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Fierce Competition among Japan, US Europe and China in Developing Key Product Eco Cars

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1. Governmental Measures

(1) Kanto Bureau of Economy, Trade and Industry

The Kanto Bureau of Economy, Trade and Industry has published report on outlook of hydrogen supply and demand in the greater Kanto area. The subject area includes Niigata, Yamanashi, Nagano and Shizuoka on top of Tokyo and the six Kanto prefectures. The bureau estimates annual hydrogen demand for transport such as fuel cell vehicles (FCVs) and fuel cell (FC) forklifts to be 2,340 t for 2020 and 9,065 t for 2025. Hydrogen supply is expected to be 4,694 t for 2020 and expanding to 11,899 t for 2025. The bureau launched the "Greater Kanto Hydrogen FC Cooperation" in in 2016, and this industry-, government- and academia-organization calculated the estimation based on governmental targets and published information. In the estimation, the supply for transport such as FCV is to beat the demand until 2020, but the demand can reach the supply in 2025 in some prefectures including Shizuoka. The report says flexible operations such as business hour extension and scale of hydrogen refueling stations might be needed to meet the demand. The supply from petroleum refinery in the area is estimated 130,000 t for 2020 and 140,000 t for 2025, which would meet the demand. On the other hand, the hydrogen supply for stationary ENE-FARM is expected to be 179,225 t for 2020 and 348,338 t for 2025, and the supply for FCs for business use is estimated 1,212 t for 2020 and 22,664 t for 2025 in the area. Because these supplies are sourced by natural gas and liquefied petroleum gas (LPG), the report assumes that the supplies are able to meet the demand. (The Chemical Daily, July 18, 2017)

(2) UK Government

On July 26th, the environment secretary, Michael Gove, announced that sales of gasoline and diesel vehicles would be completely banned from 2040. The government aims to help solving serious air pollutions in urban areas and global warming. The change is expected to back up electric vehicle (EV) related technological development by promoting the vehicles. This movement will support local governmental measures to ban or charge vehicles which do not meet standards in seriously polluted areas. Many fuel efficient diesel cars are used in Europe, and NOx pollution has been recently getting worse. Consumers lost trust in diesel cars due to German-based Volkswagen's emission fraud, which helps the ban. The Netherlands and Norway are considering a ban on sales of gasoline and diesel vehicles from 2025. Last autumn, the Bundestag of Germany decided to ban sales of gasoline vehicles by 2030. The Chinese government has brought in a similar policy, and intends to grow EV to be its key industry by rapidly shifting to the vehicles. The Japanese government also targets 50 to 70% for EV and plug-in hybrid vehicles (PHVs) in the new car sales by 2030. However, a drastic change in policy is difficult as there are many parts manufacturers for conventional cars. According to the International Energy Agency (IEA), the new EV sales are 750,000 for 2016, and the accumulated sales reached over 2 million. The energy white paper published by the Japanese Ministry of Economy, Trade and Industry (METI) in June says that transport such as cars were 65% of global oil consumption in 2014. Fitch Ratings, a credit rating firm, has analyzed that gasoline demand will decrease by a quarter if EV keeps 50% of new car sales for 10 years or longer in Europe. In contrast to this, electricity demand will increase. For example, an estimation shows a 10% rise in electricity consumption in Japan if all passenger cars are replaced with EVs. Although the UK is trying to increase the ratio of renewable energy such as wind power to over 20% to be less dependent on coal, the power supply currently is on the edge. If old nuclear power stations are not smoothly replaced with new ones as planned, the country might see power shortages in 2020's. Power generation costs of renewable energy are going down specifically in Europe, but building new nuclear power stations is difficult worldwide since

Fukushima's accident. To promote an EV shift, energy policies are required to accommodate expanding demand in electricity while working on measures to solve global warming and air pollution. (The Nikkei, July 27, 2017)

(3) Japan, US & Europe

Global automakers are forced to shift their core business to EVs and PHVs. The Chinese government has clearly given preferential treatment to EVs, and India has reduced tax for EVs. Major European countries have also announced a tightening of regulations on gasoline vehicles. Toyota Motor has a strategy to make hybrid vehicles (HVs) and FCVs as its core eco cars, but it is also considering commercial production of EVs in China from 2019. The Chinese government's subsidy, preferential tax reduction, and preferential treatment for vehicle registration in urban areas for EVs drove the car producer inevitably to work on the vehicles. Toyota has a target to stop production of combustion engine cars by 2050, and has already launched an EV Business Planning Department at the end of 2016. They aim for early development of competitive EV using expertize on HV batteries. Early July, Volvo of Sweden announced that all of its product range would be EV and HVs from 2019. German-based, Volkswagen also plans to make the sales ratio of electric powered cars 20 to 25% in its group by 2025. Honda plans to make two thirds of its car sales HV and EV by 2030. Currently, EVs are more expensive than gasoline cars, but automakers are quickly developing technology to improve performance while reducing the costs of core components such as batteries as well as attracting consumers with subsidies. (The Nikkei, July 27, 2017)

(4) FDMA

The Fire and Disaster Management Agency (FDMA) of the Ministry of Internal Affairs and Communications (MIC) has started working on safety measures of hydrogen refueling stations for growing FCVs. They will compile safety measures for sharing refueling bays of refueling stations with hydrogen refueling facilities, dangerous facilities for hydrogen refueling stations using organic hydride, refueling stations with compressed hydrogen, refueling facilities using booster pump for liquid hydrogen and unmanned refueling stations with hydrogen refueling facilities which are remotely monitored, by the end of FY2017, and will take required actions such as revising regulations of the technical standards and laws related to fire defence from FY2018. For sharing refueling bays, the differences between natural gas and hydrogen refueling facilities, and their safety measures will be studied to establish technical standards. Safety measures will be researched for hydrogen refueling stations using organic hydride and booster pumps for liquid hydrogen to establish technical standards. The agency will consider revising the law related to fire defence for unmanned refueling stations with hydrogen refueling facilities which are remotely monitored after establishing technical standards of the High Pressure Gas Safety Act. (The Chemical Daily, July 28, 2017)

(5) METI

On August 1st, the Ministry of Economy, Trade and Industry announced that the Committee on Energy Situations would be newly launched to compile experts' opinions to develop a long-term energy strategy for 2050. Japan targets an 80% reduction in greenhouse gases of that of 2013 by 2050 in the Paris Agreement. To achieve the goal, the committee will discuss what the role of nuclear power should be in the power mix and the growth of renewable energy use, and they will report the results to the minister. The committee consists of 8 experts from the business and academic community, and will hold the first meeting on 30th to decide the direction of the strategy by the end of the year. The minister says that we cannot achieve the goal for the agreement by just extending previous strategies. The committee will keep the use of FCVs which emit no CO_2 in mind, and will talk over how industry and society should accommodate new technologies. (The Yomiuri Shimbun, August 2, 2017)

(6) Minister of Economy, Trade and Industry

On August 4th, Minister of Economy, Trade and Industry Hiroshige Seko who has stayed in office for the third administration of Abe said that a public-private joint team would steadily work on industrial recovery and revision of the basic energy plan determining reconstruction of Fukushima, decommission of the nuclear power station and solutions for contaminated water as the priority issues at the press conference after the cabinet meeting. "Also, METI needs to improve policy to prepare the environment for the Japanese car industry to take a lead in the global market.", he says. (The Denki Shimbun, August 7, 2017)

2. Local Governmental Measures

(1) University of Yamanashi

University of Yamanashi and Yamanashi Prefecture together applied "Yamanashi FC Valley for Hydrogen Society" for the Development Program of Local Innovation and Ecosystem which is subsidy of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and they announced that the project was selected for the subsidy on August 1st. The term is five years from 2017. Local business will also join the project to reduce production costs of FCs. (The Nikkei, August 1,

2017)

(2) Tokyo

On August 2nd, the governor of Tokyo announced issues for her second year after one full year in the office. She emphasized work on preparation of super aging and 2020 Olympics and Paralympics in cooperation with all sorts of other organizations in Japan. "There are options such as EV and FCV. Tokyo will support their growth, and the Tokyo Olympics will lead the area", she expressed for movement of UK and France. (The Nikkei, August 2, 2017)

3. FC Element Technology Development & Business Plans

(1) NIMS

The National Institute for Materials Science (NIMS) and the University of Tokyo have discovered that microbes used for microbial fuel cells (MFCs) produce electricity by fermentation. Their aim is to develop material production technology in an environmentally friendly way; for example, producing a material while generating power. They found out that the microbes with defective enzyme for fermentation resulted in half the production of electric current. Additionally, protons are transported from inside the microbes to outside during fermentation. When hydrogen is replaced with deuterium, current production speed reduced. By adding flavin adenine dinucleotide which mediates proton transport, current production increased by single to double digits. If power producing fermentation is added to Escherichia coli;, a chemical material can be produced by fermentation process while producing electricity. (The Nikkan Kogyo Shimbun, July 17, 2017)

(2) Sumitomo Metal Mining

Sumitomo Metal Mining is accelerating to work on samples for expanding the market of scandia, a scandium oxide. They have developed technology to collect scandium, a rare metal earth, from the production process of nickel and cobalt mixed sulfide. In the Philippines, a facility to produce an intermediate product of scandia is being constructed, and a production facility of the final product is under construction in Japan. The firm plans to start supplying the material for FCs, the main usage, from next spring. Scandia is used as a binder to give ceramics and glass heat and impact resistance during sintering. The concentration of scandium is low in ores, but the material is found in many ores. Due to this nature, the material is produced as by-product during the extraction of other elements. The firm built a test facility to collect the element from nickel ore at its subsidiary in the Philippines in 2013, and established the technology to efficiently collect the material at a commercial level. Currently, they are constructing a production plant of the intermediate product in the Philippines and a refinery in its Harima Refinery. The investment is about ¥4 billion, and the production capacity will be 7.5 t each year. Half of the material in the market is used for electrode and anode materials of FCs such as solid oxide fuel cells (SOFCs). It is believed that their production of scandia is to be the first at a commercial level in a developed country. (The Chemical Daily, July 25, 2017)

(3) Hitachi Zosen

On August 25th, Hitachi Zosen started experimental operation of SOFCs for business and industrial use at Izumi Center of Osaka Research Institute of Industrial Science and Technology. The FCs output 20 kW using natural gas as fuel. The system achieves over 90% of total energy efficiency including heat use, one of the best in the market. The firm will evaluate performance and durability by operating for over 4,000 hours, and collect data for facility improvement and reduction in costs. Because the planar SOFC stack of NGK Spark Plug used in this system generates at higher power density, higher efficiency is expected. The test system achieves about a 50% lower heating value (LHV) standard. A hot water tank is installed outside the FC system, and used as hot water supply and heating in the laboratory building of the test center. The system will operate continuously with actual load for a long period as the test. The FC units can be installed to build a couple of kilowatt level system. The firm expects the product to be used at apartment and office buildings, hospitals and schools. The dimensions are 2.2 m wide, 4.3 m long and 2.8 m high. An aseismic device is installed at the bottom of the system, and the system accommodates a low pressure natural gas supply. This project is using a subsidy of the New Energy and Industrial Technology Development Organization (NEDO), and also the Battery Strategy Research Center of Osaka Prefecture supports it. The prefecture published H2Osaka Vision to promote hydrogen related projects in 2016, and this SOFC project is one of them. The manufacturer will release the SOFCs starting with introducing usage, and promote them. The firm plans the system to accommodate various fuels such as methane produced from biomass materials and hydrogen made using renewable energy in the future. (The Denki Shimbun, July 26, 2017)

(4) Tohoku University & Kyushu University

A study group of the Institute of Multidisciplinary Research for Advanced Materials of Tohoku University and the Institute for Materials Chemistry and Engineering of Kyushu University has developed a new carbonaceous catalyst which has an

ordered frameworks like organic crystls and contains metal. This enables it to produce a new material with advantages of carbon materials such as conductivity and heat and chemical resistance while having a chemical structure to achieve catalytic properties, which leads to development of new materials to be catalysts to convert CO_2 and to replace platinum of FCs. metal organic crystals can be highly reactive catalysts by precise design, but they have issues such as no conductivity and vulnerability to heat and chemicals. On the other hand, carbonaceous catalysts containing metal have properties such as conductivity and resistance to heat and chemicals, but lower reactivity. The group found a synthesis route of new carbonaceous catalysts containing metals with ordered frameworks like organic crystls. A variety of useful applications are expected. (The Chemical Daily, July 27, 2017)

(5) NGK Spark Plug

On August 7th, NGK Spark Plug announced that it aimed to commercialize planar SOFCs under development for business and industrial use. They are already working on SOFCs for home use, and will also develop business and industrial uses. In June, Hitachi Zosen started test operation of 20 kW output level SOFCs in cooperation with Osaka Research Institute of Industrial Science and Technology. NGK supplied its large planar SOFC stack for this test project. They aim to commercialize both cylindrical and planar SOFC stacks. A planar stack has higher power density and easily produces high output due to layered FCs. (The Nikkan Kogyo Shimbun, August 8, 2017)

(6) AIST

A team of Materials and Chemistry of the National Institute of Advanced Industrial Science and Technology (AIST) has developed a glucose dehydrogenase which can be used to measure glucose level in blood, and has high reactivity and durability to improve performance of MFCs. They succeeded in improving conventional enzymic activity to 46 times by increasing reaction temperature from 30 ºC to 70 ºC. This dehydrogenase takes out electrons by oxidizing glucose. The team extracted dehydrogenase from thermoascus aurantiacus which lives in a high temperature environment, and identified the structure to affect heat resistance and reactivity in the enzyme. Then, the new dehydrogenase was made by genetic modification. The enzymic activity significantly increased from 7 to 320 reactions unit per milligram. Increasing the reaction temperature also improved generation efficiency of MFCs which use electrons as energy. The team plans to commercialize it in five years. (The Nikkan Kogyo Shimbun, August 9, 2017)

(7) Seiryu Power Energy

Seiryu Power Energy has started the sales of 4.4 kW FC system using hydrogen as fuel for industrial and office use since it developed the product. In addition to power generation, the waste heat is used for a hot water supply. The whole system is ¥20 million. They target is10 systems for the first financial year. Brother Industries' FCs and heat exchanger produced by Morimatsu Industry are used in the FC system. The system is suitable for sewage treatments and solar power plants which can easily produce hydrogen. A major manufacturer in Japan already decided to install the system. The hydrogen FC system development is carried out by signing partnership among Seiryu Power Energy, Gifu Prefecture, Yaotsu-cho of Gifu Prefecture, Gifu University, Morimatsu Industry and Brother Industries. (The Nikkei Business Daily, August 9, 2017)

(8) Miura

Miura has developed a 4.2 kW SOFC system for business use, of which the generation efficiency and total efficiency are 48% and 90% respectively, under NEDO project, and will start sales from October. They started the development from FY2012 in cooperation with Sumitomo Precision Products and tested the system with actual using load such as restaurants as NEDO project from FY2013. The target efficiency was confirmed during the course. The product size is 1880 mm wide by 810 mm deep by 1780 mm high. The system has a hot water tank and required equipment package, which allows minimum installation work of piping and wiring on site. The fuel is natural gas. The firm anticipates over 100,000 units of sales to restaurants and expansion of sales from 2025 when FCs are expected to be more common. (The Chemical Daily, August 9, 2017)

(9) MHPS

On August 9th, Mitsubishi Hitachi Power Systems (MHPS) announced that it is started sales of new pressurized hybrid power generation system combining SOFCs and a micro gas turbine (MGT) developed for business and industrial use. The system has 250 kW level of SOFCs and 50 kW level of MGT, and the price is closed. METI has a target price of ¥1 million/kW for SOFCs, but the system price has not reached the level. MGT is produced by Toyota Turbine And Systems. Made with ceramics, the SOFCs operate on natural gas without reformer at 900ºC. Compressed air from MGT is sent to cathode side of SOFCs, and generation efficiency improves by increasing cell voltage under pressurized condition. The remaining fuel and air from SOFCs are burned in a combustor to operate MGT. Due to this, the system has improved efficiency as a hybrid system. Being cogeneration, heat is

collected as steam and hot water to push up total efficiency. Supported by NEDO, MHPS tested a 250 kW system at four places in Japan until FY2016. 55% of generation efficiency was achieved, and it was confirmed that the system operated stably with a durability evaluation, start and stop test and variable load test. (The Denki Shimbun, August 10, 2017)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) Tokyo Institute of Technology

Tokyo Institute of Technology has developed a highly durable photocatalyst to produce formic acid from CO_2 by applying visible light. They achieved a photocatalyst structure which concentrates on the reaction with CO_2 and a three times longer life by reducing deterioration by by-products. This product is expected to be used for production of formic acid which is to be used as fuel in the future. The team combined an improved ruthenium compound to be able to bind to organic molecules of which the base is urea. The photocatalyst produces formic acid from CO_2 with under 450 nm height. In the reduction reaction, the reaction related to CO_2 is increased from previous 75 to 99% to reduce unwanted reduction reaction. This reduces deterioration of photocatalyst, and improves strength of the structure. The durability improved to about three times of that of conventional one. To be commercialized, the durability needs to increase by 1,000 times. (The Nikkei Business Daily, July 19, 2017)

(2) Shimizu Corporation

Shimizu Corporation started test operation of hydrogen energy system for building this summer in cooperation with AIST. In the system, unused solar power production produces hydrogen, and hydrogen is stored. Stored hydrogen produces electricity and heat to be supplied to buildings as needed. In April, the firm built a system to supply about 60% of the electricity and heat required for a building with total floor area of about 1,000 m^2 at Fukushima Renewable Energy Institute of AIST. They aim for the system to be used at buildings and town blocks by 2020. Solar panels generate power, and excess power electrolyzes water to produce hydrogen to be stored in tank made of hydrogen storage alloy. Hydrogen is sent to FCs to produce electricity and heat as needed. Solar power production varies by weather and time of day. Storing hydrogen for a long period can solve mismatching demand and supply of energy. The test operation also aims to develop expertize on new energy management. The firm developed its own smart building energy management system (BEMS) to achieve energy saving by controlling both power supply to buildings such as power generation and storage facility and power consuming appliances such as air conditioning and lighting, and has commercialized the system. Next challenge is to monitor and control hydrogen production, storage and use. They put stress on it being a "system to allow buildings to use over 80% of solar power." Although cost stands in the way for the system to be used at many office building, they hope governmental measure such as preferential treatment of floor area ratio for buildings with highly environmental performance to promote hydrogen use in the construction industry. (The Nikkei Business Daily, July 24, 2017)

(3) Sumitomo Chemical

Sumitomo Chemical will commercialize a membrane to separate CO_2 from a gas. An inorganic carrier to capture CO_2 is blended into highly heat and pressure resistant resin to form a membrane. Sheets of the membrane are rolled into elements, and dozens of the elements are installed as separation equipment. This equipment is used to separate 50% of CO_2 to reduce the load of chemical absorption techniques which are carried out afterwards in order to cut down operation costs of the whole CO_2 capturing system. A chemical plant installed a couple of pieces of the equipment as the first project, and the project is at a ¥1 billion level. This time, the firm will be rewarded based on degree of reduction in actual costs of the operation. The project is carried out in a joint venture with Renaissance Energy Research. (Fuji Sankei Business i, July 24, 2017)

(4) Chiyoda

On July 28th, Chiyoda Corporation, Mitsubishi Corporation, Mitsui & Co. and Nippon Yusen will start a full scale experiment of the global supply chain of hydrogen. A natural gas plant in Brunei will produce hydrogen by steam reforming. Hydrogen will be liquefied by chemical reaction with toluene, and transported to the Kawasaki coast area by ship. It will be turn backed to gas, and be supplied to thermal power plants as fuel. Related plants will be built by December 2019, and test operation will start in January 2020. The maximum amount of hydrogen to be produce each year is 210 t, equivalent to about 40,000 FCVs, and the investment is estimated at a couple of billion yen. Keihin refinery of Toa Oil, a member of Showa Shell Sekiyu group will supply its thermal power plant with transported hydrogen as fuel. The project aims to establish technology for a full scale hydrogen power generation business by 2030. (The Nikkan Kogyo Shimbun, July 28, 2017)

(5) FiS

FiS which is a research and development firm of

semiconductor gas sensors worked on development of a hydrogen detector to identify hydrogen leaks and explore the market. Their sensors are supplied for FCVs and ENE-FARM. They plan to increase users in China and the US. Since inquiries made to them for FCVs, lorries and busses, sample shipping started in April, 2017. They have developed technology to reduce energy consumption to hundredth of that of existing product by making heating for sensor operation more efficient and cutting down idling. (The Nikkan Kogyo Shimbun, August 1, 2017)

(6) Kyoto University

Kyoto University has announced that it developed an efficient hydrogen storage system using an iridium catalyst. Hydrogen is reacted with dimethylpyrazine containing nitrogen to be stored as dimethylpiperazine. The same iridium catalyst can promote dehydrogenation. There are methods to store and release hydrogen using organic hydrides such as methylcyclohexane, a cyclic compound, and toluene and decane and naphthalene, and they catch attention as a safe and efficient way to store hydrogen. However, dehydrogenation requires high temperatures of over 200 ℃ and a large amount of solvent. This heterocyclic compound containing nitrogen needs lower temperatures for dehydrogenation. Also, the team found out that the catalytic reaction worked under 15 atm, a lower pressure than conventional one. Furthermore, it was confirmed that its catalytic performance did not go down for four continuous dehydrogenation and hydrogenation cycles, and performed hydrogen storage and release at almost 100% efficiency. The team found out that less reaction solvent reduced hydrogenation yield, but the catalyst promoted some degree of reaction without solvent. (The Chemical Daily, August 2, 2017)

(7) Shimizu Corporation

Shimizu Corporation is trying to fortify proposal of construction business, its core, by assessing energy supply and urban development businesses from an environmental perspective. Their environmental business has been operated as a decarbonizing value chain, and they will use the business for energy saving buildings and town blocks by organically connecting it to their other businesses. Recently, they started a scheme to install photovoltaic generator and gas cogeneration at buildings or on premises of their users at their expense. The users take advantage of these energy facilities, and the construction firm charges subscription fee to the users as maintenance, repair and renewing costs. This is expected to lead to consumer electricity sales which are to start supplying external customers with electricity from FY2018. The firm operates solar power plants at two locations, and is working on geothermal and biomass power generation in cooperation with other firms. A joint project with AIST is working on hydrogen related technological development to produce hydrogen by using surplus solar power generation to be stored for FCs to generate electricity later as needed. The firm plans to establish system by 2020. (The Nikkei Business Daily, August 4, 2017)

(8) Hitachi & Marubeni

On August 4th, Hitachi, Marubeni, Miyagi Coop, Tomiya City of Miyagi Prefecture announced that they would start an experiment project to develop a supply chain of low-carbon hydrogen which was selected as technological evaluation by the Ministry of the Environment (MOE). The project will evaluate a system of hydrogen produced using solar power to be distributed to households of Miyagi Coop members, Coop stores, and School Children's Club. The organizations plan to start full scale operation in the city from 2020 by getting the results together by FY2019. The project uses an established solar power system at a distribution center of Miyagi Coop, and a water electrolyzer will produce hydrogen using solar power. Hydrogen will be stored in cassettes of hydrogen storage alloy to be transported through the established distribution network of the coop with other delivery goods. Users will connect these cassettes to pure hydrogen FCs to convert the gas into electricity and heat. The project expected users to use hydrogen from dusk until dawn when solar power production goes down. This low-carbon hydrogen supply and demand chain can be operated to use locally produced energy nationwide. (The Chemical Daily, August 7, 2017)

(9) Fuji Keizai

Fuji Keizai has published forecasts that the hydrogen fuel related market is to be ¥590.3 billion for FY2030, 32.1 times of that of FY2015. Sales of forklifts and buses using FCs will be fully commercialized, and the range of FCVs will increase from those currently available. Due to these factors, demand on hydrogen refueling stations is expected to rise. The market of hydrogen fuel is estimated to be ¥147.2 billion for FY2030, 2,944 times of that of FY2015. Hydrogen is expected to be in increase demand facilitated by the planned operation of hydrogen power plants. The market of the hydrogen power generation system to be tested from FY2017 is estimated to be ¥196.1 billion for FY2030. Since test operation of a power generation system is to start in FY2017 and three systems are to start in FY2020, the fuel market is expected to expand. (Nikkan Jidosha Shimbun, August 7, 2017)

(10) 7-Eleven & Toyota

On August 9th, 7-Eleven Japan and Toyota Motor announced

that they signed a basic agreement for partnership to reduce energy use and CO_2 emissions in logistics and shops. They plan to contribute to the realization of low-carbon and hydrogen society by using vehicles and generators using hydrogen which are to be newly developed by Toyota. The actual project will use FC lorries for distribution and FCs for transport tracks to shops and refrigerator and freezer units. In shops, new power sources will be added to installed photovoltaic generators, and new energy management system will help further energy saving. One of the new power sources is FC power generator which is to be a base power supply of shops with hydrogen refueling stations attached. Another is stationary power storage systems using automobile storage batteries. This will be installed at shops, and the firms will consider using it as emergency power source for disasters as well as energy saving. Toyota will invest to develop FCV market and related infrastructure quickly. (The Nikkei Business Daily, August 10, 2017)

5. ENE-FARM Business Plans

(1) Japan Gas Association

On July 25th, the Japan Gas Association revealed the result of natural gas cogeneration installation for FY2016. The accumulated capacity of installed cogeneration is 5,304 MW as of the end of FY2016, an increase of 157 MW from the end of FY2015 and a 3.1% rise. They surveyed the installation results of cogeneration using natural gas as fuel to 203 natural gas supplier nationwide. In the accumulated capacity, business use is 1,188 MW, a 7 MW increase from the end of FY2015 (0.6% rise), and industrial use is 3,877 MW, a 128 MW increase from the end of FY2015 (3.4% rise). Home use, mainly ENE-FARM, is 240 MW, a 23 MW increase from the end of FY2015 (10.6% rise). The accumulated number of installed systems is 294,949, a 34,370 increase (13.2% rise) as of the end of 2016. The details of the figure are 6,428, a 126 installation increase (2.0%) for business use, 1,112, a 48 installation increase (4.5% rise) for industrial use and 287,409, a 34,196 installation increase (13.5% rise) for home use. (The Denki Shimbun, July 26, 2017)

6. FCVs

(1) Toyota

Toyota has started planning to produce EVs in China in 2019. They determined their eco car strategy with HVs as the core eco car and FCV as the core of next generation cars. However, EVs receive favorable regulations, reduced tax and preferable treatment for registration in urban areas from the government in China which consumes 30% of global new car sales. This drives automakers to shift to EVs. The Chinese government defines cars with lower environmental impacts such as EVs as new energy cars, and plans to enforce automakers to produce certain amounts of these cars from 2018 at the earliest. Toyota aims to start commercial production of EVs by 2020, but is now considering to pushing the timing forward. The EV market is already taking off in China. According to the International Energy Agency (IEA), the total sales of EVs and plug-in electric vehicles (PEVs) are 650,000 in China which has the most by outrunning the US. BYD, a major Chinese automaker, increased sales of new energy car to the 100,000 level in 2016. Toyota's sales are 1,210,000 vehicles for 2016 in China. However, gasoline cars and HVs make up the majority, and the firm has no EVs or PEVs. They still determine FCVs as the ultimate eco car, but will carry out development in all direction as a realistic strategy due to faster global movement to EVs than expected. Nissan will release a lower-price EV which shares a chassis among French-based Renault and Mitsubishi Motors in China from 2018. Honda will start local production of EVs solely for the Chinese market in 2018 to release two joint ventures. German-based Volkswagen will get down to the EV business by launching a joint venture with JAC in China. (The Nikkei, July 23, 2017)

(2) Toyota

Toyota Motor plans to establish self-driving technology on public roads by early 2020's. Their aim is to achieve level 4 technology which requires complicated judgements including junctions for urban areas. European and American automakers including German-based Volkswagen have announced to introduce the same level self-driving cars around 2020. Toyota Motor aims to commercialize level 3 self-driving car which works for changing lane on express roads in 2020. They are considering to choose from the next generation of luxury range Lexus or MIRAI to be self-driving. (The Nikkei, selfdriving July 25, 2017)

(3) Yano Research

Yano Research has undertaken research into the domestic market of power conditioning systems (PCSs) for new energy such as photovoltaic generator and FCs, and has published the results. The market scale for PCS for new energy is ¥128.5 billion for FY2016, a 28.3% decrease of that of the previous year. The market level of photovoltaic generation is expected to be half for FY2020 due to shrinking demand on industrial photovoltaic generation which was supported by the feed-in tariff (FIT). The research firm analyze that the PCS market relying on FIT reached its peak in FY2016. Domestic PCS

manufacturers are expected to explore demand without relying on FIT, and to increase proposals for other renewable energy use or combining with storage battery or local production and consumption of solar power for industrial use. The research firm expects to increase proposals of systems such as home energy managements systems (HEMS), vehicles to home (V2H) and zero energy home (ZEN) for home use. (The Denki Shimbun, August 4, 2017)

(4) Nikkan Jidosha Shimbun

Last month, the Secretary of State for Environment, Food and Rural Affairs of the UK officially announced that gasoline and diesel cars would be banned from new car sales from 2040 following France. EVs and FCVs are building up their presence. A professor analyzed that EV seems to be an easy option for infrastructure, but FCV has a slight advantage for employment. The population of Japan is 127 million, and the population of France and the UK combined is 132 million. The market trend in Japan is HV. Also it is believed that HV and diesel are still marketable in Asia. However, the ratio of elderly people will reach the peak, and new born now will start working after finishing universities in 2040. (Nikkan Jidosha Shimbun, August 7, 2017)

(5) Hyundai Mobis

On August 8th, Hyundai Mobis, a core component firm of Hyundai Motor Group, announced that start-to-finish production of FCV core components was prepared by investing ₩70 billion, ¥7 billion. A single plant will produce FC stacks and motors in large amount to reduce the costs. The production capacity is 3,000 units each year, and the firm will supply products to Hyundai Motor, a group member. Hyundai Motor will release a new FCV in this year, and will revise the production system for the new release to catch up with Japanese automakers including Toyota and Honda which are leading the FCV market. (The Nikkei, August 9, 2017)

7. FCV Component Development & Business Plan

(1) Aisan

Aisan Industry has started operating Hirose Technical Center, a research and development base newly built in Toyota City. The investment is about ¥3.5 billion. Reliability test facilities were transferred from Honsha Plant, Anjo Plant and Toyota Plant to centralize the function. The new center carries out research and development of a variety of power sources such as FCV and electric powered vehicles. (The Nikkan Kogyo Shimbun, August 8, 2017)

8. Hydrogen Refueling Station Technology Development & Business Plans

(1) Yamato H2Energy

Yamato H2Energy Japan has worked three measures on to the originally developed simple hydrogen refueling station to supply hydrogen over a wide area. They were set up by Yamato Sangyo, a pressure control system producer, in 2014, but are now independent. They work on FC systems and hydrogen supply facilities. Their range offers a fully automatic system to dispense to FCVs and a semi-automatic system requiring manual work from about ¥9 million, and they have been delivered for automakers' tests. Yamato H2Energy does not focus on filling FCV tanks fully, but expects to up to half fill the tanks in three minutes. The target use is for temporary refueling when FCVs nearly run out of hydrogen in a place where a large hydrogen refueling station is too far away. One of the new measure is a newly developed chiller to pre-cool hydrogen to reduce the temperature increase in tanks when hydrogen is filled in short time; the price is a couple of ¥10 million. The second measure is development of their product for road service to supply FCVs which have run out of fuel with hydrogen. The third is product development for FC forklifts which are used in plants and warehouses. Hydrogen refueling operation has to be applied to prefectures due to the High Pressure Gas Safety Act, and road services are required to submit operation areas. However, the detailed procedures are currently unclear. METI will announce application procedures in this fiscal year. (The Nikkei Business Daily, July 31, 2017)

(2) Toho Gas

Minato AQULS which is operated by Toho Gas has refueled its first FC bus with hydrogen. Demonstrational rides of a FC bus were held in Nagoya City, and the refueling station filled the bus once a day for three days. The gas supplier will consider commercializing hydrogen refueling to FC buses as its proper business by reviewing demand. Their refueling stations can fill passenger FCVs automatically. However, the refueling station needs to set filling speed and finishing pressure individually for FC buses, because these buses have different size tanks. The firm operates refueling of FC bus run by Toyota City, and will consider regular business by changing the system program. (The Nikkan Kogyo Shimbun, August 2, 2017)

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