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Honda & GM to Jointly Produce Core Components for FCVs

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1. Governmental Measures

(1) Administrative Policy Speech of Japanese Government

Prime Minister Shinzo Abe has made the administrative policy speech for FY2017. "As a powerful card for energy security and counter-global warming measures, hydrogen energy is just about starting off an upcoming hydrogen society in Japan by previous regulatory reformation." he said for the "regulatory reform to create innovation". In Tokyo, the world's first bus with large capacity fuel cells (FCs) will start operation in March. Next spring, hydrogen refueling stations will be prepared in 100 locations nationwide. In Kobe, electricity will be supplied from hydrogen power generation. The government aims for the usage level of fuel cell vehicles (FCVs) to be 40,000, 40 times of that of the current level, by 2020. To do so, they will carry out a large amount of hydrogen transport using a liquid hydrogen ship to develop the world's first global hydrogen supply chain from production, transport though to consumption. To achieve the goal, the government will reform the regulations by examining those controlled by various ministries and agencies. As "reconstruction of the disaster affected areas", an advanced experiment project will start to produce hydrogen at a large-scale using renewable energy in Fukushima. (The Asahi Shimbun. January 21, 2017)

(2) DOE of US

The Energy Information Administration of the US Department of Energy (DOE) has published an annual report for 2017 of an estimation of the energy market in the US for the period between 2017 and 2040. They point out that natural gas and renewable energy are likely to become the core energy source for the capacity of new generators in their reference case based on existing technologies and current economy and population trends. The report mentions that nuclear power is likely to decrease its capacity because of cheap natural gas and declining power demand. For the estimation, each industry for power generation, transport and building was analyzed. The trend of power in demand in the US is slowing down due to growth of energy saving products and sluggish population growth. In the power generation industry, wind and solar power generators are expected to be added by a total of about 70 GW for the period of 2017 to 2020 through tax exemption and reduction in capital costs. The majority of wind power facilities are likely to be built by the end of 2023 when the tax exemption for wind power is to end. Solar power is expected to grow until 2040 by reduction in costs and permanent tax exemption of 10%. Solar power and natural gas are likely to take a major part of the additional capacity for newly built generation facilities from 2030. Additional capacity of nuclear power is expected to remain at 4.7 GW at existing facilities for the period between 2018 and 2040. It is unlikely that a new nuclear power station which has not been already announced will be built by 2040 due to high investment costs. Because 10.6 GW capacity of nuclear power is expected to be closed by 2040, nuclear power is likely to decrease its capacity. The energy consumption of transport is anticipated to reach a peak in 2018 due to improvement in fuel efficiency. Plug-in hybrid electric vehicles (PHEVs) are likely to increase its share in the light-duty vehicle sales from under 1% in 2016 to 4% by 2040. The sales of environmentally friendly cars including PHEVs and FCVs are estimated to reach 1.5 million vehicles by 2025 taking about a 9 % share of the estimated sales of light-duty vehicles. In the building area, the number of households and floor area for business use are expected to be increased. On the other hand, improvements are expected in energy efficiency and energy standards of appliances. Energy consumption of home and buildings for businesses is likely to either stay the same or slightly decrease for the period from 2016 to 2040. (The Denki Shimbun, January 25, 2017)

(3) Agency for Natural Resources and Energy of METI

On January 31st, the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry

(METI) decided the actual scheme by which budget is added to the budget bill for FY2017 to support purchase of ENE-FARM, domestic FCs. The scheme has standard and maximum prices for total price of FCs and installation fees, and the agency will keep the "scheme to reduce price" that the amount of subsidy becomes higher for cheaper products in order to make the market independent fast. The subsidy is individually set for polymer electrolyte fuel cells (PEFCs) and solid oxide fuel cells (SOFCs). The standard price for PEFCs is ¥1.11 million and ¥1.27 million as the maximum price. The standard price is ¥1.46 million for SOFCs, and ¥1.57 million for the maximum price. These prices are lowered from the ones for FY2016. The products priced lower than the standard prices are eligible for ¥0.11 million for PEFCs and ¥0.16 million for SOFCs. The products with prices between the standard and maximum prices qualify for ¥0.05 million for PEFCs and ¥0.08 million for SOFCs. The products priced above the maximum prices are out of the scope of the subsidy. However, the standard and maximum prices shift upwards for products with independent operation function or designed for cold environment. For cold environments specifications, ¥0.3 million is added to both standard and maximum prices. (The Denki Shimbun, February 1, 2017)

2. Local Governmental Measures

(1) Aichi Prefecture

On January 17th, Aichi prefecture announced that it would extend its own exemption scheme of the automobile tax for eco cars for two years. The subjects are purchased and registered new EVs, plug-in hybrid vehicles (PHVs) and FCVs in the prefecture. These cars will be completely exempt from the automobile tax for five years following the year of purchase. The tax is calculated monthly for the first year, and this is also exempt for these eco cars. (Fuji Sankei Business i, January 18, 2017)

(2) Ibaraki Prefecture

Ibaraki Prefecture has held "Ibaraki Hydrogen Use Symposium in Kamisu" in Kamisu City, and a related event was held to offer passenger experience of FCVs using Toyota's MIRAI and Honda's CLARITY FUEL CELL in cooperation with Ibaraki Toyota, Ibaraki Toyopet and Sekisho Corporation. The symposium was held to promote "Ibaraki Hydrogen Strategy" which was compiled in March 2016 aiming to be "Hydrogen Advanced Prefecture, Ibaraki", and to make the public understand and be more interested in hydrogen. About 200 people participated in it. Furthermore, the prefecture announced that "Ibaraki Council for Promotion of Hydrogen Use" would be launched in cooperation with industry, government and academia to promote projects set by the strategy. (Nikkan Jidosha Shimbun, January 23, 2017)

(3) California

Hydrogen business is starting off in California, USA which is particularly environmentally conscious in the US, and is making small achievements by forming a hydrogen energy center. There are blue boxes of a vending machine size installed at refueling stations in Hollywood. US-based venture FirstElement Fuel (FE) installed these hydrogen refueling facilities in October 2016. According to an operator in charge, "at least eight to ten FCVs" visit a facility for refueling each day. This rate is over four times of that of average usage level of hydrogen refueling stations in Japan. Global automakers sell their latest eco cars in California which implements strict regulations for emissions, and over 1,000 FCVs are on road there. For this, more infrastructure projects are carried out. Commercial hydrogen refueling stations similar to the ones installed by FE were found only in two locations in 2015, but the number of locations increased to 23 in the autumn of 2016. It is estimated to be 50 locations by 2017. In Japan, hydrogen refueling stations were installed at 80 locations as of the autumn of 2016 which outdoes California, and the accumulated FCV sales are also same level as California. However, California works differently from Japan. Hydrogen refueling stations are prepared in four urban areas in Japan, but these facilities are concentrated in Los Angeles, California. Prepared infrastructure is supporting FCV growth, although the growth is localized. This growth backs up infrastructure preparation, and accelerates construction of facilities creating a good cycle. These small achievements started in the urban area are spreading nationwide. A commercial hydrogen refueling station also operates in San Diego. FE has started operation of an experimental refueling station in Washington jointly with DOE. California subsidizes 85% of construction costs for refueling stations which are to supply hydrogen of which one third is produced using renewable energy to be CO_2 free. Also, whole operating costs will be paid by the state for the first three years. French-based Air Liquide is "trying to make half of its hydrogen production CO_2 free by 2020". The set hydrogen price is about ¥1,000/kg, and some operators think this is too low, offering too little benefit. Hydrogen price in California is about ¥1,900/kg, nearly double of that of Japan, which offers more benefit. Construction costs of hydrogen refueling stations in California are ¥200 to 300 million, half of that of Japan. FE's refueling stations work as self-service facilities for 24 hours eliminating the need of workers for refueling. "FE's facility is

small, and the regulations on temperature and pressure control are not so strict. It seems difficult to do the same thing in Japan." an expert of hydrogen refueling stations says. The issue for promoting hydrogen refueling stations in Japan is a balance of safety and reduction in costs. (The Nikkei Business Daily, January 26, 2017)

(4) Fukuoka Strategy Conference for Hydrogen Energy

The Fukuoka Strategy Conference for Hydrogen Energy held a "seminar for parts of FCs, ENE-FARM" in Fukuoka City, and about 50 people participated in it. The members of the conference are 794 companies and organizations as of January. The New Industry Promotion Division of the Department of Commerce and Industry takes administration of the conference. The conference supports local businesses to get opportunities while reading new technology trend and ENE-FARM and FCVs to grow. In the seminar, Hy-Life Project was introduced as well as Kyushu University related research centers such as Hydrogen Energy Test & Research Center (HyTReC) and AIST－Kyushu University Hydrogen Materials Laboratory (HydroMate). The conference will carry out projects to assist local businesses to enter the market. (Dempa Shimbun, February 1, 2017)

(5) Setagaya City

On February 2nd, the Mayor of Setagaya City announced that a hydrogen refueling station would be open for FCVs in November in its area. A truck with a hydrogen dispenser on board will be parked on premises owned by the local government. The local government will encourage residents and businesses to purchase FCVs. The costs of construction for power source and safety will be paid by the local government, and the operator will be chosen through an invitation. The operator will pay the costs of truck, equipment, and maintenance. The local government will purchase a FCV for official use in FY2017. (The Nikkei, February 3, 2017; The Nikkei Business Daily, February 6, 2017)

3. FC Element Technology Development & Business Plan

(1) Taisei Corporation

On January 17th, Taisei Corporation announced that it would install 250 kW SOFCs by Mitsubishi Hitachi Power Systems (MHPS) in Taisei Technology Center in Yokohama City. This is the first project in Japan to use electricity and heat from SOFCs for smart community starting in FY2017. This is a part of a project carried out by MHPS contracted from the New Energy and Industrial Technology Development Organization (NEDO). As a joint operator, Taisei will operate the system to supply exhaust heat from SOFCs to buildings on the premises for air conditioning. They will develop an area energy management system (AEMS) to link and control building energy management systems (BEMS) installed in buildings there, and AEMS will be installed in FY2017 to optimize networked use of heat and electricity. Excess power will be sent to their own facility on the premises. Each BEMS collects energy data of its building. AEMS will analyze the data from all of the buildings from BEMS to collectively manage energy of these building using an information and communication technology (ICT) network. Taisei joined Yokohama Smart City Project (YSCP) which was carried out as an experiment of METI, and achieved energy saving using smart BEMS by Toshiba. Taisei aims to expand the smart community range through the new project. (The Nikkei, January 18, 2017)

(2) Fuji Keizai

Fuji Keizai, Chuo-ku of Tokyo, announced research results of the global market of FC systems. The market for FY2015 was ¥106.4 billion of which 80% is taken by systems for home and business use installed at commercial facilities and buildings. The FCV market is expected to expand to an annual few million shipping level by 2020, and the global FC system market is estimated to ¥4,906.3 billion, 46.1 times of that of FY2015, by 2030. The market can be divided into uses for FCV, industrial and business, home and otherst. The category of others including forklifts and busses is expected to move onto a phase of diffusion or practical use from FY2016. The global FCV sales are expected to grow into 2,870 vehicles, 2.9 times of that of 2016 and accumulated 40,000 vehicle of shipping by FY2020. FCV shipping is anticipated to increase to a couple of 10,000 vehicle level annually from 2020, and the number is estimated of 787,000 by FY2030. The market might quickly develop, if many measures are implemented for reduction in CO_2 due to the Paris Agreement. Regional research shows that hydrogen refueling stations need to be installed quickly in the US where zero emission vehicle (ZEV) regulations are spreading. Also, hydrogen infrastructure preparation is steadily progressing in Europe. China has implemented new energy vehicle (NEV) regulations, which has backed up market growth of next generation eco cars. However, there is no sign of significant activity of hydrogen refueling station installation. The global market of key stack parts combining PEFC and SOFC is ¥18.7 billion for FY2016. The estimated sales for this area are ¥294.5 billion by FY2030. Currently, the FCV market hardly affects the market of stack parts, but it is expected to increase its impact to sales of stack parts from 2020 when the FCV market is expected to fully take off. Manufacturers are cutting down stack size, and the number

of stack parts per output is expected to decrease. (Nikkan Jidosha Shimbun, January 23, 2017)

(3) AIST & Atsumitec

On February 9th, Atsumitec, Naka-ku in Hamamatsu City, and the Department of Materials and Chemistry Inorganic Functional Material Research Institute of the National Institute of Advanced Industrial Science and Technology (AIST) announced that they have developed a small and high output SOFC system using ethanol as fuel. They operated the system continuously for a couple of 100 hours to examine it. The system is expected to be used as a power source for robots and drones as well as emergency power source during disasters. SOFCs degrade by carbon deposition when butane is directly supplied, which was an issue. The group developed technology for operation control and nano-structure material for electrode which allows partial oxidation reforming or steam reforming of ethanol to prevent carbon deposition. (The Nikkan Kogyo Shimbun, February 10, 2017)

(4) Bloom Energy Japan

On February 10th, Bloom Energy Japan, Minato-ku in Tokyo, held a ceremony of operation start of "Bloom Energy Server", a FC power generation system for business and industrial use, installed at the Kumagaya Daini Plant of Porite in Kumagaya City, Saitama Prefecture. The power output is 250 kW. This is the world's first project to supply fuel from satellite station of liquid natural gas (LNG). The FC system will provide 60% of the required power for the plant. It is independent and supplies power during power cuts, which improves business continuity. Bloom Energy Japan is a venture equally capitalized by SoftBank Group and US-based Bloom Energy. This project is the fifth for the Bloom Energy Server installed in Japan, and the total installed output is 2050 kW. Electricity price depends on gas costs. The FC system continuously supplies power 24 hours 365 days to meet the basic demand, which reduces power purchase from the grid. This makes it easy for Porite to switch to a new power supplier which has a smaller capacity. Porite uses electric furnaces for sintering metal powder to produce metal parts. They were thinking of getting an independent power source for power cuts caused by frequent lightning in summers. The preparation costs combining FCs and satellite station for LNG are about ¥460 million. The manufacturer provides separators, parts to isolate hydrogen and oxygen in FCs, for Bloom Energy Server. The mayor of Kumagai City and people from related business such as Iwatani participated in the ceremony. (The Denki Shimbun, February 13, 2017)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) Yamaguchi Liquid Hydrogen

A group led by Yamaguchi Liquid Hydrogen, Osaka Prefecture, will start an experiment using a pure hydrogen cogeneration system in Shunan City, Yamaguchi Prefecture, on January 16th, aiming to sell the system as a next generation infrastructure to business offices from FY2018. The group for the development consists of Iwatani, Tokuyama Corporation, Yamaguchi Liquid Hydrogen, Toshiba Fuel Cell Power Systems and Chofukosan. This is the world's first cogeneration system using pure hydrogen as fuel. A pure hydrogen FC unit of 0.7 kW developed by Toshiba Fuel Cell Power Systems generates electricity. Hot water from the FC unit is sent to a hydrogen boiler of 8.7 kW developed by Chofukosan and Iwatani, and is stored in a hot water tank of 90 L at 80 ºC. The current price of the system is a few million yen, and the cost to produce hot water is double of that of natural gas. The pure hydrogen FC system moved into the commercialization phase in September 2016, and it is used by Toyota and Huis Ten Bosch in Nagasaki Prefecture. (The Nikkei Business Daily, January 18, 2017)

(2) Tohoku-Electric Power

Tohoku-Electric Power Co. is working on moderation of power production fluctuation due to expanding renewable energy use, and carrying out an experiment to stabilize grid power using storage batteries at its substations. The utility firm will examine a new method of adjusting power output by producing hydrogen, and this is the first test of the method in the power industry. A hydrogen production system was installed for the experiment at their Research & Development Center in Sendai City, and it was revealed to the media on January 26th. Overall test operation and adjustment will be carried out after installing FCs to complete the whole system. The experiment will be carried out by continuing the operation until March 2019 for two years. A photovoltaic generator of 50 kW is newly installed on the roof of the research and development center to produce electricity. Electricity is sent to a hydrogen production system of water electrolysis and a storage battery. Produced hydrogen is stored in a tank of hydrogen storage alloy, an equivalent of 300 kWh discharge, and sent to FCs of 9.9 kW for generating electricity to be used in the center. A container is used to store core units and installed on 400 m^2 land on the premises. Hydrogen is handled with thorough safety practice to "prevent leaks, detect to stop leaks and stop built up of leaked hydrogen". In this research, the storage battery absorbs power production fluctuation for short periods,

and power production fluctuation for long periods is taken care of by hydrogen. The utility firm is investigating the best ratio of hydrogen and storage battery. In the Tohoku area, solar power plants have been prepared. The utility firm is taking measure for frequency fluctuation at the Nishisendai Substation by installing a storage battery system. Also, their Minamisoma Substation is working on an action for excess power with same system. (The Denki Shimbun, January 27, 2017)

(3) Mizuho Information & Research Institute

Mizuho Information & Research Institute has estimated the amount of greenhouse gas production for whole processes of material mining, hydrogen production and transport in 28 cases to supply hydrogen to FCVs considering the current energy mix and technology level. Presently, the majority of hydrogen is extracted from natural gas, and an equivalent of 1.38 kg of CO_2 is emitted per 1 m^3 of hydrogen. This is a similar environmental performance to hybrid vehicles (HVs). Hydrogen produced by electrolyzing water using wind power can be liquefied and transported. This method produces an equivalent of 0.28 kg of CO_2 including emissions from production and installation of power generation facilities. This allows reducing the emissions to fifth of that of natural gas. (The Nikkei Business Daily, January 30, 2017)

(4) Honda

On January 27th, Honda announced that "Tottori Hydrogen Learning Center", an educational center of hydrogen energy demonstration, was opened in Tottori City in cooperation of Tottori Prefecture, Tottori Gas, and Sekisui House. This is a part of the project to prepare hydrogen energy demonstration and environmental education center carried out by the prefecture. This is the first project to prepare a hydrogen refueling station, house and FCV together in Japan, and promotes smart house and FCVs. This center is on the premises of Tottori Gas Group, and will be open in April. Honda's smart hydrogen refueling station produces and supplies hydrogen, and this is the first in the Sea of Japan and Chugoku area. Honda will provide know how on hydrogen education, and deliver CLARITY FUEL CELL. (Nikkan Jidosha Shimbun, January 30, 2017)

(5) Siemens

German-based Siemens, and Voestalpine, the largest steel producer in Austria, and Verbund, the largest electricity supplier in Austria, will start a demonstrational project of green hydrogen with reduced CO_2 emissions in Austria. This project will use an electrolysis plant, the world's largest level, of 6 MW to produce hydrogen using renewable energy. Hydrogen will be used for steel production. These firms aim to shift low carbon manufacturing by using hydrogen. As well as the three firms, Energy Research Centre of the Netherlands (ECN) joins the demonstration project, H2Future Project. The construction of facility for the experiment has started in Linz, Austria. Siemens will provide technology to efficiently produce hydrogen from electricity using proton exchange membranes. Verbund will supply electricity from a small scale hydroelectric plant, and the steel works will produce green hydrogen to be sent through a pipe line for steel production. The project cost is €18 million, approximately ¥2,200 million, and the EU subsidizes this by €12 million. The experiment will last for 54 months. Siemens, a major producer of power generation turbines, will develop experience of proton exchange membranes, and investigate energy storage technology to convert electricity to hydrogen on a large-scale. Hydroelectric generation takes over 60% of the total power generation in Austria. Verbund expects to expand use of its power, and the project allows Voestalpine to reduce the amount of coal and the production of CO_2 in the steel production. (The Nikkei Business Daily, February 9, 2017)

5. ENE-FARM Business Plans

(1) Toray Construction

Toray Construction, Kita-ku in Osaka City, will complete "Chalier Nagaizumi-cho Grand Marks" for sale, all units of which can share electricity in Nagaizumi-cho, Shizuoka Prefecture, in March. To settle over supply and shortage, households which need more electricity will receive excess production from ENE-FARM, a domestic FC system, in units which can spare power. This system allows the whole condominium to reduce electricity purchase from the grid and utility bills for each household by 60%. Shizuoka Gas and Panasonic developed T-Grid System to be installed in the condominium in order to monitor and control ENE-FARM installed at all the units. The condominium will sign a purchase contract on high voltage electricity from the grid with the electricity supplier to distribute power to all the units. ENE-FARM power production normally follows the usage level of its household. However, the FC systems which have spare capacity in the condominium will increase output for the households using more than the maximum power output of 700 W of their FC systems. This electricity sharing will be carried out through the internal wiring in the condominium to reduce power purchase from the grid. The excess power production from FC systems for sharing will be purchased by Shizuoka Gas to offset electricity and gas bills of households. This energy management system (EMS) enables average

reduction of ¥4,000 to 5,000 each year comparing to normal operation of ENE-FARM. (The Nikkan Kogyo Shimbun, January 23, 2017)

(2) Tokyo Gas

On January 20th, Tokyo Gas announced that ENE-FARM, domestic FCs for apartment units, would be used in all the units of Clio Yokohama Tsunashima which is a seven-story building having 66 units in total to be sold by Meiwa Estate. This is the first time for Meiwa Estate to use ENE-FARM for condominiums. Utility bills can be reduced by ¥40,000 each year compared to houses with conventional heat source, and CO_2 emission is estimated to be cut down by 0.9 tons each year. This condominium is the first to be certified for low carbon building by Kanagawa Prefecture, which gives tax relief and the lenient regulation on floor-area ratio. The FC system to be installed in the condominium has a function to continue electricity generation during power cuts. If the system operates when a power cut starts, it can supply up to 500 W for four days at the most. The condominium will have a photovoltaic generator and storage battery in its common area. (The Denki Shimbun, January 23, 2017)

(3) ECCJ

On January 23rd, the Energy Conservation Center, Japan (ECCJ) announced the Energy Conservation Grand Prize for FY2016. They chose eight products including a domestic FC cogeneration system of Aisin Seiki and Osaka Gas from 132 applications. The prize giving ceremony will be held at Tokyo Big Sight on February 15th. (Nikkan Jidosha Shimbun, February 24, 2017)

(4) Tokyo Gas, Panasonic & Toho Gas

On February 9th, Tokyo Gas and Panasonic announced that they jointly developed a new ENE-FARM which was a FC system for houses with longer continuous operation at a lower price. The system has extended the maximum continuous operation from the current 22 to 120 hours. The suggested retail price of a standard model is ¥1.498 million excluding sales tax, and this is the first product to achieve under ¥1.5 million in Japan. The product will be released by Tokyo Gas in April, and Panasonic aims to produce 30,000 units for the first year. Improvement of parts for the power generation unit allows extending the operating life to 90,000 hours, about 10 years, and this is 30% longer than that of the existing product. Also, the continuous operation became 5 times longer. When grid power is cut by disasters, the system can still continue power generation for a maximum of eight days, which is double of that of the existing product. On the other hand, the price is lowered by reducing the number of parts. Furthermore, the system is capable of using the Internet of Things (IoT) enabling remote control hot water for bathing and under floor heating by smart phones. Panasonic will introduce a model for liquefied petroleum gas (LPG) in addition to a model using natural gas. (The Nikkan Kogyo Shimbun, February 10, 2017)

On February 10th, Toho Gas announced that a new ENE-FARM by Panasonic similar to the system above would be sold from April. Toho Gas sold 12,000 units of ENE-FARM in total by the end of January, and aims to sell 3,300 units for FY2016. (The Denki Shimbun, February 13, 2017)

(5) Hiroshima Gas

On February 9th, Hiroshima Gas announced that ENE-FARM which is a domestic FC system for apartment units would be used for a condominium with total 90 units to be built in Hiroshima City and sold by Shoei Fudosan in Hiroshima City. This is the first condominium to have the FC system installed in all the units in Hiroshima Prefecture. The gas supplier started selling the FC system for apartment units in December 2014. A developer decided to use the system for a condominium in Hiroshima City last April, which was the first for the product to be used for a condominium. The condominium which just placed the order is the third building, and the total number of units to use the system has reached 123. The FC system will be used in Florence Yoshijima Grand Stage to be built in Naka-ku, Hiroshima City. The construction will start in February, and the completion is expected in June 2018. The ENE-FARM is produced by Aisin Seiki, and its generation efficiency is 46.9%. (The Denki Shimbun, February 13, 2017)

(6) Panasonic

Panasonic plans to increase the number of sales of domestic FCs from serval hundred to 2,000 units for Europe in FY2017. They will introduce a model compatible with the property of local gas into the market of Germany where majority of sales happen, and will also expand the sales to other countries. They released the first domestic FCs in Germany in 2014 in cooperation with Viessmann, a major local boiler producer. Panasonic provides FC units of 750 W output, and Viessmann sells a system by combining boiler with the unit. Panasonic previously used FCs using gas of higher heating value, but released an improved model allowing using gas of lower heating value in 2017. By this improved model, Panasonic's unit can cover all the range of gas in Germany. They will also expand the sales to Switzerland and the UK. Because the European market of domestic FCs is small, the German government prepared a subsidy scheme for installation. Also, the feed-in tariff is ready for FC users to sell excess power production to utility firms as promotion. Toshiba Fuel Cell

Power Systems also have a partner of German-based boiler maker. (The Nikkan Kogyo Shimbun, February 15, 2017)

6. FCV

(1) Toyota, BMW & Shell

On January 17th, 13 global major automakers and energy firms including Toyota, Honda and German-based Daimler launched a new organization to promote hydrogen energy use such as FCVs. FCV use is left behind EV's, and the automakers are trying FCVs to catch up their sales by this joint organization without organizational borders. Research results will be shared among members to expand use, to make the business profitable and to establish standards. This was revealed at the annual meeting of the World Economic Forum held in Davos, Switzerland. "Hydrogen Council", the new organization, has members of 13 businesses including German-based BMW, French-based Alstom, British–Dutch based Royal Dutch Shell and Anglo American, a British major mining firm, as well as Kawasaki Heavy Industries (KHI) and South Korean-based Hyundai Motor. It will invest over ¥170 billion in FCs each year. Toyota and French-based Air Liquide will serve as co-chair. Wanting more businesses to join them, they welcome new members, and point out that expanding usage will improve economics of scale. In the organization, discussion will take place on method to increase investment in ventures which have new technologies for hydrogen. The members will jointly publish advantages of hydrogen energy, and request their governments to increase hydrogen supply bases which are important as infrastructure. As FCV development costs high, automakers cooperate to speed up the development. Toyota and German-based BMW signed a partnership. Honda and US-based GM collaborate. Another alliance is Nissan, German-based Daimler and US-based Ford Motor. Toyota is also developing EVs, and thinks many technologies of HV such as motor and battery can be used in EVs. (The Nikkei, January 18 & 20, 2017; Fuji Sankei Business i, January 19, 2017)

(2) Toyota

On January 17th, Toyota announced that an experiment on FCV would start in May in the United Arab Emirates (UAE). A hydrogen refueling station will be installed in Dubai where the temperature is high, and the project will look into driving and refueling with three FCVs of MIRAI. The firm also aims to make the public understand more of hydrogen society there. As well as Toyota, other members of this project are Masdar which is a renewable energy firm funded by the UEA government, Abu Dhabi Oil, Air Liquide which is a French-based global major industrial gas producer and Al-Futtaim Motors which is Toyota's distributer in UAE. The project will jointly carry out research on hydrogen production, distribution and feasibility as well as the experiment. Toyota says that "UAE has a large potential of capacity of hydrogen production". Toyota is working on realizing hydrogen society by targeting a 90% reduction in CO_2 emissions of their new cars of that of 2010 by 2050. (The Nikkei Business Daily, January 18, 2017; The Tokyo Shimbun, January 18, 2017)

(3) Honda

Honda has become serious about EV development after being behind others. Although they determined FCV as the ultimate eco car, FCVs have not been used much. Also, the environmental regulations will be tightened from this autumn in the US, which is another issue to solve urgently. The automaker will focus on the sales of EV to start this year in the US and development of next generation EV. Their FCV CLARITY FUEL CELL started to be available on lease in March, 2016. However, the sales target is 200 vehicles for the first year in Japan, and only 12 dealers sell it in California, USA, for a while. This is far from successful. On the other hand, Nissan has sold about 250,000 of EV LEAF worldwide. Toyota previously put weight on FCV, but revealed in November 2016 that it planned to start mass production of EVs by 2020. The new regulation will be imposed on 2018 models and these successors this autumn, which drives Honda to develop EVs. HV is a good area for Japanese automakers, but it will be removed from the ZEV list. Japanese automakers will need to sell more ZEVs to get certain points in the regulation scheme. According to Mitsubishi UFJ Securities, the minimum sales levels for Honda to clear the regulation are 3,000 EVs, 1,000 FCVs and 8,000 PHVs of 2018 models, which is high. If they do not get enough points, they have to either pay a penalty or buy points from other manufacturers which have hit the target. Honda does not have a huge budget for research and development, and developing both EV and FCV is a burden. Nonetheless, Honda started leasing the EV FIT in 2012, and this EV held the record for the world's longest driving range solely on battery at the time using the expertize on earlier HVs and FCVs. (The Asahi Shimbun, January 27, 2017)

(4) Honda

On January 30th, Honda and US-based GM announced that they planned to jointly produce core components for FCVs in the US from 2020. A joint venture will be launched by investing a total of $85 million, about ¥9,700 million equally split by the two firms, and will newly employ about 100 workers. Since President Trump criticized the automobile trade

between Japan, Honda has made a movement to build better relationship with the US. Both automakers singed a partnership for development of core components for FCVs in 2013. As a part of the partnership, they decided this time to produce these components in the US where the largest FCV market will be. This is the first joint venture in automobile business for Honda to establish with an American firm. The venture is Fuel Cell System Manufacturing of which there are six members of the board. The first president will be from GM. The production facility will be prepared in GM's established battery plant near Detroit, Michigan. This is the first for Honda to commercially produce cell stack, a core component of FCVs, in the US in cooperation with another automaker. Honda currently assembles CLARITY FUEL CELL, its solely developed FCV, including the core components in Takanezawa-machi, Tochigi Prefecture. They plan to transfer the production of cell stacks to the venture in the US to reduce costs by volume production of core components through the joint production with GM in the future. Also, this venture allows GM to use the technology of Honda's FCV which is available on lease from 2016 to make GM's entry into the FCV market early. Additionally, GM can diversify risks by sharing investment and production with Honda. Since Mr. Trump criticized Toyota's investment in Mexico, he is most likely to ask other Japanese automakers to expand employment in the US. (The Nikkei, January 31, 2017; Nikkan Jidosha Shimbun, January 31, 2017)

(5) Toyota

On January 31st, Toyota Motor announced that it planned to use 170 to 180 FC forklifts which can take 2.5 tons by 2020 in its Motomachi Plant in Toyota City, Aichi Prefecture, where FCV MIRAI is produced. They will replace over half of 290 forklifts running on conventional engines currently in use in the plant with FC ones. Once their range for FC forklift is fully developed, they will promote the products and start using the forklifts in their other plants as a part of Toyota Environmental Challenge 2050 to make their plants CO_2 free by 2050. On 31st, the Motomachi Plant started to use two FC forklifts by Toyota Industries. These FC forklifts do not produce CO_2 while in operation, and can be refueled in about three minutes. For refueling, they will be transported to the Takahama Plant of Toyota Industries in Takahama City, Aichi Prefecture, for a while. Toyota Motor plans to increase the number of FC forklifts in the Motomachi Plant to 20 by 2018 and 170 to 180 by 2020, and will consider preparing a hydrogen refueling station in the plant. (Nikkan Jidosha Shimbun, February 1, 2017; The Nikkan Kogyo Shimbun, February 8, 2017)

(6) Toyota & Suzuki

On February 6th, Toyota Motor and Suzuki announced that they signed a partnership on next generation technology. Many businesses including IT firms fiercely compete in development and promotion of next generation technologies such as automated driving and electrification. The two firms plan to take a dominating position by forming a partnership. They are expected to cooperate to capture the Indian market in the future. The negotiation of the two firms for this partnership started in October 2016, and a capital alliance will be considered later. Issues for Toyota which sells 10 million cars each year are to put more effort in development of automated driving as well as development of eco cars such as FCV and EV, and to form partnerships for its own technologies to be widely used. Suzuki's annual sales are 3 million vehicles, and it is renowned to produce affordable cars. On the other hand, Suzuki does not have resources to keep expensive research and development. Daihatsu, a subsidiary of Toyota, and Suzuki compete for the top share in Kei-class car, under 660cc engine, in Japan, which means Toyota and Suzuki are competitors through Daihatsu. Both Toyota and Suzuki started as loom manufacturers, and their roots are in the western part of Shizuoka Prefecture. Mr. Osamu Suzuki, the representative director of Suzuki knew Mr. Shoichiro Toyoda, the honorary chairman of Toyota, in person, and approached Mr. Toyoda for this partnership. Then, the negotiation started in October. (The Asahi Shimbun, February 4, 2017; The Yomiuri Shimbun, February 7, 2017)

(7) Guangdong Dynavolt Renewable Energy Technology

Guangdong Dynavolt Renewable Energy Technology which produces lithium-ion batteries (LIBs) in Guangdong, has acquired Shanghai Fuel Cell Vehicle Powertrain, a technology developer for FCV powertrains in Shanghai. Guangdong Dynavolt Renewable Energy Technology purchased a total of 51.01% of the shares from members of the China Electronics Technology Group, a major software developer in China, to take control over the firm. Guangdong Dynavolt Renewable Energy Technology plans to establish a presence in the FCV market as well as the EV market which is its core business expecting market expansion of new energy cars in China. Zhong dian hai kang and the 21st Research Institute of China electronic technology group, both members of the China Electronics Technology Group, sold 44.63% and 6.38% of share respectively to Guangdong Dynavolt Renewable Energy Technology which purchased the shares for 48.69 million CNY, ¥827.73 million. Guangdong Dynavolt Renewable Energy Technology expects this acquisition to lead to developing overall technology for new energy cars using expertize from LIB for EVs. Shanghai Fuel Cell Vehicle Powertrain was

established in 2001 by Shanghai Automotive Industry Corporation Group along with other organizations, and carries out technological development of FCV powertrain platform and related components. Their sales were 8.5 million CNY, ¥144.5 million for 2015. "Made in China 2025", an industrial promotion policy of China, states that infrastructure preparation would be completed for hydrogen production and supply by 2025. According to the Standardization Administration of the People's Republic of China, FCV is expected to be used at a 10,000 vehicle level by 2020. (The Chemical Daily, February 7, 2017)

7. Hydrogen Refueling Station Technology Development & Business Plans

(1) Hiroshima Toyopet

On January 17th, a seminar to create next generation energy industry was held in Nishi-ku Culture Center in Hiroshima City. Hiroshima Toyopet gave a talk saying that it would open the first hydrogen refueling station, a mobile system, in Hiroshima in its Shiwa logistics center in Higashihiroshima City in February. This is the second hydrogen refueling station in the Chugoku area after Shunan City, Yamaguchi Prefecture. This movement raises expectations for hydrogen society in Hiroshima. (Nikkan Jidosha Shimbun, January 19, 2017)

(2) Nippon Steel & Sumikin Pipeline & Engineering

On January 24th, Nippon Steel & Sumikin Pipeline & Engineering (Nippon Steel & Sumikin P & E), a 100% subsidiary of Nippon Steel & Sumikin Engineering, announced that it held an opening ceremony of Shikaoi Hydrogen Farm built to produce hydrogen using biomass of livestock waste and to supply hydrogen in Shikaoi-cho, Kato-gun, Hokkaido on the day. The hydrogen production plant was jointly built with Air Water, Kajima Corporation and Air Products in Japan for a project which has started examining hydrogen supply chain using livestock waste in Shikaoi-cho and Obihiro City. The project is selected for the "Experiment Projects of Community Cooperation and Low Carbon Hydrogen Technology" organized by the Ministry of the Environment (MOE), and looks into a total hydrogen energy supply chain of refining, production, storage, transport, supply and consumption using locally produced renewable and unused energy. The experiment will last up to five years from FY2015 to FY2019. The Shikaoi Environmental Conservation Center ferments livestock waste to produces methane. In the project, this fermentation facility supplies biogas to Shigaoi Hydrogen Farm to produce hydrogen installed on the same premise. Produced hydrogen is used as fuel for pure hydrogen FCs in the conservation center, or stored in a curdle to be transported to a neighboring facility in order to produce electricity and hot water. The capacity of hydrogen production facility is about 70 Nm^3/hr. The filling pressure to the curdle is 19.6 MPa. The conservation center will install a stationary hydrogen refueling station which is the first one in Hokkaido, and hydrogen will also be used as fuel for FCVs and FC forklifts. Pipes in the compressor, heat exchanger and accumulator of the hydrogen refueling station use HRX19 stainless steel for high pressure hydrogen developed by Nippon Steel & Sumikin P & E. The refueling station allows improved safety and reduction in size specifically by nearly 200 spots of welding in the accumulator. The pressure levels of hydrogen refueling station are 70 MPa for FCVs and 35 MPa for FC forklifts. Air Water operates Shikaoi Hydrogen Farm. (Japan Metal Daily, January 25, 2017)

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