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METI Facilitates a Hydrogen Energy System by Using Surplus Electricity from Solar and Wind Power Generation

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1. Governmental Measures

(1) METI

The 2016 initial total budget of the Ministry of Economy, Trade and Industry (METI) is expected to increase by 13% or 1.28 trillion yen compared to 2015 in total amount of general account budget and special account budget for energy measures. On December 21, METI proposed the budget to the economic and industrial subcommittee of the Liberal Democratic Party. The budget includes 27.9 billion yen increased approximately 2.3 times from the previous year for actualization of hydrogen society including FCV introduction support. (The Nikkan Kogyo Shimbun, December 22, 2015)

On January 9, METI decided to change a policy as providing preferential treatment for a purchase subsidy to EV or PHV rechargeable at home for a longer running distance on a single charge. The policy will be implemented from April. Although the amount is determined on the basis of price difference with gasoline-powered vehicle, METI aims to accelerate a popularization of the vehicle types with superior environmental performance. It also plans to enhance a maintenance support for charging points. Clean diesel vehicle and FCV also maintain the current standards even after April this year. (The Denki Shimbun, January 10, 2016)

METI develops a system to produce hydrogen by electricity from surplus renewable energy. It plans to nationally expand a hydrogen storing structure for the time of surplus electricity (e.g. solar power electricity) and utilizes such energy as fuel of FCV and power station. The plan leads to a reduction in emissions of greenhouse gas by effectively utilizing solar or wind power electricity as a weather-depending electricity production. METI will discuss a policy through "Hydrogen and Fuel Cell Strategy Council" with the participation of Tokyo Gas and Chiyoda Corporation to actualize such plan and then plan to make the demonstration in the next year. In the demonstration, it produces hydrogen from water at a water electrolysis facility by using electricity over 1,000kW generated by photovoltaic power station and wind power station. The hydrogen will be stored in tank. According to METI, it will be the first demonstration in business at a large-scale facility over 1,000kW. It temporarily carries the hydrogen to a nearby hydrogen ST by tank truck and utilizes it as fuel for FCV, but in future, it will be used for power generation of mixed hydrogen combustion as mixing hydrogen in thermal power generation to reduce greenhouse gas emissions or used as fuel for FC electric generation. METI would like to expand the structure to other locations in future. Since renewable energy such as sunlight and hydrogen do not produce greenhouse gases at the time of electricity generation, they can be prospective energy as countermeasures against global warming. Yet electricity amount generated by sunlight and wind may fluctuate depending on weather so there is a concern for electric power failure when electricity amount would largely exceed or fall against demand. Since the introduction of an electric power fixed price purchase system in July 2012, the number of easily-built solar power generation facilities with higher purchase price has rapidly been increased. 5 companies including Kyushu Electric Power Company temporarily stopped to purchase renewable energy due to a possibility of electric power failure. METI will make adjustment of electricity amount by storing hydrogen which is converted from surplus electricity when electric power generation by sunlight or other sources may largely be increased. By subsequently using such hydrogen for automobile and electric power station as fuel, it aims to utilize renewable energy without any waste. The issue will be cost as requiring several hundred millions of yen for initial investment to install water electrolysis apparatus and also another cost for hydrogen storage and transportation. Hydrogen supplied to FCV is traded as 1,100 yen/kg, but it

would be difficult for the price to be lower when using renewable energy. METI will support corporate research & development for technical innovation such as transportation and storage of hydrogen. It aims to lower the cost through such multiple approaches simultaneously. (The Nikkei, January 12, 2016)

(2) MLIT

The Ministry of Land, Infrastructure, Transport and Tourism adopted 6 companies (total 10 vehicles) as subsidiary agency of "Environmentally-friendly local transportation services" to introduce EV or FCV for companies in transport business. For instance, 1 EV taxi for Musashino Jidosha Kotsu (Koganei City, Tokyo), 3 PHV taxis for Nihon Taxi (Gifu City), and 3 EV taxis for Hinomaru Limousine (Bunkyo-ward, Tokyo). The Ministry subsidizes 1/3 to half of costs including charging facility for company with introduction of EV, PHV, or FCV. (Nikkan Jidosha Shimbun, December 28, 2015))

2. Local Governmental Measures

(1) Saitama Prefecture

On December 21, Tsukishima Kikai Company and Saitama Prefecture announced a collaborative research for practical application of hydrogen production technology with use of digestion gas generated from sewerage treatment plant. A demonstration facility with hydrogen production capacity 8～10$Nm^3$was constructed at Takasaka purification center in Higashi Murayama City. The center demonstrates quality and usage of hydrogen produced by use of digestion gas in the facility. The research term will be until 2017 and the agreement on collaborative research has been concluded recently. Digestion gas generated during the treatment process of sewage sludge is flammable gas with principal component of methane and also expected to be used efficiently as one of the renewable energies contributing to global warming countermeasures. Construction for the demonstration facility will start from August 2016 in the land 200m^2 on the premise of the center. The facility will be constructed by end of November in the same year and a demonstration test will be conducted by March 2018. In the demonstration test, digestion gas generated at the center is purified and then concentration performance is confirmed while the facility produces hydrogen from purified digestion gas and examines to secure hydrogen quality satisfying a fuel specification for FCV fuel. It also plans to conduct a usability research for hydrogen. (The Chemical Daily, December 22, 2015)

(2) Kyoto Prefecture

Kyoto Prefecture finalized its medium-term plan for FCV popularization. It will exempt taxes such as automobile tax to make potential buyers purchase PCV more easily. It aims to facilitate and popularize environmentally-superior FCV through public vehicle and utilization of event. It also plans to introduce 20,000 FCVs in Kyoto until 2025. For popularizing FCV, Kyoto will attempt to extend a limited term from 2016 to 2017 and beyond for the ordinance of automobile tax exemption for Eco-car (ecologically friendly car). Hydrogen ST will be installed at 2 sites in Kyoto City within this year and the number will be expanded to 16 sites until 2025 by installing one hydrogen ST per 20-30km range. (The Nikkei Business Daily, January 8, 2016)

3. FC Element Technology Development & Business Plans

(1) Fuji Electric

Fuji Electric Company acquires German N2telligence. It is a venture company with a technology to reduce oxygen from room by using FC and also achieves to prevent fire incidence such as at warehouse of luxury automobile and data center. The company will purchase 70% of the equity from investment companies and the founder of N2telligence until end of January. The amount for acquisition will be approximately 1 billion yen. Fuji Electric Company wishes to expand the sales of FC manufactured at its own factory and eventually reduce a production cost. N2telligence was founded in 2006 and currently holds an exclusive right to use the FC related-patents owned by Airbus. Since FC generates electricity by reaction of hydrogen in city gas and oxygen in the air, it creates an environment with less fire occurrence by reducing room oxygen concentration. Fuji Electric Company in going to send its employees after the acquisition and currently plans to raise the sales of N2telligence from annual 1～2 hundred million yen to over 5 billion yen until 2018. The company also develops the demand in South Africa as a production country of catalyst. (The Nikkei, January 5, 2016)

4. Hydrogen Infrastructure Development & Business Plans

(1) Dainichi

Dainichi Company developed a prototype of fan heater with use of hydrogen as fuel. Because hydrogen generates clear/colorless flame due to a molecular structure without carbon and also generates water by combustion reaction, the

characteristic of hydrogen heater can be described as moist warm air with high water content. The government precedes various policies for an actualization of hydrogen society, but currently equipments for hydrogen are limited only to ENE-FARM and FCV. For that reason, the company aims to make a contribution to actualize such society by proposing a new way of hydrogen usage such as heating equipment. The company is the No. 1 manufacturer or has approximately 50% market share for kerosene fan heater in Japan. (The Nikkan Kogyo Shimbun, December 22, 2015)

(2) Toyota Industries

Toyota Industries Corporation developed a technology for efficiently changing reflector-collected sunlight to heat in collaboration with Japan Fine Ceramics Center. The normal heat utilization at 400℃ or lower can be increased up to 650 ℃. The company explained that ammonia and hydrogen can be produced without use of fossil fuel. It is a successful accomplishment by "Strategic innovation creative program" of Cabinet Office. The company will develop a test production system for key parts and examine a production capacity for ammonia and hydrogen until 2018. It is a structure to collect heat by intensively shedding sunlight on pipe-like parts called a heat absorbing tube through reflecting sunlight with a rain gutter-shape mirror. Heat absorbing tube is structured as placing metal tubes in a glass tube. The company achieved to reduce the amount of sunlight reflection on the glass surface by SiO_2 coating as much as possible. It also developed a film consisting of sunlight absorbing layer and heat trapping layer by using semiconductor materials for covering a metal tube. (The Nikkei, December 28, 2015)

(3) Sugino

Sugino Machine (Toyama Prefecture) plans to expand its hydrogen energy-related business. The company applies its core technology to the business; mainly a unique high-pressure hydrogen technology as water jet. It accelerates a development of related technologies and devices such as for hydrogen ST and FC. The company started a collaborative research with Professor Matsubayashi from the Department of Information and Computer Science, Kanazawa Institute of Technology. He has rich business knowledge for hydrogen-related business as participating a FC research & development overseas. The company applies know-how gained from the development or delivery of various devices for hydrogen-related fields. It has already experienced an actual delivery of pressure resistance testing machine to Hydrogen Energy Test and Research Center (Fukuoka Prefecture) and the machine has been utilized for durability/safety assessment of hydrogen tank so far. In addition, the company proposes cutting/cleaning machine for hydrogen-related parts by water jet in the hydrogen-related field. (The Nikkan Kogyo Shimbun, January 6, 2016)

(4) Iwatani

On January 7, Iwatani Corporation announced to increase its production capacity of liquid hydrogen by 25%. The company constructs one additional liquefaction plant of hydrogen gas for the affiliated company in Yamaguchi Prefecture and plans to operate it in November 2017. The company will construct one additional liquefaction plant of hydrogen gas for the affiliated company in Yamaguchi Prefecture by the investment of approximately 4 billion yen and plan to operate it in November 2017. Demand for liquid hydrogen has recently been increasing due to the demand by rocket fuel and semiconductor manufacturing. The company decided to increase the production because it expects an increase in demand of liquefied hydrogen when FCV popularization is progressed further. The production increase will take place at "Yamaguchi Liquid Hydrogen (invested by Iwatani Corporation 65% and Tokuyama 35%)". Yamaguchi Liquid Hydrogen purchases hydrogen from Tokuyama and produces liquid hydrogen by refrigerating it. The total supply capacity of liquid hydrogen by Iwatani Corporation will be increased to 15,000 L/h by constructing another new plant with additional production capacity of 3,000L/h liquid hydrogen. Iwatani Corporation also produces liquid hydrogen in Sakai City (Osaka) as well as Chiba and Yamaguchi Prefecture. The company expects that hydrogen demand in 2025 would be increased by 16 times compared to the present level through FCV popularization on a full scale so it will continuously plan to invest in additional production in future. (The Nikkei Business Daily, January 8, 2016)

5. ENE-FARM Business Plans

(1) Osaka Gas

Osaka Gas announced the household electricity retailing rate starting in April, the next year. On December 25, Osaka Gas announced the household electricity retailing rate starting in April, the next year. The company will offer a discount in combination with gas contract. The discount range will be expanded by a long-term contract for 2 years. It offers a special price for household adopting ENE-FARM

as domestic-use FC. (The Nikkei, December 26, 2015)

(2) JX Nippon Oil & Energy Corporation

On December 25, JX Nippon Oil & Energy Corporation announced to transfer the sales operation of ENE-FARM to its affiliated company from April, the next year. ENEOS Globe as a LP gas wholesaler and Japan Gas Energy will purchase and sell the product. Yet, a new energy company of JX Nippon Oil & Energy Corporation will be selling the product until end of March. (The Nikkei Business Daily, December 28, 2015)

(3) Sekisui House

Sekisui House will promote Zero Energy House (ZEH) and construct 80% of newly-built houses as ZEH by 2020. It also facilitates a renovation to actualize a comfort & ecological life for existing houses. The company introduced and sold the ZEH applied products "Green First Zero", then the popularization rate shows 60% in 2014, and 74% in 2015 (the first half) for newly-built houses. High heat insulation property, energy-saving equipment, adoption of solar power generation, and domestic-use FC will be important to facilitate ZEH and the company has already adopted the accumulated total of 37,000 equipments. The company plans to actively adopt a multiple layered-vacuum glass for improvement on heat insulation property in 2016. (The Chemical Daily, January 6, 2016)

6. Cutting Edge Technology of FCVs and EVs

(1) Panasonic

Panasonic will construct a battery plant for EV in China. The total investment will be 50 billion yen. The company seeks an operation in 2017 through collaboration with local companies. The Chinese government actively supports popularization of Eco-car with superior environmental performance due to the serious air pollution. Panasonic also proceeds a construction of battery plant in the US so the company strengthens the business foundation further in two huge markets or the US and China with the expected growth. The company also constructs a plant in Dalian, Liaoning Province of Chinese northeastern region. The plant manufactures a square-shaped vehicle LiB for EV or PHV using engine accessorily while moving. Panasonic is the largest company for vehicle LiB in the world. The company operates a battery plant for computer, but this will be the first time to operate a plant only for vehicle battery. The annual production capacity is estimated as approximately 200,000 for EV. Eco-car as EV and PHV shows a strong demand in China. The country supports the popularization by providing maximum 55,000 yuan (approximately one million yen) per eco-car as purchase subsidy. A major government-owned automobile company Beijing Automobile and a major independent automobile company BYD Automobile have launched new cars for EV and PHV one after another in the market, and foreign automobile companies such as Nissan and Volkswagen are now shifting to a local production for those cars. In summer this year, a research company Fuji Keizai estimated the market expansion of EV and PHV in China as approximately 7.5 times or 650,000 vehicles in 2025 compared to 2015, but the market has been expanding even faster than expected. According to China Association of Automobile Manufacturers, the number of EV and PHV productions during January - November was rapidly increased by 4.4 times or 290,000 vehicles compared to the previous year. The association also mentioned, "The number will be exceeded to almost 350,000 vehicles in the full year of 2015". LG Chemical of South Korea or a No.3 company for vehicle LiB in China established a local factory in Nanjing in October , Jiangsu Province and actively sells the product to automobile companies. Panasonic is also planning to increase the supply to each automobile company by establishing a local production system soon. The company targets the annual sales 100 billion yen for vehicle LiB business in China. Furthermore, the company is now constructing a large LiB factory in the US as having invested total five billion dollars (approximately 600 billion yen) in collaboration with an EV venture company Tesla Motors. The factory will partially be operated in 2016 and plan to install the vehicle LiB in 500,000 EVs by 2020. On January 8, sources recently learned that Panasonic exclusively supplies LiB for low-models of EV (scheduled to launch in 2017) to Tesla Motors of the US. Both companies jointly invested in and plan to start the production at a battery factory (Nevada) in 2016. Tesla Motors gets a battery supply from LG Chemical for some vehicle types, but Panasonic will be a main supplier for the low-end models in future. On the same day, the executive of Tesla Motors told us at the factory in California, "The battery for the low-end model will entirely be supplied by the joint factory with Panasonic". LiB is a core parts and power source for EV. Panasonic invested approximately 30 billion yen to Tesla Motors. The company currently produces batteries at its factory in Osaka, Japan for Tesla's "Model S" as main automobile and "Model X" as sports type multiple-purpose vehicle. Although the

company did not reach an exclusive agreement, it has been actually supplying the entire quantity so far.
The purchase reservation for the low-end model "Model 3" will start from March, 2016. The company will suppress the vehicle price as half or approximately 35,000 dollars (4.1 million yen) while achieving travel distance of approximately 200 miles (320km) per charge or almost the equal distance of Model S. (The Nikkei, January 10, 2016)

(2) Suzuki

Suzuki steps forward for the practical use of motorcycle with FC as power source. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) plans to develop the world's first safety standards for FC motorcycle as early as January 2016 and Suzuki starts a public road experiment with approval from MLIT in the same year. FC is considered as an environmentally-powerful card and Suzuki attempts to establish a new business foundation through FC motorcycle while an automobile called MIRAI of Toyota gets public attention. Suzuki will manufacture FC motorcycle called "BURGMAN" by the joint company with a British venture company Intelligent Energy. A high-pressure small hydrogen tank is adopted for FC to be equipped in motorcycle. Firstly, the company manufactures a motorcycle equivalent to one with 120 cc class engine. The technology gained from downsized tank will be utilized in small-size automobile as Suzuki's area of expertise. Although MIRAI becomes popular, safety standards of motorcycle is not globally coordinated yet. MLIT will coordinate the specific safety standards of motorcycle such as collision or come-off of hydrogen tank at the time of wreck. Suzuki will manufacture the product after satisfying the standards and receiving a product type approval from MLIT. (The Nikkei, December 27, 2015)

(3) Mori Building

Mori Building widely introduces batteries for EV and PHV in parking lots at their own complex facilities such as Roppongi Hills (Minato-ward, Tokyo). On January 3 2016, total 394 regular battery chargers will be available at 3 facilities in Tokyo. Conventionally only a few units were installed in the past. It will lead and place importance on the visitor convenience when EV popularization progresses in future. 239 battery chargers will be installed at Roppongi Hills. The number will be the largest in Japan according to Mori Building. For other, the company also plans to introduce battery chargers to Toranomon Hills and ARK Hills (Minato-ward, Tokyo) as well. The charging fee will be 30 yen for the first 15 minutes and 2 yen per minute after that (tax not included). Among the facilities operated by Mori Building, a battery charger was installed at Roppongi Hills for the first time in 2011. Although only a few customers visit the charging places for EV at present, the company determined that those places would be supported by the national popularization policy in future. It estimates that 15-20% of all battery chargers will constantly be used in 2020. (The Nikkei, December 28, 2015)

(4) Honda

Sources recently learned that Honda enters the final stage of comprehensive partnership for Eco-car with GM. Both companies jointly develop only FCV at present, but the joint operation will be expanded to PHV as a main stream of the next generation Eco-car. The selling price can be lower if the companies jointly purchase parts instead of purchasing separately. Honda introduces the energy management technology at the booth of CEATEC JAPAN Implementation Council in 2016 International Consumer Electronics Show (CES) in Las Vegas during the period from January 6-9. The company proposes a structure where hydrogen is produced from renewable energy through "Smart hydrogen ST" with a high-pressure water electrolysis system (power creator), then electricity is supplied to houses and facilities by an external power supply device called "Power Exporter 9000" by using energy generated from FCV's "CLARITY FUEL CELL". (Nikkan Jidosha Shimbun, January 7, 2016))

(5) Sumitomo Seika

Sumitomo Seika Chemicals Company developed an adhesive material leading a longer operating life of LiB for EV. A battery performance can be extended by doubling a bonding strength for electrode member and also contributing to capacity enlargement. It aims to reach billions of yen in sales after 5 years. The company plans to develop battery materials as one of the main businesses following after the main materials of disposable diaper. The test production was already stared at the Beppu factory (Harima-town, Hyogo Prefecture). The battery materials plan to be used for EV and mobile phone in 2016. The exclusive mass-production line will be constructed as soon as the sales are increased. Powdered positive or negative-electrode material is glued on metallic foil for LiB's electrode to generate electricity. It was difficult to extend a battery life because the material might be peeled off from the electrode due to weak adhesiveness even after the material performance enhancement. (The Nikkei, January 5, 2016)

(6) Nissan

On January 5, Nissan announced to adopt a cloud service "Azure" of Microsoft (MS) for in-vehicle information system of EV "Leaf". By adopting the worldwide MS cloud service, the reliability and attractiveness of in-vehicle information system can be enhanced. Over 200,000 Leafs have been sold in the world so far. The company also adopts Azure for a part of in-vehicle information system in relation to a luxury brand "Infinity". Toyota and Ford have already adopted the MS cloud service for their in-vehicle information system. (The Nikkei, January 6, 2016)

(7) National Electric Vehicle Sweden (Nevs)

Nevs as a manufacturer of EV under the SAAB brand successfully received orders for EV in China one after another. The company concluded an agreement with a Chinese automobile leasing company to supply total 150,000 vehicles by 2020. It also supplies 20,000 vehicles to state-owned companies as well. Nevs aims to expand the business with the strong support by EV introduction in China. Nevs will also supply EV to a newly-established leasing company "Panda New Energy" in China. It concluded a service agreement for 100,000 vehicles in addition to 150,000 vehicles by 2020. The order reception amount is 78 billion yuan (approximately 1.47 trillion yen). Panda New Energy aims to become the largest EV leasing company in the world within 5 years. Nevs also supplies 20,000 vehicles to China Volant Industry, an affiliated company of China Aerospace Science & Industry Corporation as a large state-owned company in China. According to Chinese media, the order reception amount is 6.6 billion yuan. China Volant Industry will also cooperate in R&D, manufacturing, and sales of EV related parts. Nevs was established in 2012 when National Modern Energy Holdings as an environmental company based in Hong Kong acquired the former Saab's assets, and the company has announced to undertake businesses mainly in China. In 2015, it established a joint company manufacturing EV under the Saab brand in Tianjin, China. (The Nikkei, January 6, 2016)

(8) Popularization of ultra small EV

The popularization movement of "Ultra small EV" which can turn in a smaller radius and is more useful for short distance transportation compared to a light motor vehicle has been progressed in each region. It seeks for a usage of EV with 1-2 passengers as a lower environmental burden in accordance with local transportation needs such as for daily use, sightseeing area, and official job by administrative officer. A driver's license is required to drive an ultra small vehicle. 2 passenger-vehicles can be driven on public roads in specified area with permission from the Transport Bureau and the vehicle safety standards are now being examined. On November 30 in the last year, 5 ultra small vehicles were lined up in front of the city hall of Kamisato-machi, Saitama Prefecture. The town residents nervously rode on the cars, took the wheel, and quietly drove the cars on the road. Such demonstration experiment was started from that day in the town. It will collect opinions or voices from the residents while the cars are leased to the residents for approximately 3 months to study various usages such as shopping. Because of a poor public transportation and aging population, the town desires to gain a new transportation option for life improvement/convenience. The ultra small vehicles on lease are for 2 passengers and a user can drive the vehicle for approximately 60km by 8-hour battery charge. Mr. Matsumoto at the age of 73 was satisfied and told, "It was an easier drive than expected". The council consisting of towns such as Asukamura village of Nara with a scattering of historical heritages offers a rent-a-car service for tourists from 2014. It hopes that the tourists can efficiently drive around the traditional town where there are many narrow roads with different heights in mountainous areas. In Misatomachi of Miyagi Prefecture, staffs at the health and welfare center use the car as a public vehicle when visiting the elderly or household with children. The town decided to purchase the vehicle with the consideration of low maintenance cost. According to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), approximately 40 subsidized projects for introduction of ultra small vehicle were carried out nationwide by September 2015. MLIT plans to hold a symposium reviewing each project in this spring and the ministry's personnel stated, "The vehicle can variously be used depending on each local necessity. We would like to deeply discuss how we can establish a regular vehicle use in the region". (The Nikkei, January 7, 2016)

(9) Meitetsu

Sources recently learned that Meitetsu Taxi Holding (Nagoya City) plans to introduce 3 vehicles of Toyota FCV called "MIRAI" from end of this month. 2 vehicles will be used as taxi and 1vehicle will be used as a chauffeur-driven hired car. The taxi requires an advance reservation and the price will be approximately the same as regular taxis in Nagoya City Meitetsu has decided to adopt the vehicle after Toyota requested the company to collect the travel data. The

vehicle refuels hydrogen at a hydrogen ST in Atsuta-ward, Nagoya City. MIRAI has already been used as a taxi in Fukuoka from March 2015. (Nikkan Jidosha Shimbun, January 8, 2016))

(10) Hyundai

Hyundai Motor Company announced to launch a new vehicle type "IONIQ" as Eco-car. The company also plans to introduce 3 vehicle types as HV, PHV, and EV in this year. The company executive stated, "HV fuel efficiency will be better than a new Prius of Toyota" and showed a strong rivalry toward Toyota as a predecessor. Firstly, the company starts selling the vehicle in South Korea from January 14. The vehicle is equipped with 1.6 liter engine and LiB. The price will start from 23 million won (approximately 2.3 million yen). The vehicle will be launched in the US and Chinese market as early as October. The company attempts to enhance development efficiency by utilizing the same platform of HV for EV and PHV. Fuel efficiency was improved by reducing a vehicle weight with securing safety performance while using ultra-high tensile strength steel as tougher and lighter than iron and aluminum. The fuel efficiency for a new Prius achieves approximately 21km/L (city) as Toyota's measured estimation in accordance with the US Environmental Protection Agency (EPA). Hyundai did not present the fuel efficiency based on the US standard, but explained that the fuel efficiency in the company measurement exceeds the official numerical value of Toyota. The company has been sequentially introducing Eco-car for its existing vehicle types such as the main brand sedan "SONATA". It aims to raise brand awareness and increase sales by introducing the exclusive ecology vehicles into a market. Hyundai is currently selling 8 types of Eco-car in the market including the vehicles from the affiliated company Kia Motor Company. (The Nikkei, January 8, 2016)

(11) BYD

BYD Auto Company (BYD), a major automobile company in Guangdong Province of China, announced the upward adjustment of earning estimates in December, 2015. Net profit was increased by approximately 6.2-6.6 times or 2.68-2.85 billion yuan (approximately 48-51 billion yen) compared to the same period a year ago. The sales of EV were also increased. (The Nikkei, January 9, 2016)

(12) VW

While Volkswagen (VW) has been suffering on diesel vehicle sales by unlawful emission, major European automobile companies now accelerate for shifting to electric vehicles. Each company proceeds to develop a better travel distance for EV and also plans to launch a simplified type of HV at a lower price from this year. Because European Eco-cars are now available after diesel vehicles, the competition may become fierce with the Japanese automobile companies. The number of vehicles sold in the world by the Volkswagen group was 9.936 million automobiles or declined by 2% compared to the previous year. The company is presently under pressure to review its strategy. Mr. Herbert Diess as a top of VW brand automobile gave a keynote speech at the trade show for consumer electronics "CES" in the US, and presented the concept car of mini-van EV "BUDDY" as appealing "Initiate a new trend". This EV can travel 600km only by electric power source. The vehicle plans to be sold in market by 2020. It will be the first vehicle for a common platform called "MEB" that was developed for electrically-driven vehicle by VW through limited investment fund. It makes a mass-production easier by creating a common installation place for high-volume battery. The luxury automobile manufacturers under the VW group have already presented EV concept vehicles with travel distance 500km per charge. In December last year, Porsche decided to launch the vehicle by 2020 with the investment of one billion Euros (approximately 128 billion yen). Audi with a decline in investment could secure an investment fund for a new EV in 2018. According to European Automobile Manufacturers Association (ACEA), EV travel distance in the current condition is 160km in Europe. However, EV developed by the VW group travels more than 3 times compared to the distance. Daimler accelerates a cost reduction by self-manufacturing for vehicle battery technology. Yet since there might be some obstacles for popularization such as high battery price and delay in battery charge infrastructure, EV market share in Europe occupies only 1% or lower in a new car category. Thus, a full replacement for diesel vehicles will be a long way to go. (The Nikkei, January 10, 2016)

(13) BMW

The BMW President Harald Krüger stated to a German newspaper in December last year, "Diesel vehicle may not be economically-superior due to strict regulations. So electric vehicles will play a critical role". BMW plans to adopt PHV for all its vehicles. (The Nikkei, January 10, 2016)

(14) Tesla

At the end of 2015, a well-known business entrepreneur

Elon Musk breathed new life into the electricity industry. The EV manufacturer "Tesla" led by Mr. Musk started shipping stationary storage cell for the first time. He explained, "Solar power generation will be progressed the most in future. If a price of storage cell is lowered, it is possible to cover the world electricity by solar power generation". Mr. Musk foresees the future that over 30% of all electricity can be generated and consumed in local area along with a combination of solar panel and storage cell. This trend of dispersed power source would become a support for EV popularization. While a comparative price competition for EV has been disappearing due to fall in oil price, sales of EV in the US reached a new high in December 2015. The ratio of solar panel installation for house has been increased to approximately 1% of all households in the US. Many EV owners who prefer a lifestyle with renewable energy start installing solar panel at their house. Most of electricity consumption at the house will be covered by solar power generation during the daytime and the surplus electricity will be sold to an electricity company. On the other hand, EV can be recharged at home during a night by using inexpensive electricity supplied by electric power company. Because of a possible suppression of excess facility investment for a peak time, electric power company develops an ideal preferential plan for EV recharge at night. If price for storage cell is smoothly lowered as Mr. Musk promised in his statement, a large EV as well as stationary storage cell can become more valuable as an alternate power source due to storing surplus electricity in area with a higher-electricity price. If so, an advantage of EV could be more significant against FCV with the consideration of a next generation Eco-car. (The Nikkei, January 12, 2016)

(15) Toyota

The president Toyoda of Toyota Motor Company stated at a joint press conference with Nihon Keizai Shimbun and Financial Times (FT), "Gasoline engine played a main role for the past century in the automobile industry. Yet, various Eco-cars will grow in the next 100 years", and he also mentioned more development for PHV, FCV, and diesel engine vehicle. For other major automobile companies, Nissan and Daimler set a key Eco-car strategy as EV and FCV respectively. On the other hand, he cited "We will respond to the choice of consumers in each region while Toyota deals with a wide range of Eco-car technology by investing one trillion yen in research & development. (The Nikkei, January 12, 2016)

7. Hydrogen ST Element Technology and Business Development

(1) Honda

On December 25, Honda announced to install and operate a package type "Smart Hydrogen Station (SHS)" with the uniquely-developed high pressure hydrogen electrolysis system at the Wako headquarters building (Wako City, Saitama Prefecture). SHS will also be installed at the Aoyama headquarters (Minato-ward, Tokyo). SHS provides a packaged function for manufacturing/storing/filling hydrogen and the demonstration experiment has been conducted in cooperation with Iwatani Corporation, Saitama City, and Kita-Kyushu City. HONDA plans to start a lease-sale for FCV "CLARITY FUEL CELL" in 2016. SHS installed at the Wako headquarters building will be utilized for filling hydrogen to a company-owned FCV during the initial introduction stage, and then such operation will be expanded to Honda FCV owned by local governments and corporations in future. (Nikkan Jidosha Shimbun, December 26, 2015)

(2) Kobe Steel

Kobe Steel developed a compact heat exchanger (approximately 1/100-3/100 of conventional size) for hydrogen ST. The microminiaturization as well as a high cooling efficiency is enhanced by adopting a multi-layer structure as stacking stainless steels with microtrenches in layers. The technology is expected to facilitate an expansion of the hydrogen ST. The heat exchanger will be a device to cool down hydrogen temperature which is increased by pressure rising. Generally, a device using steel pipes with a few centimeters in diameter becomes standard, but some problems occur when a device becomes bigger and needs higher costs for construction burdensome and pipe arrangement. The newly-developed heat exchanger uses a flow passage through microtrenches with 1-2mm in width and also provides a multi-layer structure consisting of approximately 100 layers. It is a mechanism that hydrogen can be cooled down by alternately circulating hydrogen and refrigerant in flow passage. The company utilized a processing method called "diffusion bonding" to enhance durability in response to high-pressure hydrogen. It is a technique to bond steels together tightly without welding or steels can closely be bonded together at the atomic level by applying pressure with high-temperature heating. (The Nikkei Business Daily, January 7, 2016)

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A POSTER COLUMN

The Future Technology 2020: Hydrogen Supply Chain

It tracks an attempt to form "Hydrogen supply chain" for industries and households as one of the futuristic views by science & technology. Hydrogen is a fuel for large rocket and FCV. CO_2 will not be produced after it is burned. Kawasaki Heavy Industries and Iwatani Corporation transport hydrogen produced in Australia to Japan by tanker and pursue research & development for a supply plan to factories and households. Hydrogen is presently produced by natural gas, but hydrogen produced by inexpensive and low-quality "lignite" from coal field would be cheaper. Lignite occupies approximately half of coal and indicates a higher amount of deposit in Australia. Kawasaki Heavy Industries aims for ocean transportation of hydrogen. Hydrogen will be transported by its exclusive tanker after being frozen at -253°C. The company is presently developing the tank for such transportation. The structure is a shape of stretched sphere with diameter 10.5m and a huge thermos bottle with double-walled vacuum. The composite material made out of strong glass fiber and epoxy resin with insulation efficiency supports internal walls. The tank targets to hold evaporation amount as much as that of liquid natural gas (LNG). The transported LNG will be supplied to factory and hydrogen ST by a large tank truck. It is also supplied to each household by hydrogen cylinder or pipeline. The company plans to establish an ocean transportation technology for liquid hydrogen by tanker until 2020. Mr. Nishimura as the company executive stated, "Reduction in CO_2 emissions will be a future issue. We certainly would like to operate a liquid hydrogen tanker until the Tokyo Olympic Games". IWATANI Corporation developed a high-efficiency FC for household in collaboration with Toshiba. The company installed and operated FC with 700W for approximately 9 months in Shunan City, Yamaguchi Prefecture and successfully demonstrated to change 51-55% of hydrogen energy into electricity.

If heat can be used for hot-water supply, it is estimated to utilize the energy up to 95%. Since the current FC for household uses natural gas, energy is required to produce hydrogen. For that reason, the efficiency of electric power generation could be around 40%. The newly-developed FC indicates a higher efficiency due to use of pure hydrogen gas and does not generate CO_2 at all. The company plans to develop FC with approximately 5kW by 2017. J Power will undertake a technology development for producing hydrogen from lignite. The development collects CO_2 generated from production process and then buries it in the ground in cooperation with the Australian government. The company will finish the test for elemental technology in this year and then start developing the actual system. The technology in each process will be nearly ready by 2020. It is estimated that a demonstration experiment for the entire system will be started as early as 2020s. (The Nikkei, January 4, 2016)