the Kansai International Airport, will start experimental operation of FC forklifts since a full-scale hydrogen refueling station was introduced to there in April in cooperation with Iwatani and Toyota Motor. Liquid hydrogen is gasified and compressed to be filled in FC forklifts. Six forklifts developed by Toyota will be used. They will reduce CO_2 emissions compared to diesel forklifts and pollution in indoor working areas and warehouses. However, a single FC forklift is expensively ¥14 million, and the firm will financially evaluate feasibility including hydrogen price. An airport has limited areas for forklifts and trailers to drive around, which is a suitable testing site for new energy. In 2012, Iwatani and Toyota joined KIX Smart Island Hydrogen Grid Council, and the project was selected for Strategic Comprehensive Special Zone by the Japanese government in 2014. In 2016, a hydrogen refueling station was installed, and operates for public. Another hydrogen refueling station will be installed in the Osaka International Airport next year to connect the two airports by FC bus. The council is considering a project to produce and store hydrogen using new energy, and to supply electricity by using stored hydrogen. The council expects the projects to be an opportunity to advertise hydrogen related advanced technology to overseas visitors. (The Nikkei Business Daily, May 29, 2017)

(3) Iwatani

Iwatani plans to install hydrogen refueling stations at 50 locations, over double the current number, by FY2020. Currently, hydrogen refueling stations exists at 22 locations throughout Japan. The firm will install these stations in Okayama Prefecture, Itami City of Hyogo Prefecture and greater Tokyo area in FY2017. The Japanese government targets for 160 locations of hydrogen refueling stations nationwide, and Iwatani is following this. The new hydrogen refueling station to be installed in Okayama Prefecture can fill three FCVs in one hour, and the estimated investment is around ¥1 billion. The station for Itami City can fill six FCVs in an

hour. Iwatani has joined a project which has a total 11 participants including Toyota to launch a venture in FY2017 to prepare hydrogen refueling stations. Iwatani has worked on over 40% of hydrogen refueling stations nationwide including construction, operation and facility sales. Their aim is to turn their hydrogen refueling business financially positive early in the future by using the framework focusing on the venture. (The Nikkan Kogyo Shimbun, June 9, 2017)

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