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Honda Released New FCV with Features of Roomy Interior and 750km Driving Range

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1. Governmental Measures

(1) METI

The Ministry of Economy, Trade and Industry, METI, will revise safety ordinances on high pressure gas in this month to allow installation of hydrogen refueling stations on smaller pieces of land, which is to make urban areas easier to have these facilities. The current regulations require 8 m clearance at least from public roads for refueling stations. The revision enable hydrogen filling facilities for cars to reduce this clearance by carrying out sufficient safety measure such as protective barriers. Also, it may be possible for hydrogen refueling stations to be unattended during closed hours such as evening and night. The regulations will be revised for operators to reduce the costs of installation and operation. (The Yomiuri Shimbun, February 25, 2016)

METI has published a long-term target for hydrogen refueling stations for FCVs to increase to 320 locations, four times of that of the current target, by FY2025. Preparation of hydrogen refueling facilities has been slower than it was targeted due to high costs. However, the ministry will support operators by deregulation and subsidy. Also, they target for 800,000 FCVs to be used by 2030 by supporting technological development by manufacturers to reduce production costs. The draft targets will be announced at the Hydrogen/Fuel Cell Strategy Council, an expert committee of METI, to be held on March 16th. An actual promotion plan will be studied with experts' opinions. Although FCV is in spotlight as a next generation eco car, construction of a hydrogen refueling station costs ¥400 to 500 million which is more expensive than gasoline one which is around ¥100 million. Furthermore, hydrogen refueling station needs over ¥40 million to operate. This expensive operation cost is another reason to slow down the preparation. The government initially targeted construction of the stations at 100 locations nationwide by FY2015. Nevertheless, the figure is expected to be 80 locations. The ministry will give support to operators to reduce costs for construction and operation by providing subsidies for technological development for cutting down facility costs and by deregulations to allow "self-service" hydrogen refueling stations that users fill their cars by themselves. FCVs were released by Toyota Motor in 2014 and Honda in March 10th, 2016. Currently, about 500 FCVs are in use. (The Nikkei, March 16, 2016)

(2) MLIT

The Ministry of Land, Infrastructure, Transport and Tourism, MILT, was working on safety standards for fuel cell (FC) motorbikes, and has announced an amendment of the standards. The standards will enter into force from February 2017. They set requirements for hydrogen containers. Also, manufacturers are obliged to design FC motorbikes to release hydrogen gas right underneath the body when their safety valves are in operation for easier handling of accident. (Nikkan Jidosha Shimbun, February 25, 2016)

(3) Japanese Government

On February 29th, the Japanese government revealed a draft of the "The Plan for Global Warming Countermeasures" to indicate basic guidelines. This plan shows reduction targets in emissions of Japan to the global community after the Paris Agreement was adopted. The short-term target is 3.8% of that of 2005 by 2020, and the mid-term one is 26% of that of 2013 by 2030. The long-term target is a very high figure of 80% reduction of that of the current emissions. Hitting these targets requires various measures to be done. The first area needs more reduction is power generation which takes about a 40% share in the

domestic greenhouse gas emissions. The plan includes nuclear power stations to start operations again and maximizing renewable energy use as requirements. On top of them, the government picks up hydrogen energy use, more efficient thermal power and shifting from coal and oil power generation which produces larger amount of CO_2 emissions to natural gas ones. Additionally, energy saving devices will be promoted. By 2030, the government plans highly efficient lighting such as light emitting diodes, LEDs, to be used at all homes and offices. The ratio of next generation cars such as hybrid vehicles (HVs) and electric vehicles (EVs) is targeted to 50 to 70% in the new car sales. A net-zero energy building, ZEB, has high insulation, and photovoltaic generator and/or FCs produce energy for it to be a utility bill free house. In the housing area, ZEB house is aimed to be widely used by 2020. To backup ZEB sales, the plan also states establishing a "negawatt market" which allows households and businesses to sell saved electricity to utility firms. Furthermore, the government will work on the most advanced technologies to be developed and promoted. Research and development to be supported is next generation power semiconductors which are largely effective to reduce energy consumption and materials to improve fuel efficiency of cars. Another area is city planning which is to care environment more. For example, a compact city is promoted to concentrate city functions in its center for saving greenhouse gas emissions. (The Nikkei, February 29, 2016)

On March 5th, Prime Minister Shinzo Abe visited Fukushima Prefecture which was damaged by the Great East Japan Earthquake and the nuclear power station accident to see its recovery. This is the 28th visit to the area damaged by the earthquake since he became prime minister. He revealed an intention to work harder to realize hydrogen society by establishing "Fukushima Concept for a New Energy Society" to discuss promotional measures for new energy with cooperation of governmental bodies and businesses. The group will consist of the government, prefecture and electricity provider. The plan is to prepare a system to produce hydrogen for 10,000 FCVs in the prefecture by 2020. "We will promote Fukushima as a pioneer to open up hydrogen society", Mr. Abe said. (The Nikkei, March 6, 2016)

2. Local Governmental Measures

(1) Tokyo

Tokyo has compiled the "Environmental Basic Plan" for 2030. The plan includes targets of 30% reduction in emissions of greenhouse gases of that of 2000, 200,000 FCVs to be used and hydrogen refueling stations at a total of 150 locations. This is the first time to revise the plan in eight years, and the officially decided at the end of March. (Nikkan Jidosha Shimbun, February 25, 2016)

Tokyo has compiled a reforming plan for its bus system for 2020 Tokyo Olympics and Paralympic Games. The plan includes 80 FC buses to be introduced ahead of private bus operators, bus bodies to be color coded for each route and a new model of information display using a lot of digital technologies. They will invest ¥22 billion over the period between FY2016 and FY2018 for its bus operation, and the number of FC buses will increase over the years to meet the objective by FY2021. A FC bus costs about ¥100 million, over double of that of common ones, and private businesses have not yet moved into it. To realize hydrogen society, the local government targets at over 100 FC buses to be used by itself and private operators, and it will lead the way. Two FC buses will be in operation in FY2016. (The Nikkei, March 1, 2016)

(2) Kyoto City

Kyoto City has allocated about ¥160 million in the budget bill for FY2016 as an installation cost of small filling facility "Smart Hydrogen Station (SHS)" which was jointly developed by Honda and Iwatani. SHS produces hydrogen using power generated by renewable energy such as sunlight, and emits no CO_2 during the production. Also, smaller space is required for installation, because the facility is about size of a shed. This archives cheaper installation cost than a common commercial hydrogen refueling station, about ¥500 million. (The Nikkei, March 18, 2016)

(3) Osaka Prefecture

Osaka Prefecture has compiled a draft of "H2Osaka Vision", a concept to promote the industry related to hydrogen energy in the prefecture. In the prefecture, larger firms and smaller businesses with related technologies will be encouraged to cooperate, and an international conference of hydrogen and FCs will be held to attract related private investment in

September. The local government will collect opinions from the residents and businesses to finish the concept in March.

Osaka-Sayama City will develop a system to produce hydrogen energy from water of about 140 ponds in its area to supply community with energy. Floating solar panels will be installed at four ponds including Otoriike, Shinike and Nigoriike, and power generation is planned to start by August. Furthermore, a hydrogen production and power generation plant will be installed near Otoriike in this year. Power from the photovoltaic generator will be partially used to electrolyze pond water to produce hydrogen for power generation later. According to Mr. Okada, an administration officer of the city planning department, using both photovoltaic generator and hydrogen power generation can "reduce weather impacts, and achieve stable power supply". Power will be supplied to public facilities such as the city office and branches and schools in the first phase, but the local government plans to sell power to local businesses and residents at cheaper rate in the future. Official cars and community buses are also planned to be replaced gradually with FCVs. (The Nikkei, March 18, 2016)

3. FC Element Technology Development & Business Plans

(1) Tokyo Gas

Tokyo Gas has started an experimental operation of business use solid oxide fuel cells, SOFCs, by Kyocera aiming for release in FY2017. SOFCs will be installed at four small commercial buildings as main power sources to evaluate efficiency and operation under fluctuated electricity consumption. Although FCs for business use have grown slower than home ones, starting sales of these products by gas suppliers are likely to back up expansion of the market. Tokyo Gas will make a decision on sales of the SOFCs developed by Kyocera with results of the experimental operation. The product outputs 3 kW. SOFCs generate power more efficiently, which can contribute to reduction in costs. The generation efficiency is 50% while keeping 3 kW output, and the gas supplier will ensure total efficiency including hot water. Also, other points to be evaluated are flexibility in operation and efficiency when the output level drops under 3 kW as demand goes down in specific time of a day. (The Nikkan Kogyo Shimbun, February 25, 2016)

(2) Toshiba FC Systems

On March 8th, Toshiba FC Systems announced that a next generation hydrogen FC system which outputs 700 W became available on the day. The system achieves 55% of generation efficiency which is the world's highest level. The development of the system was completed using the "Yamaguchi Prefecture Industry R&D Strategy Subsidy", and the firm decided the commercial sales. Because the system uses hydrogen directly, the power generation starts in one to two minutes. The manufacturer developed a 3.5 kW pure hydrogen FC system as a project of Yamaguchi Prefecture for FY2015, and will start an evaluation test of the system this month in Shunan City. This trial system has the same performance and characteristics as those of the 700 W hydrogen FC system commercially available now. Operation data will be collected from the experiment, and benefit and operational method will be evaluated aiming for commercialization in FY2017. (The Denki Shimbun, March 9, 2016)

(3) IMS

The Institute for Molecular Science (IMS) of the National Institutes of Natural Sciences has developed a new electrolyte material for FCs to achieve 2 to 3 V, over double of that of conventional ones, with cooperation of the Tokyo Institute of Technology and Kyoto University. Because automobiles require a high voltage, a large number of FCs is installed on vehicles. If each FC performs at the higher voltage, the number of FCs can be a half to reduce the size of FC systems. Another advantage is that the product does not use expensive platinum catalyst. The developed electrolyte material transports anions of hydrogen between FC electrodes. In common FCs, cations carry electrons. However, anions create larger energy difference than cations. Due to this reason, the new material can achieve power generation at a higher voltage. Hydrogen anions are very unstable and easily broken. This was an obstacle for an electrolyte material using anions to succeed. The study team made anions to stably move by making alternate layers of metal oxide and lithium hydride. An actual FC was created with the electrolyte to ensure power generation. Currently, many FCs are serially

connected for products require a high voltage such as cars. The new electrolyte material can reduce the number of FCs to half, which significantly reduces size and weight. Because the electrolyte operates at around 300°C which is higher than conventional FCs for automobiles, the catalytic reaction is also expected to occur without expensive platinum. The team plans to produce electrolyte material to increase output as well as voltage in order to succeed FCs which can be used in actual products. (The Nikkei Business Daily, March 18, 2016)

4. Hydrogen Infrastructure Element Technology Development & Business Plans

(1) RITE

On April 1st, the Research Institute of Innovative Technology for the Earth, RITE, will open the Inorganic Membranes Research Center which leads to commercialization of technologies for expanding hydrogen use and CO_2 capture and storage, OCS, in Seika-cho, Kyoto Prefecture. Inorganic membranes use ceramics and metals as materials to efficiently separate target substances. CO_2 can be separated from fossil fuel, and high purity hydrogen can be extracted from liquid compounds. The research center works on development of innovative technologies for early commercialization, creating industries and also planning of joint projects of material manufacturers and industrial users. RITE is developing three types of inorganic membranes. They are a membrane using palladium and a "silica membrane" and a "zeolite membrane" which both use ceramics as their material. (The Denki Shimbun, March 4, 2016)

(2) KHI

Kawasaki Heavy Industries, KHI, will cooperate to develop a transport technology of hydrogen which is expected to be next generation energy with fewer impacts to the environment for FCVs fuel and power generation with Royal Dutch Shell, an Anglo-Dutch multinational oil company. A Japanese business alliance has been formed with KHI as its core member, and plans to produce hydrogen at a low cost in Australia and to export the material to Japan in a liquid form. Shell has extensive expertise in energy transport. Their participation in the alliance is likely to give an impetus to hydrogen energy supply at large scale and establishment of international standards for marine transportation. KHI has developed technologies for commercial production and transport of hydrogen in cooperation with Iwatani and J-Power. With newly joining Shell, these firms launched a technological research association. Hydrogen will be produced from lignite which is low grade coal found plentiful in Australia, and be transported in a dedicated ship in a liquid form at ultra-low temperatures. The wholesale hydrogen price is planned to be reduced to ¥30/1 Nm^3 (0°C and 1 atm) to be sustainable. If the plan goes well, hydrogen power generation costs, ¥16/kWh, will be 20% higher than that of liquefied natural gas (LNG), but nearly half of that of oil. Shell has full of knowhow for LNG development and technological development for transport. Hydrogen technology is led by Japanese businesses. By joining the alliance, the oil company probably wants to build a position in the marine transport business which is expected to be in demand globally as well as in Japan. KHI will work on building a tanker ship and storage tank. Iwatani will develop a loading facility from the tank to lorries. J-Power will work on a production plant. The import base is planned to be located in Port of Kobe. An experimental operation is aimed to start by 2020. The alliance aims to import annual 660 kt, a 1.5% equivalent of the total power generation in Japan, by 2030. JX Nippon Oil & Energy and Chiyoda Corporation are individually developing a technology to transport hydrogen dissolved in a liquid such as toluene. French-based Air Liquide and German-based Linde have started a hydrogen supply using natural gas pipeline in Europe. Furthermore, Toyota Motor started commercial sales of FCVs, and US-based GE and Mitsubishi Heavy Industries, MHI, are developing a power generation technology as hydrogen use. Establishing a marine transport system is likely to lead to society to consume hydrogen at a large-scale. (The Nikkei, March 14, 2016)

(3) Toyota

On March 14th, Toyota Motor announced that the industrial hydrogen supply network planned in the Keihin Coastal Area would move onto experiment in FY2016. Hydrogen produced from renewable energy will be transported and used as fuel for FC forklifts in fruit and vegetable markets and warehouses. They aim to reduce maximum 94% of CO_2 emissions of that

of gasoline forklifts. The project members are Toshiba, Iwatani, Kanagawa Prefecture, Yokohama City and Kawasaki City as well as Toyota. The project will be carried out until 2018. Hydrogen will be produced by electrolyzing water using electricity from wind turbines held by Yokohama City. Hybrid vehicles, HVs, will transport hydrogen to four facilities including Yokohama plant of Kirin Brewery Company as fuel supply for 12 forklifts. CO_2 emissions are estimated 16.3 kg/day from hydrogen production, transport and use. The project is expected to achieve significant reduction in the emissions comparing to rechargeable (229 kg/day) and gasoline (266 kg/day) forklifts. The biggest issue for this project is costs. Although the detailed costs are closed, Mr. Shigeki Tomoyama, a senior managing officer of Toyota, said at the press conference on the day that "simple addition would be high". The project will examine feasibility and costs of the network using Hokkaido and remote islands where wind power generation is well suited. (The Nikkei, March 15, 2016)

(4) JAEA

Japan Atomic Energy Agency, JAEA, has succeeded an operation of an experimental hydrogen production plant which keeps chemical reactions at high temperatures involving iodine and sulfuric acid. Previously, the experiment used a glass container. This is the first time for the commercial level reactor to produce hydrogen continuously. The reactor uses a combination of glass and silicon carbide. Sulfuric acid strongly reacts with various substances. The previous experiment was mainly carried out in a glass container. The trial plant is 18 m wide, 5 m deep and 8 m high. The plant produced hydrogen at 10 L/h for eight hours without corrosion in the experimental operation. JAEA is researching a "High Temperature Engineering" test reactor, a next generation nuclear power plant. This test reactor is expected to supply 950°C heat as well as electricity. The organization plans to use heat for hydrogen production. This high temperature engineering test reactor will be connected to the larger hydrogen plant for evaluation of hydrogen production. (The Nikkei, March 21, 2016)

5. ENE-FARM Business Plans

(1) Osaka Gas

On February 24th, Osaka Gas announced that a new ENE-FARM was developed with cooperation of Kyocera. They improved generation efficiency to the world's highest 52% by using waste heat from power generation. The system is small, which makes easy installation in apartment units. The gas supplier will start buying excess power from the new FC systems. The FC sales will start from April. ENE-FARM extracts hydrogen from natural gas, and generates power by reaction of hydrogen and oxygen. The power generation was improved by approximately 5% by using ceramic substrate. Also, the installation area was reduced by 20% of that of previous product. A common gas boiler can be used as a heat source, which eliminates the need of installation of dedicated heat implement. The price is approximately ¥250,000, 10%, lower than that of the existing product. The utility firm aims at 15,000 units, a 20% increase, for ENE-FARM in its sales area. Excess power from new products can be sold to the firm at a price which follows gas value using ¥13/ kWh as the base. ENE-FARM generally reduces household electricity consumption by 80%. Furthermore, the new product can give a ¥6,000 income each year. The firm estimates about 70 MWh to purchase from its customers in FY2020, and will purchase electricity only from households of which gas supplier is Osaka Gas. ENE-FARM is often used by households using energy more than the average. For electricity and gas liberalization, cheaper electricity plans will be offered for home ENE-FARM users to attract consumers before other firms. (The Nikkei & The Nikkan Kogyo Shimbun; February 25, 2016)

(2) Sekisui House

On February 24th, Sekisui House announced that Osaka Gas's ENE-FARM would be installed in its residential skyscrapers to be built in Osaka City. A total of all 543 units of two buildings to be completed in 2019 will come with the FC systems. This is the world's first skyscraper condominium with FC systems in all the units. The FCs allows reducing energy use including air conditioning by 25% of that of units without FCs. Additionally, excess power can be sold to Osaka Gas. These buildings will use ENE-FARM to be released in April. (The Nikkei, February 25, 2016)

(3) Tokyo Gas

On February 29th, Tokyo Gas and Panasonic

announced that new ENE-FARM for apartment units was jointly developed. The new product has more flexibility for installation to make apartment design easier. The function to continue power generation during power cuts is optional for the existing model, but the new range offers an integrated version. The new system will be available from natural gas suppliers including Tokyo Gas from July. As well as standard exhaust, extended exhaust piping will be added to the new product range. Previously, it was difficult to install FC systems in recessed places because fume tends to stay long there. This extended piping allows installation of the FC system in such places. The allowance of piping distance between the hot water tank unit and backup heat source was extended to 15 m, 5 m longer than of that of the existing model. This enables these units installed at far ends of an apartment unit. The power output is 200 to 700 W. When natural gas and water supply work during power cuts, new ENE-FARM can continue to output maximum 500 W for four days at most. The optional independent start function combined with the function to continue power generation allows switching on the system to produce power without electricity from the grid during power cuts. There is no manufacturer's suggested price. (The Denki Shimbun, March 1, 2016)

(4) Toho Gas

On February 29th, Toho Gas announced that Aisin Seiki's ENE-FARM Type S would be available from April 1st. Using SOFCs, this product improved generation efficiency by 5.5% of that of the existing model achieving the world's highest generation efficiency of 52%. The suggested retail price for the standard specifications is set ¥1.998 million including tax. As well as improved generation efficiency, the hot water tank was reduced its size to be integrated in the FC unit, and the main unit is also made smaller. The required installation area for houses was reduced by about 30% of that of the existing product. The price is also cut down by 20%. The gas supplier has sold ENE-FARM since May 2009, and the accumulated sales reached 9,000 units at the end of January 2016. Their mid-term business plan was published in March 2014, and states the "best energy use for each customer". The firm aims to expand the sales of energy creating and highly energy efficient equipment such as ENE-FARM. (The Denki Shimbun, March 1, 2016)

(5) Hiroshima Gas

Hiroshima Gas's accumulated ENE-FARM sales reached 1,000 units at the end of January. This result was achieved in seven years since the product became available from the firm in FY2009. Half of their sales is dual generation, a combination of photovoltaic generator and the FC system. (The Nikkan Kogyo Shimbun, March 2, 2016)

(6) Panasonic

Panasonic will introduce ENE-FARM which takes liquefied petroleum gas, LPG, into the market in 2017. They have started sending proposals to major wholesalers to find out needs, and will try to achieve earlier release by working out details such as distribution channel and maintenance system. Currently, ENE-FARM is mainly used in the area where natural gas is supplied, and is sold over 20,000 units each year. The manufacturer aims for sales at a couple of thousand level by expanding the sales to the LPG area by FY2017. The cost of polymer electrolyte fuel cells, PEFCs, has been reduced, and the system has been matured a lot. Due to the reasons, the firm made a decision on the market introduction. Although Toshiba FC Systems will be the first firm to sell LPG type ENE-FARM, many LPG suppliers requested the product to Panasonic. (The Nikkan Kogyo Shimbun, March 9, 2016)

6. Cutting Edge Technology of FCV & EV

(1) Volvo & Aston Martin

European luxury automakers are working on electromobility at a faster speed. Volvo Car Corporation, Sweden, will introduce an EV of which driving range is about 500 km into the market in 2019. UK-based Aston Martin has made a decision on joint development with Chinese firm. Following the three German global auto giants of expensive ranges, other European carmakers shifted their strategies more to electric powered cars. Their main reason is to accommodate tightening environmental regulations, but another factor is that US-based Tesla Motors have established itself as a luxury EV brand.

"The new platform (powertrain) will be designed for both purely rechargeable EVs and plug-in hybrid vehicle, PHVs. This will accelerate electrification in all

our ranges.", Ms. Victoria Falksund, an executive in charge of design, said at the press conference held at Volvo in Stockholm on February 18th. Battery cost is going down, and the rich consumers will pay for luxury cars with attractive advanced technology. Mr. Håkan Samuelsson, the CEO, told Nikkei that "the driving range will be around 500 km". This range is the same level of the luxury EVs planned by German-based Audi and Porsche. Since Volvo joined Chinese-based Geely Automobile Group in 2010, the Swedish automaker has turned its business around. Their sales units and profit were renewed in the term ending December 2015. The firm has increase the budget for research and development of electromobility. All of their models including small cars is planned to be renewed, and PHV version will be offered in all the range.

On February 18th, Aston Martin signed for joint development and production of EV with Le Holdings, a Chinese conglomerate. Aston Martin's sedan "Rapide" will offer an EV version in 2018. The reason behind is strict regulations for CO_2 emissions in the EU. Automakers are required to reduce the emissions of their new cars to 95 g/km or less in average by 2021. Another reason is Tesla. "The total sales are performing in a different digit, but environmentally conscious wealthy consumers are attracted by Tesla brand." Tesla has established itself as a luxury EV brand in Europe, and other luxury carmakers need to compete in electric powered car. Otherwise, they may lose their potential customers. (The Nikkei, February 23, 2016)

(2) Sumitomo Metal Mining

Sumitomo Metal Mining will increase production capacity of battery materials for EVs by 40% in two year. Tesla Motors is an American EV producer and uses materials of Sumitomo Metal Mining. Since Tesla plans release of a new EV, the supply capacity of the Sumitomo Metal Mining will be fortified to respond to the demand. The material producer plans to invest about ¥20 billion in production of materials for automobile batteries over three years and to expand the sales to other car makers. Their aim is to grow the battery material business which is expected to give more steady profit than mining and smelting businesses. They will produce more cathode material for lithium-ion batteries, LIBs, which are power sources of EVs. Their Harima Refinery makes a nickel material for cathodes for Tesla in Harima City of Hyogo Prefecture, and is considered to be the core of this production facility enhancement. The monthly production will be increased to 2,550 tons by the term ending March 2018. They exclusively supplies cathode material for automobile batteries of Tesla through Panasonic. The material has been also produced at the Isoura Plant, Niihama City of Ehime, and a new plant will start its operation in March in Naraha-cho, Fukushima Prefecture. Sumitomo Metal Mining aims to supply its cathode material for "Model 3" which is a dissemination model to be released in 2017, and to expand the sales to Tesla with increased production capacity. The material producer will also enhance the production capacity of nickel, a cathode material. Their Taganito refinery, Mindanao Island in the southern Philippines, will be increased its capacity to annual 36,000 tons, a 20% rise, with investment of ¥300 million in 2018. (The Nikkei, February 25, 2016)

(3) Mitsui & Co.

On February 24th, Mitsui & Co. announced that it would invest about ¥1 billion in Sunverge Energy, California, which develops software to efficiently send and distribute electricity from storage batteries, photovoltaic generators and EVs. Their capital contribution ratio will be 10%. Since renewable energy is expected to be more in demand, the firm will try to sell the software to operators of power distribution systems. The electricity business will be open to enter in Japan, and more diversified power sources such as photovoltaic generators and storage batteries will be connected. The power from these facilities needs to be distributed stably and efficiently. (The Nikkei, February 25, 2016)

(4) Honda

On February 24th, Honda held a press conference in Tokyo, and Mr. Takahiro Hachigo revealed global business restructure for major global regions. More products made in Japan and Europe will be exported to the US where their sales are going stronger to solve their overflowing production capacity of just under 900,000 vehicles in total worldwide by 2020. They will make an effort in environmental measures by expanding the sales of zero emission cars, which emit no greenhouse gases during driving, to 15% in their total sales by 2030. Their long-term issues are

development of advanced environmental and safety technologies. The sales of FCVs and EVs together are aimed to take 15% of the total sales by 2030. The sales ratio of PHVs and HVs are targeted at 50% or more. "PHV will be the core technology for us, and our resource will be concentrated in electrification technology." he said. The manufacturer intends to develop a wide range of advanced technology. (The Nikkei, February 25, 2016)

On February 26th, Honda revealed its exhibition outline for "FC Expo 2016, 12th International Hydrogen/FC Exhibition". Their display will cover electricity usage from renewable energy, smart hydrogen refueling station which enables production and supply of hydrogen gas at high pressure with reduced carbon emissions and "Power Creator", high pressure water electrolysis system. Their concept to realize hydrogen society is "create, use and connect", and advantages of the concept will be presented in diorama. Also, "Clarity Fuel Cell" to be released in March will be displayed in the booth of the Research Association of Hydrogen Supply/Utilization Technology, HySUT. On March 2nd, they will give a talk on actions to realize hydrogen society. (Nikkan Jidosha Shimbun, February 27, 2016)

On March 10th, Honda started the sales of its new FCV. Although Toyota started commercial FCV sales earlier, Honda made roomier interior by reducing the size of the power unit. Their motor provides output at the world's highest level, and the FCV is aimed to outperform Toyota's FCV with more comfortable interior and better driving performance. Only these two carmakers sell FCVs in the world at the moment, and FCV has many hurdles such as preparation of refueling infrastructure and expensive price to solve to be popular. Honda's new product is named "CLARITY FUEL CELL". Mr. Shimizu, the person in charge of the development, explained the reason why the sales started over one year behind Toyota's FCV "MIRAI". "We were improving our product to be more attractively advanced, and this does not mean that we were technologically behind." He emphasized and showed vying attitude against Toyota. Honda has own technology to give it confidence. They reduced the size of the power unit by 33%, which allowed the bulky drive unit to be installed in the hood rather than under floor. This is the first for FCV sedan, and gives interior more space. MIRAI can take four people. On the other hand, Clarity can take five people and three golf caddie bags. Furthermore, the motor's maximum output is 130 kW which is the world highest level in FCVs. Toyota's FCV can drive 650 km on a full tank. Honda extended the range by 100 km to about 750 km. "We want to promote the car with completely different driving level." Mr. Hachigo, the president of Honda, emphasized their passion for driving. Their FCVs will be sold on lease, and the production for FY2016 is planned to be around 200 vehicles which are mainly for local governments and businesses. The sales area will be expanded to Europe and the US by the end of 2016. However, the production capacity will be limited for a while. Mr. Hachigo only stated that their initial target was a couple of 10,000 level sales each year by 2020. The price of ¥ 7.66 million will be a barrier to get popularity. Clarity is ¥0.4 million higher than MIRAI, and the price with governmental subsidy largely exceed of that of other eco cars such EVs and HVs. Honda aims to bring the FCV price down to the HV level by 2025, and is considering a joint production of power unit with US-based GM, a partner, to improve volume efficiency to achieve the target. However, this is not easy. An even larger issue is slow progress in preparation of hydrogen infrastructure. It has been noticeable that some of European and American carmakers are shifting to EV which is cheaper in price and easier to prepare charging infrastructure. "We want many car producers to join the market for FCV promotion, and will not decline requests to use our patents." an executive of Honda said. Although they are competing against Toyota, the two firms are likely to need each other's cooperation to prepare environment for the vehicle. (The Nikkei, March 11, 2016)

(5) Hyundai Motor

Hyundai Motor, the largest South Korean-based automaker, will unveil an EV version of "Ioniq" which solely offers eco cars at the Geneva International Motor Show starting from March 1st. The EV is likely to drive over 169 km on a single charge. (The Nikkei, February 26, 2016)

(6) BYD

BYD, a major Chinese automaker, announced that its net income (preliminary figure) for the term ending at December 2015 was estimated 2.8293 billion CNY

(approximately ¥49 billion), 6.5 times of that of the previous term. The Chinese government is providing generous subsidy for eco car purchase, which has supported their strong sales of eco cars. (The Nikkei, March 1, 2016)

(7) Uzushio Electric

Japanese EVs are becoming popular in the Philippines. One of the manufacturers is Uzushio Electric which produces electric equipment for ships in Imabari City of Ehime Prefecture, but not an automaker. Over 350,000 three-wheeler taxis drive around in the Philippines. The firm aims to sell its electric three-wheelers for taxis. Their core business is electric systems for ships. However, they entered to the EV market to diversify their business. They evaluated that their controlling and power distribution technologies for ships could be applied to EVs. The developed electric three-wheeler can drive about 40 km on a full charge, and can drive on 16 degree slopes and in 25 to 30 cm deep paddles to accommodate the regional road conditions and climate with frequent typhoons. The sales have made a smooth start. The firm has sold 17 EVs for Boracay, a tourist island, with cooperation of Orix. In February, they solely signed a sales agreement for 3,000 vehicles with the government of the Philippines. The government promotes electric three-wheeler taxis, and plans 17,000 EVs to be used. Electric three-wheelers are also used as taxis in other developing countries such as India and Indonesia. The firm aims to expand the business to other regions than the Philippines in the future. (The Nikkei, March 14, 2016)

(8) SoftBank

SoftBank Group will start a service to lend electric motorbikes to tourists in sightseeing areas and provincial cities in March through its subsidiary. The first location is Tonosho-cho, Kagawa Prefecture in the Setonaikai area. The group will prepare about 10 vehicles of "EV-neo", Honda's electric motorbike, in Tateshima. These motorbikes will have communication devices for the service provider to remotely monitor driving status to support safety rides. (The Nikkei, March 17, 2016)

7. FCV & EV Part Development

(1) AIST

The National Institute of Advanced Industrial Science and Technology, AIST, has elucidated a charging and discharging mechanism of "lithium–sulfur battery (Li–S battery)" which is under development for applications including EV. This result will contribute to development of electrode materials to achieve high capacity and voltage. Li–S battery is one of next generation storage batteries, and its electrode contains sulfur. Although the capacity is expected to be 3 to 4 times of that of LIB which is commonly used these days, the details of the charging and discharging mechanism were unclear. Dr. Atsushi Sakuda, a researcher of AIST, investigated the mechanism by combining structural analysis by X-rays and computer simulation in cooperation with Kyoto University. Lithium, titanium and sulfur were neatly positioned constituting the crystal structure of the electrode material before charging. During charging, some lithium moved to electrolysis solution, and sulfur went in the holes of lithium. When lithium goes back to the holes during discharging, the crystal structure became neat again. (The Nikkei, March 14, 2016)

(2) H-one

On March 15th, H-one, a car part manufacturer for Honda, announced that it started production of a metal separator to constitute a FC. This product is for Honda's FCV "CLARITY FUEL CELL" and is produced at the Maebashi Factory. Production of separator requires precise metal processing technology, and the firm decided to make FC parts by using own technology. Separators are placed between membrane electrode assemblies, MEAs, which generate current by chemical reaction of hydrogen and oxygen, to let hydrogen, oxygen and electrons go through. Manufacturers of separators are required to be capable of making thin products with superfine holes. The firm works on car body parts for Honda, and the separator production uses the technologies built from the experience of automobile part. (The Nikkei Business Daily, March 16, 2016)

8. Hydrogen Refueling Station Element Technology Development & Business Plans

(1) Iwatani

On February 22nd, Iwatani announced that the first hydrogen refueling station for Yamanashi Prefecture

was open in Kofu City. The station supplies FCVs with fuel in the prefecture located 1 km west from the Kofu Station. Hydrogen is transported from Iwatani's liquid hydrogen production center in Chiba by lorries. The refueling station is installed with liquid hydrogen tank which can fully fill 300 vehicles of Toyota's FCV "MIRAI", and can supply six FCVs/hour. The hydrogen sells for ¥1,100/kg. (The Nikkei Business Daily, February 23 2016)

Iwatani, the largest hydrogen gas supplier in Japan, will increase its number of hydrogen refueling stations for FCVs to about 30 locations, 10 locations more, by March 2017. The investment is likely to go maximum ¥3 billion. Focusing on preparation in regional urban areas, the firm will prepare filling facility in Sendai City which is to be the first one in the Tohoku area. Since FCVs are still in the launch stage, hydrogen refueling stations are not frequently used. However, the firm will make an upfront investment expecting market expansion. As well as Iwatani, other operators such as JX Nippon Oil & Energy are preparing hydrogen refueling stations, and the number of the stations is expected to be around 80 locations by the end of 2016. Nevertheless, the locations of these facilities are concentrated in large urban areas such as Tokyo and Osaka. Mr. Masao Nomura, the president of Iwatani, says that "they want to expand the refueling network to expressways and transit points of urban areas." The firm is considering installation in Okayama Prefecture. Once these facilities are prepared in every several hundred kilometers, FCVs can drive easier in regional cities which have fewer FCVs in use. Also this makes FCV users in large urban areas easier to drive long distance. Toyota and Honda released FCVs, but the number of the vehicles is limited. The usage rate is 10 vehicles each day even for relatively used hydrogen refueling stations. Still, Mr. Nomura believes that hydrogen energy will be in demand more and more by coming hydrogen society, and the firm intends to continue aggressive investment. (The Nikkei, March 12, 2016)

(2) Taiyo Nippon Sanso

Taiyo Nippon Sanso, the largest industrial gas producer in the Japanese gas market, will accelerate business of hydrogen refueling station package. Their hydrogen refueling station package "Hydro Shuttle" has been commercialized, and is armed with its attractive price which is a half of that of conventional product for competition. The firm targets gasoline distributers, suppliers of natural gas or oil for the product sales. The package requires minimized space of 9 m x 2 m floor area and 2.5 m high, and can be installed on a vehicle for mobile station. As stationary facility, the product works as off-site production station which supplies cars with hydrogen transported from production facility. (Dempa Shimbun, February 24, 2016)

(3) JX Nippon Oil & Energy

The first hydrogen refueling station at large commercial facility has been open in Japan. On February 23rd, JX Nippon Oil & Energy and IKEA Japan, a furniture retailer, installed a mobile hydrogen refueling station for FCVs on the premises of "IKEA Kohoku" a superstore of furniture and home accessories in Yokohama City. JX aims to make hydrogen refueling station known more by preparing the equipment at the shop. (Nikkan Jidosha Shimbun, February 24, 2016)

On March 4th, JX announced that a hydrogen refueling station started operation in Fushimi-ku, Kyoto City. Being an off-site facility, the station does not have production equipment, and the installation cost is estimated about ¥500 million. This is the first hydrogen refueling station operating in Kyoto Prefecture. The firm operates hydrogen filling facilities at 23 locations including the new one, and will expand the locations to 40. The station is about 300 m^2 in size, and is installed in an established refueling station for combined operation. The refueling station can fill a FCV in about three minutes. The hydrogen fuel price is ¥1,000/kg excluding tax. The opening hour is 9:30 am to 5:00 pm on weekdays. "We want to back up FCV promotion." Mr. Hiroya Nishijima, a director of JX, said. (The Nikkei, March 5, 2016)

(4) The Japan Steel Works

The Japan Steel Works has developed a small hydrogen station package unit allowing a significant reduction in initial investment. Steel accumulators and small diaphragm compressor are packaged in a compact unit for hydrogen refueling stations. Hydrogen compressing ability is 55 Nm^3/hour, and the size is a fifth of that of common products for hydrogen

refueling stations. The manufacturer commercialized the new unit at a low cost for FCV promotion to contribute to hydrogen infrastructure preparation. For the launching phase of FCVs, the unit highly compresses hydrogen gas and stores in accumulators, and achieves hydrogen supply in a short time for one FCV per hour. Once the FCV market is fully fledged, units can be moved or added. The package consists of three accumulators of 300 L hydrogen capacity, peripheral equipment and option space as well as two-stage diaphragm compressor. By enclosing accumulators and compressor in a package, the product is made for compact size of approximately 13 m^2 installation area (2.9 m wide and 4.4 m deep). (The Chemical Daily, March 8, 2016)

(5) Nippon Steel & Sumikin P & E

Nippon Steel & Sumikin Pipeline & Engineering, Nippon Steel & Sumikin P & E, completed production of commercial hydrogen refueling station, and has delivered to JX Energy which ordered the product. The filling facility was added to Dr. Drive Self Shiomikoen, Koto-ku of Tokyo, which is operated by ENEOS Frontier, a subsidiary of JX. This is the first commercial hydrogen refueling station project for Nippon Steel & Sumikin P & E. The station consists of a compressor, accumulators, chiller and dispenser. The floor area is 1057 m^2. Being an off-site system, facility uses compressed hydrogen transported from production plant to supply FCVs. The supply capacity is 300 Nm^3, and filling pressure is 70 MPa. The pressure works for the tanks of FCVs which are currently available in the market. 70 MPa (full tank) is the international standard, and it takes three minutes to fill a FCV. (The Nikkan Kogyo Shimbun, March 21, 2016)

9. Hydrogen Measuring and Safety Technology Development

Panasonic has developed an ultra violet (UV) sensor to detect flame at a hydrogen refueling station. The manufacturer improved detecting accuracy of UV to avoid mistakenly reacting to sunlight. Each hydrogen refueling station is required to install a flame sensor, and the firm tries to catch the demand. When hydrogen catching fire, a sensor detect flame of hydrogen which is colorless and difficult to find. The firm started the sales of new product at ¥500,000. The price is slightly lower than conventional UV sensors. The new product can detects "UV-C" which is a specific UV wave coming from flame in 0.5 seconds at the fastest. UV-C in sunlight is captured at the ozone layer, and does not reach the ground. The size of the product is 7 cm diameter and 3 cm high. The sensor can detect a flame of a cigarette lighter in 5 to 10 m distance. The product is explosion proof for hydrogen refueling stations to withstand blast. As well as refueling stations, the firm aims to sell the product for waste disposal sites. Hydrogen refueling stations are required higher safety standards. As FCV and hydrogen refueling station to expand their market, highly precise safety devices at low costs have started to be in demand. The firm developed the new sensor to catch the demand. (The Nikkei Business Daily, February 23, 2016)

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