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Voluntary Action Plan Established to Secure Safety of H_2 Refueling Station

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1. Governmental Measures

(1) Obama Administration

On November 3rd, the Obama Administration revealed a new electric vehicle (EV) promotion as a reaction to the adoption of the "Paris Agreement" to combat global warming from 2020. Charging facilities will be installed on 48 major highways as close as every 80 km, for EVs to be able to drive without worrying about low battery. The government will promote EVs to reduce CO_2 emissions. This project will prepare chargers on about 40,000 km of highways across the eastern and western states in America. Nissan, US-based GM and German-based BMW will participate in this project, and electricity providers and state governments will also cooperate. Additionally, governmental debt guarantee of a maximum $4.5 billion, about ¥460 billion was announced. (The Nikkei, November 4, 2016)

(2) MLIT

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has started the third invitation of the "Community Green Transport Project" to promote public transportation to move onto the next generation. Being a support for business purpose vehicles, the project will subsidize half the purchase costs of fuel cell (FC) buses and taxis and one third of the preparation costs for electric taxis and trucks including chargers. The ministry will take applications until November 18th, and then an expert panel will choose projects for the scheme. The requirements are found on the MLIT website. (Nikkan Jidosha Shimbun, November 4, 2016)

(3) METI Kansai

On October 31st, METI Kansai published "Resource and Energy Policy Users' Guidebook". The guidebook introduces resources and energy related policies such as subsidy schemes for the purchase of next generation cars and preparation costs of chargers, taxation of investment promotion for smaller businesses and support for hydrogen infrastructure preparation. The governmental body is trying to encourage more businesses to use the schemes by giving easy to understand information on support for the private sector. For the guidebook, they picked up the schemes which are easily to be used in the Kansai area out of the whole resources and energy related policies planned in the supplementary budget for FY2015 and budget for FY2016. The guidebook includes subsidies for next generation car purchase (fuel cell vehicles (FCVs), EV, plug-in hybrid vehicles (PHV) and clean diesel cars) and subsidies for charger infrastructure preparation for EVs for the automobile area. The subsidy scheme for device purchase of Eco-drive Management System (EMS) is shown for businesses in the guidebook. The Tax Measures System to Promote Capital Investment to Improve Productivity has been used widely to aide equipment purchase, and is also in the guidebook as for support for smaller businesses. (Nikkan Jidosha Shimbun, November 4, 2016)

(4) Agency for Natural Resources and Energy of METI

The Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry (METI) has held the fifth meeting of "CO_2 Free Hydrogen Working Group", and possibility of hydrogen pipeline use was discussed. The meeting determined that pipeline has possible advantages in costs to transport hydrogen produced using renewable power to be used in adjacent areas over compression which is commercially available method to transport the material. Also, the working group concluded that

regulations for hydrogen gas leaks from pipelines should be studied to secure safety. According to ministerial ordinance of the Gas Business Act, a material needs to be added to hydrogen gas to give it a "odorant", additive for smell, for leak detection for energy usage to be transported by pipelines. However, hydrogen supply with odorant possibly affects stack performance of FCs. Due to this reason, the additive need to be removed just before feeding to FCs, which is an extra process. The High Pressure Gas Safety Act requires hydrogen refueling stations to have detectors for hydrogen leaks instead of adding smell. Other countries do not use regulations to add a smell for hydrogen for pipelines as a leak detection measure, the working group suggests that regulation change should be considered. The fifth meeting was held late October. The group will compile a report on the expansion of CO_2 free hydrogen energy from production to use by the end of this fiscal year. (The Denki Shimbun, November 11, 2016)

(5) METI

METI's survey has revealed that only 40% of local governments have comprehensive plans to realize hydrogen society or targets for FCV use throughout Japan. The reason appears to be that the governmental preparation plan of hydrogen refueling stations is focused on four big urban areas. Some local governments have requested further deregulation on hydrogen refueling stations and a reduction in the price of FCVs and FC buses. The Japanese government will keep supporting promotion and development following the roadmap. The ministry revealed the information in the "Conference for Local Governmental Cooperation for FCV Promotion". They asked 47 prefectures and 20 government-designated cities whether these 67 local governments have hydrogen promotion plans, subsidy schemes or issues for these. 27 local governments replied they have comprehensive plans or roadmaps compiled, and this is 40% of the 67 local governments. Actual plans of these local governments are the promotion of ENE-FARM, subsidy for purchase of FC buses and forklifts, development plans for hydrogen related industry and cooperation with local businesses for related technological development and promotion for technology use. 22 local governments, about 30% of the total number, have FCV promotion plans. Also, 30% of the local governments have preparation plans of commercial hydrogen refueling stations. 17 local governments subsidize FCV purchase. 50 % of the local governments support over ¥1 million to those who meet requirement of no delinquency of rent or tax over one year. Replies for issues are reduction in construction or operation costs of hydrogen refueling stations, support scheme to attract smaller businesses to enter the industry and the reduction in the price of FCVs, FC buses and hydrogen, fuel for these vehicles. (Nikkan Jidosha Shimbun, November 16, 2016)

2. Local Governmental Measures

(1) Yamanashi Prefecture

On November 4th, Yamanashi Prefecture, Tokyo Electric Power Company Holdings (TEPCO), Toray and Takaoka Toko announced that they had signed a partnership for technological development to produce hydrogen using electricity from solar power. They aim to develop an energy system to produce hydrogen using renewable energy to be stored for use without producing CO_2. The technological development will start in June 2017, and the experiment will last until the end of FY2020. The project will use electricity from the solar power plant of TEPCO in Kofu City as power source for water electrolysis equipment to produce hydrogen. Production of solar power fluctuates depending on the weather. The project will use this fluctuating energy efficiently for hydrogen production. (The Nikkei November 5, 2016)

(2) Fukuoka Prefecture

On November 8th, Mr. Hiroshi Ogawa, Governor of Fukuoka Prefecture, visited METI and handed a request on promotion of hydrogen, FC and renewable energy to Mr. Hisayoshi Ando, Director-General of the Commerce and Information Policy Bureau. In the request, the governor asked to fortify measures to develop demand structure of stable energy better for the environment at a low price and to promote comprehensive energy policy for stable energy supply. For hydrogen and FC, he requested expansion of support for operation costs in order to reduce the costs of hydrogen refueling stations at an early stage of FCV growth. Additionally, the request points out the necessity of electricity storage system using hydrogen to be commercialize in order to stably utilize renewable energy of which the output largely

fluctuates. Furthermore, it emphasizes importance of further expansion of distributed energy such as renewable energy and cogeneration facilities. Other points of the request are, support for facility purchase, deregulations, and research and development to be continued. The request proposes to set guideline for wind power to be installed in sea area except port and fishing harbor for expansion of offshore wind power. The prefecture asked to make the Kanmon grid connection to be multipath for foundational preparation. (The Denki Shimbun, November 9, 2016)

(3) Osaka Chamber of Commerce and Industry

On November 15th, a delegation of the Osaka Chamber of Commerce and Industry visited the United States Department of Energy (DOE), and exchanged opinions on issues and measures on hydrogen energy promotion. "We hope this interaction will lead to developing a partnership and technological cooperation and to bringing US and Japanese firms' better survival measures in competition." said Mr. Naokazu Kumagai, the leader of the delegation and an Executive Officer of Hitachi Zosen. Apart from Hitach Zosen, the participants of the delegation are from eight firms including Iwatani which operates hydrogen refueling stations and Osaka Gas which sells domestic FCs. An officer in charge of the energy at DOE gave an explanation of a hydrogen safety test and loans for renewable energy. (The Nikkei, November 16, 2016)

(4) Saitama City

"E-KIZUNA Summit" has held in Saitama City to aim for development of a wide intercity network towards promotion of next generation cars which are essential for low carbon society. Five prefectures, 24 cities and 18 companies participated in the conference, and they confirmed they would cooperate with each other to expand use of these vehicles. Their aim is to supplement the areas where governmental measures fall short. Having been suggested by Saitama City, the summit has been held since 2010, and this conference was the seventh. They determine EVs and FCVs to be promoted as next generation cars. The Japanese government aims to increase the ratio of the next generation cars from current 26.5% to 50 to 70% in new car sales to hit its target of reduction in greenhouse gas emissions by "20% of that of 2013 by 2030". To achieve these targets needs preparation of hydrogen refueling stations and the introduction of next generation cars to public transport. This requires cooperation of local governments and businesses. For the new United Nations Framework Convention on Climate Change "Paris Agreement", this time conference made a declarative statement as below. "The worldwide counter measures started combating the problem. We have an obligation to carry out measures to stop global warming now by developing a future less dependent on fossil energy. The conference will send proposals to the government. (The Mainichi Newspapers, November 16, 2016)

3. FC Element Technology Development & Business Plans

(1) The University of Tokyo

A study team of Prof. Yasuhiro Kato at the University of Tokyo confirmed that mud collected at bottom of sea offshore the Minami-Tori-shima of Ogasawara Islands contained a plenty of scandium which is a rare earth expected to be used in alloy and next generation FCs. This result will be published in a debrief meeting at the university in the afternoon of October 28th. Their resource estimation of scandium oxide is about 150 kt which is an equivalent of about 9,900 times of current global demand. Currently, scandium supply is limited to mines in China and Russia. The price is about $5,100/kg, which is a high level. Stable supply is an issue for the material. Due to this, a Japanese firm has newly started mining operation on land, and an American resource firm has developed a plan to collect the material from deep sea of the Pacific. In 2012, the study team discovered that offshore of Minami-Tori-shima has wide areas of mud at the bottom containing high concentration of rare earths including terbium. Further research revealed that mud of specifically high concentration of rare earth existed in an area of 315 km^2 250 km off the shore of the island. A large amount scandium can be collected. The material lies at the 5,000 m deep under the sea, and the issue is technological development to collect it. (The Yomiuri Shimbun, October 28, 2016)

(2) Panasonic

On November 2nd, Panasonic, Shizuoka Gas and Shizuoka City signed a comprehensive partnership for FC experiments. They will develop a pure hydrogen FC system to directly produce hydrogen without using

natural gas. Shizuoka Gas will start operation of a hydrogen refueling station next spring in Shizuoka City, and Panasonic will install the FCs. They aim to commercialize the system by 2020, and will carry out multiple experiments exporting power to neighboring shops and households. (The Nikkei November 7, 2016)

(3) Nanotec

Nanotec which produces deposition equipment to process the surface of metal parts in Kashiwa City of Chiba Prefecture has developed new deposition equipment to coat FC separators with carbon in cooperation with Nissan. Cell separators are plates to go between cells, and function to divide fuel gas and air. The new equipment advantageously shortens the coating time to a tenth. This will significantly improve production efficiency of FCs which is the core component of FCVs. Separators need to be coated to prevent corrosion by reaction of hydrogen and oxygen. Gold plating is another option for the purpose, but carbon coating allows a reduction in costs. Nanotec's new machine uses a large power source and improved discharging electrodes to achieve coating at 10 times the speed of the existing model. The new model can coat 1066 nm/minutes. The time for coating thickness of 30 nm can be shortened by 2 seconds per plate. The size of the separators varies depending on the specifications of automakers, but coating times previously took about 20 seconds per plate. Generally, 100 separators are needed to produce a single FC stack. The standard model currently available for carbon coating from Nanotech is 5 m wide, 3 m deep and 2 m high. The price is estimated at about ¥100 million. The new model will sell for a higher price, but can contribute to a reduction in costs as a whole due to its more efficient coating. (The Nikkei, November 11, 2016)

(4) SCREEN

On November 17th, SCREEN Finetech Solutions, an operating company of SCREEN Holdings, announced that RT Series which is production equipment to coat electrode catalyst directly to electrolyte membrane for polymer electrolyte fuel cells (PEFCs), and to dry membrane. The machine can lead to a reduction in production costs of FCVs and domestic FCs. Depending on specifications, the price is expected to be around ¥400 million. SCREEN Finetech Solutions has already delivered it to a firm. They plan to sell five machines in the FY2017. The coating and drying technology from their production of liquid crystal displays is used in the new machine which feeds a 10 to 15 μm electrolyte membrane sheet continuously roll to roll, and to directly coat catalyst on both side of membrane while reducing deformation of the membrane. This method allows a reduction in running costs of 15% and of initial cost by 30% of that of masking and printing which are conventional methods to coat electro the catalytic layer on electrolyte membrane. The performance of catalyst coated membrane improves by 15%. (The Nikkan Kogyo Shimbun, November 18, 2016)

4. Hydrogen Infrastructure Element Technology Development and Business Plans

(1) NILIM

On October 31st, the National Institute for Land and Infrastructure Management (NILIM) announced a draft guideline for technology to produce hydrogen from sewage. The guideline shows technological points for production and supply of hydrogen for FCVs. This is the first guideline for technology use. This technology has been tested at an experimental level plant as a project of MLIT carried out by Mitsubishi Kakoki, Toyota Tsusho, Fukuoka City and Kyushu University. (The Chemical Daily, November 1, 2016)

(2) Toshiba

Toshiba will rapidly expand its infrastructure business. On top of ENE-FARM, the largest share, they will try to expand sales of hydrogen energy supply systems to consume locally produced energy for remote islands and components to produce and store hydrogen. Their aim is ¥100 billion sales for hydrogen related business for 2020 and to promote renewable energy use and hydrogen as effective method to stabilize grid power. The firm will develop large-scale hydrogen storage system as power storage aiming to commercialize in late 2020's. This will expand the product range for their hydrogen infrastructure business. As the latest activity, their 3.5 kW pure hydrogen FC system was delivered to the energy management building of the Honsha Plant of Toyota Motor which started the operation. Toshiba decided to install a model for business buildings at its Fuchu Complex. This system is combined with a

photovoltaic generator, and is planned to produce electricity to supply equipment including FC forklifts on site. Tohoku Electric Power and Iwatani are contracted from New Energy and Industrial Technology Development Organization (NEDO) to investigate the possibility to make a business of a total energy system including storage, transport and use which has the world's largest class hydrogen production facility. They aim to commercialize large-scale hydrogen storage and power production system "H2Omega" which is a combination of solid oxide electrolyzer cells (SOECs) and solid oxide fuel cells (SOFCs) by late 2020's. (The Chemical Daily, November 1, 2016)

(3) Takenaka Corporation

On October 31st, Takenaka Corporation announced that a technology test to use hydrogen energy would start as the second phase of "Takenaka Carbon Free Model Town" under development in the Shinsuna area of Koto-ku where its Tokyo Main Office is located. They will build a whole system covering production, storage and use in FCs of hydrogen on the premises of its TAK E-HVAC Shinsuna Headquarters Building in the area by April 2017. The system will optimize use of electricity, heat and hydrogen with their energy management system (EMS) "I. SEM". The firm is promoting the system in parallel with the experiment aiming to join a leading project around 2020. Their target is a reduction in CO_2 emissions by 40 to 60% for a 100,000 m^2 level town by 2030. In the experiment, the test system will be developed in the existing building to collect expertize on hydrogen handling design and construction and control for efficient hydrogen use as well as development of a comprehensive energy management system. Hydrogen production and storage equipment and stationary PEFCs will be installed by investing ¥200 million, and the experiment will start in April 2017. The plan is to produce hydrogen by water electrolysis using surplus solar power production and to store hydrogen using a low pressure tank and hydrogen storage alloy aiming for advanced use. The firm will start a test of natural gas reforming SOFCs in 2018. This experiment will send direct current generated by FCs to I.SEM for using direct current as it is to evaluate lossless energy conversion system which is highly efficient. Expected waste heat use is absorption chillers for buildings and disinfection for high temperature 95ºC steam and supply to hospitals and hotels to heat water for low temperature 60ºC steam. (The Chemical Daily, November 11, 2016)

(4) NILIM

NILIM has compiled a guideline for technology to produce hydrogen from sewage biogas. Having used an experimental project of MLIT, the guideline indicates technological points for design, pre-purchase examination and maintenance. An estimation shows that this type of hydrogen production system can pay back the initial investment in 10 years from an operation start under certain conditions. The guideline is a reference for local governments. The organization made the guideline using the data of "HyLeC Fukuoka Hydrogen Station" which started the operation from March 2015. For the refueling station, biogas is made by fermentation from sewage sludge at the Central Sewage Treatment Center in Chuo-ku, Fukuoka City, and the gas is refined to methane gas by removing impurities. Over 99% purity hydrogen is produced by reacting methane gas with steam at high temperatures. As well as supplying hydrogen, CO_2 produced during the reaction will be also collected and liquefied to sell. The construction of the station costed about ¥950 million. The estimation result shows the initial cost can be recovered in 10.2 years if sales prices are ¥100/Nm^3 for hydrogen and ¥120/kg for CO_2. The facility's expected lifetime is 15 years. Furthermore, FCVs using hydrogen can reduce greenhouse gas emissions by 30% of that of gasoline cars. According to MLIT, about 500,000 FCVs can be fueled when hydrogen is produced from sewage biogas and sewage sludge at all the sewage treatment works in Japan. The ministry hopes that the guideline can be largely used, because the guideline leads to promotion of refueling stations which use unused energy to supply locally produced hydrogen. (Nikkan Jidosha Shimbun, November 7, 2016)

5. ENE- FARM Business Plans

(1) Osaka Gas

Osaka Gas is trying to expand sales of FC systems with new ENE-FARM which was introduced into the market in April 2016. They developed the first program in Japan where they purchase surplus

electricity production by keeping operation at the rated output of the ENE-FARM which is a highly efficient SOFCs jointly developed with Kyocera. The FC system was made smaller for more flexible installation for apartment units, and the sales of the ENE-FARM range have reached about 9,000 units for the first half of FY2016, a 40% increase of that of the same term for FY2015. The gas supplier developed a strategy to explore the market including established houses which are a target for retro fitting the system. ENE-FARM "Type S" available from April was developed in cooperation of Kyocera, Toyota Motor, and Aisin Seiki. The existing model also uses SOFCs, but the new model has improved generation efficiency, with lower heating value (LLV), from 46.5% to 52%. At the same time, the capacity of the new hot water tank was reduced from 90 L to 28 L, and a significant reduction of installation area was achieved by integrating the power generation unit. By connecting them, the new model can use a standard gas boiler as its heat source. This system allows adding the power generation unit to existing boilers of established houses. On top of these performance and improved installation specifications, the gas supplier will promote their own purchase scheme of excess power production which is the "first in Japan". The existing model basically changes electricity production up to its rated output to follow household demand. However, Type S keeps producing power at its rated output of 700W. The gas supplier buys excess power production when household demand becomes low in order to use the power for its electricity sales business. The purchase tariff uses ¥13/kWh as its base, and changes depending on an adjusted amount based on their material cost which changes every month. A model household can expect to expand reduction in utility cost from an annual ¥92,000 to ¥10,2000 combining electricity sales and gas discount based on installation of home cogeneration system. The price of the new system is ¥1.785 million, a ¥0.25 reduction, which cuts down consumers' impact further. Type S will be installed at all the 298 units of a residential sky scraper in the center of Osaka that Sekisui House aims to finish the construction by the end of 2018, and will start selling the units from late January 2017. Including this condominium, a total of seven new condominiums, 842 units all together, have decided to install the system. According to the gas supplier, sales of the system to retro fit to established houses are going strong. SOFCs that Osaka Gas puts effort on operate at high temperatures, and produce power more efficiently than PEFCs which are the main FC product of gas suppliers in other areas. SOFCs can also contribute to a reduction in costs by volume production. The number of ENE-FARM uses went over 150,000 units in Japan for FY2015. The government ambitiously targets for 1.4 million units by FY2020 and 5.3 million units by FY2030. It is interesting to see how much the presence of SOFCs focusing on "more power generation" is for hitting the governmental targets. (The Denki Shimbun, November 11, 2016)

6. Cutting Edge Technology of FCVs & EVs

(1) Toyota Moto

Toyota Motor is now considering preparing commercial production of EVs by 2020 to fully enter the EV market. Because environmental regulations are getting stricter for automobiles worldwide, the automaker will add EV in its core product range following hybrid vehicles (HVs) and FCVs which are the strategic products of eco cars. A new department will be set up for planning and development of EVs inside the firm in early 2017. In cooperation with its group members, the automaker aims for an early start of EV production. They will develop an EV which can drive over 300 km on a single charge. One of proposed plans is to use the same platform, chassis, as HV "PRIUS" and key product "COROLLA" to make a sport utility vehicle (SUV) which is globally becoming popular. The Battery Material Engineering & Research Division launched in January 2016 will accelerate development of the battery, the core component which affects the performance. The automaker will balance the performance such as driving range and charging time with price by examining the possibility of purchasing components from suppliers. The target market for the sales is countries which promote EV in the world including Japan which gets global attention due to the 2020 Tokyo Olympics. In the US, California imposes regulations that EV has to take a certain percentage of each automaker's sales. China provides a generous subsidy for promotion to help the sales. From 2012 to

2014, Toyota sold an electric SUV in the US which was developed in cooperation with US-based Tesla Motors, and this was Toyota's only previous EV achievement. Toyota gave up this business to be fully grown due to issues such as battery cost and short driving ranges, and kept away from the product in contrast to others including Nissan which devotes to EVs. However, regulations and promotions in favor of EVs have been introduced worldwide. Since the issues like driving range and charging infrastructure have improved, Toyota shifted to whole-direction an eco car strategy including EV. German-based VW had eco car strategy using a diesel car as the core, but also changed its strategy. They revealed their plan to increase the ratio of EV units in the sales from the current 1% to nearly 25%. In China, the largest EV producer BYD will expand production. In the US, EVs including a small sedan "Model 3" to be released by Tesla in 2017 have become popular. Considering these competitors' activities, Toyota will decide on its production scheme. According to the International Energy Agency (IEA), the global sales of EV were 328,000 units for 2015. This is under 0.4% of the whole new car sales. However, there is a forecast figure to reach 8% in 2030. In the future, HV, PHV and EV are more likely to stay in the market together, and automakers are required to offer a variety of power sources. (The Nikkei, November 7, 2016)

On November 17, Toyota Motor announced that a new department would be set up for strategy planning and development of EVs inside it. In cooperation with their group members, they aim for an early start of commercial EV production. Auto giants introduced their EVs at the Los Angeles Auto Show, currently being held in the US, but they are carefully watching global warming measures of Mr. Donald Trump, the next president. Depending on his policy, automakers are possibly be uncertain and exposed. Toyota will launch "EV Business Planning Department" in December. As well as Toyota itself, people from Denso, Aisin Seiki and Toyota Industries will join the department for the full-scale EV development as a team effort of the whole Toyota group, and it is planning to start commercial production by 2020 when the Tokyo Olympics is to be held. Toyota will consider joint development of technology for electric power unit such as motor with Mazda. The new department will start with four people, and will hire more people or/and borrow manpower from other departments as needed. Being an independent organization, this team does not belong to existing in-house companies or headquarters, but aims to operate like a venture. "The team will solely focus on its area, and establish a way for the work to flow fast." Mr. Akio Toyoda, the president, explained. (The Nikkei, November 18, 2016)

On November 30th, Toyota Motor announced that the "EV Business Planning Department" which is to be launched on December 1st will work on strategy planning and development of EV, and will be directly under management of Mr. Akio Toyoda, the president. The general manager will be Mr. Kouji Toyoshima who was in charge of the fourth generation of HV "PRIUS" released in December 2015. As shown in the executive changes announced on the day, Mr. Mitsuhisa Kato, an executive vice president, and Mr. Shigeki Terashi an executive vice president, will join the management of the department as well as the president. This organization will be independent from four in-house car companies launched in 2016. The department will start with a total of four members including three employees of Denso, Aisin Seiki and Toyota Industries as well as Mr. Toyoshima. (The Nikkei, December 1, 2016)

(2) Tesla

On November 7th, US-based EV producer Tesla Motors announced that use of its quick chargers would be subject to fees for its product ordered from January 2017. They have prepared their own charging infrastructure as EV promotion for free. Since the spread period is setting off by reduced EV price, they decided to charge for quick charger use. This profit is planned to be used for further charger preparation. The models ordered from January 1st 2017 will pay for quick charger use. However, these cars will be eligible of free charger use of 1,000 miles, about 1,600 km. The charger fee will be set lower than the gasoline price. The firm will start shipping of its popular model of EVs in 2017. Their products can be recharged through domestic wall sockets, but quick chargers are often used during long journeys. Because the shipment of this popular model is to increase the number of EVs on roads, their charger network needs to be expanded quickly. (The Nikkei, November 8,

2016)

(3) Mazda

Mazda will release an EV in North America by 2019. They will also introduce a PHV in 2021 or later. "Zero Emission Vehicles (ZEV) Program" will be tightened in 2018 in the US, and the manufacturer will accommodate the regulation. They will consider joint development for electrification technology such as motors with Toyota, their partner. Their product range of eco cars will be expanded for the North American market by introducing a diesel car in 2017. The subjects of the development are a small class of EV of which weight affects driving range, and medium class for PHV which uses a gasoline engine. They will consider using their own technology Wankel engine as a generator. This will extend the driving range of EVs, a weak point, by converting gasoline into electricity. They have not set a target date of EV and PHV introduction into the Japanese market. The manufacturer will consider a partnership for technological development of the drive system such as motor and battery with Toyota. Although Mazda has sold originally developed EVs in Japan, their HVs use technology provided by Toyota. EVs will be individually developed at each manufacturer to give character. On the other hand, the two firms will work on common components and technology such as batteries together to reduce costs and the period of their development. In 2018, California will make its ZEV program stricter. In the new program, HV will be deleted from the ZEV list, and automakers are required to sell certain amount of EV, PHV and FCV depending on their total sales units. Because the program is applied to Mazda, the automaker decided to introduce electric powered vehicles. (The Nikkei, November 17, 2016)

(4) VW

On November 22nd, German-based VW revealed its business plan for VW brand passenger vehicles, its core range. They aim for the world largest share of 1 million EVs by 2025, and will also produce EVs in the US. (The Nikkei, November 23, 2016)

7. Hydrogen Refueling Station Technology Development & Business Plans

(1) Suzuki Shokan

Suzuki Shokan announced that a hydrogen refueling station would be installed in its Toyota Business Office. As well as refueling facilities, the office will also have a FC forklift for handling operations. The facility uses an on-site system to produce hydrogen by electrolysis using photovoltaic generators. The facility will start its operation in April 2017, and will work as a demonstrational operation. The firm sells industrial gas and chemical products as its core as well as industrial equipment. In February 2015, they signed partnership with US-based Air Products for design, construction and operation of hydrogen refueling stations for material transport such as forklifts. Suzuki Shokan aims to spread its business of hydrogen refueling stations for handling vehicles in Japan. Their target is to install hydrogen refueling stations at five locations by 2020 so far. They decided the installation for daily handling operation at Toyota Business Office. One FC forklift will be purchased. Using photovoltaic generation system, the station uses electricity from solar panels using copper, indium and selenium, called CIS thin-film solar cell, on the building roof, and produces hydrogen by electrolyzing water on site. The hydrogen production equipment to be installed uses a polymer pure water electrolysis system, and produces up to 5 Nm^3/h. The hydrogen compression equipment can process 89 Nm^3/day at normal operation pressure of 45 MPa. As well as accumulators, the dispenser is non-pre-cool type, and fills at 35 MPa. The construction will start from the beginning of 2017, and the operation will start from April 2017. (The Chemical Daily, November 4, 2016)

(2) Honda & Solar Frontier (Showa Shell)

On November 9th, Solar Frontier, which is a subsidiary of Showa Shell and a solar panel producer, announced that it joined an experiment of Honda's hydrogen refueling station using a photovoltaic generator. They provided 20 kW panels to the experiment started in Tokyo. The project uses solar power, renewable energy, to produce hydrogen fuel for FCVs. Solar Frontier aims to expand the usage of solar panels. In the experiment, hydrogen is produced by splitting prepared water using electricity generated by the solar panels. The panels provided by Solar Frontier uses copper, indium and selenium as their material, which are called CIS thin-film solar cells. These cells advantageously keep their generation

level when temperature goes up comparing to common silicon panels. CIS thin-film solar cells are currently used at solar power plants. Honda developed a small hydrogen refueling station, and uses it in the experiment. Previously, it was difficult to fully fill hydrogen tanks, but high pressure of 70 MPa enables this. (The Nikkei Business Daily, November 10, 2016)

(3) Solar Frontier

Solar Frontier, Minato-ku of Tokyo, has announced that its solar panels were used for Honda's experimental hydrogen refueling station. The solar panels are used as a power source of water electrolysis to supply FCV with hydrogen. This is the first time for Solar Frontier to provide its panels for FCV related products. The panels for the experiment output 20 kW. On October 24th, Honda started the experiment of a refueling station to produce and store hydrogen using renewable energy in Koto-ku, Tokyo. (The Nikkan Kogyo Shimbun, November 17, 2016)

(4) Air Liquide Japan

Air Liquide Japan, Minato-ku of Tokyo, will start operation of a hydrogen refueling station for FCVs in Miyawaka City, Fukuoka Prefecture in March 2017. They have been designated as a corporation member for the "Green Asia International Strategic Comprehensive Special Zone", and will prepare hydrogen refueling station "Fukuoka Miyata Hydrogen Station" on the premises of the Miyata Plant of Toyota Motor Kyushu. The station can fill a FCV with hydrogen in three minutes. Air Liquide Japan is 57th firm using the special zone scheme for its investment in the facility, and the scheme gives preferential treatment in tax. (The Nikkan Kogyo Shimbun, November 21, 2016)

Air Liquide Japan will install the first commercial hydrogen refueling station for Kobe-City in Hyogo-ku. About ¥500 million will be invested in the construction, and the station will be open in late March 2017. The operation will be jointly carried out in cooperation of Air Liquide Japan and Marui Shokai (Nishi-ku, Osaka City), a distributer of Mitsubishi Corporation Energy (Chiyoda-ku Tokyo). (The Nikkan Kogyo Shimbun, November 21, 2016)

8. Hydrogen Measuring, Observation, Safety and Explosion Proof Technology Development

(1) Petroleum Association of Japan & The Japan Gas Association

Hydrogen related organizations including the Petroleum Association and the Japan Gas Association will develop a voluntary action plan for securing safety of hydrogen refueling stations in this fiscal year. Hydrogen has not been widely used as commercial energy, and users show high anxiety about gas leak and explosion. Because of this reason, these organizations will establish voluntary measures which are stricter than the legal safety requirements for hydrogen fuel to be more accepted by society. According to METI, a few accidents have occurred at hydrogen refueling stations each year since 2005. The number of hydrogen refueling stations in operation increased to 50 locations in FY2015, and 11 accidents happened. From the beginning of 2016 to the end of June, 15 accidents occurred. The majority is gas leak, but small explosion took place in the past. October 2014, a lorry carrying hydrogen had a burst tire, and the vehicle caught fire. At the time, a safety valve worked, which prevented the tank from exploding. Hydrogen refueling stations and FCVs have multiple safety devices. Moreover, hydrogen is ultra-light, and dispersed quickly if leaked. These properties reduce risks of large-scale explosion or fire. However, the number of accidents is expected to rise as the number of hydrogen refueling stations goes up. Because ambiguous anxiety lingers about hydrogen among consumers, the industry decided to develop a voluntary safety action plan. The actual operation will be carried out by the Association of Hydrogen Supply and Utilization Technology (HySUT), and Japan Automobile Manufacturers Association will cooperate. (Nikkan Jidosha Shimbun, November 18, 2016)

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