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Experimental Hydrogen Production from Renewable Energy

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1. Governmental Measures

(1) MOE

On April 17th, the Ministry of the Environment (MOE) announced it had selected four proposals including the one from Air Water Plant & Engineering as regional cooperation and low-carbon hydrogen technology demonstration projects for FY 2015. This project aims to promote mid- and long-term counter measures for global warming through the application of hydrogen and low carbon technologies. The proposal of Air Water is to produce hydrogen from biogas derived from waste of livestock, and to transport it using a simple method using cylinders for stationary fuel cells (FCs) at facilities in a community. Lasting for five years, the experiment will be carried out in the community of Shikaoi-cho, Kato-gun of Hokkaido. (Japan Metal Bulletin, The Hokkaido Shimbun & The Chemical Daily, April 18 & 20, 2015)

MOE has started a subsidy scheme to promote refueling stations supplying hydrogen produced from renewable energy. The aim of the subsidy is to develop systems to install refueling stations to provide fuel cell vehicles (FCVs) with hydrogen created by renewable energy such as solar power and biomass power generation in a community. The ministry started taking applications this week. This scheme is a part of the "Promotion Project for Hydrogen Society Using Renewable Energy" which was newly started this fiscal year. The project will promote the installation of hydrogen refueling stations which are essential for FCVs by developing systems using hydrogen produced with regional resources and advantages. The subsidy scheme supports development of systems which includes facility installation to provide FCVs and FC buses with hydrogen produced at renewable energy plants such as solar power. The ministry will support three quarters each of the costs of hydrogen refueling stations and the construction up to ¥120 million. The budget is ¥570 million, and five applications are planned to be awarded. (The Chemical Daily, April 28, 2015)

(2) METI

The Ministry of Economy, Trade and Industry (METI) has reported predicted effects of energy saving measures to 2030. According to the report, the transport field can save the equivalent of 16.07 GL oil compared to the energy consumption of FY 2012 by promoting next generation cars and working on traffic. With energy saving measures in other fields, power demand in 2030 can be reduced by 17.1 % that of FY 2012. The ministry will use the estimate to decide the constituent ratio of power. The estimation was calculated with the penetration rate of 29% of hybrid vehicles (HVs), 16% of electric vehicles (EVs) and plug-in hybrid vehicle (PHVs) combined, 1 % of FCVs and 4% of clean diesel cars. The calculation determines 9.389 GL of potential energy saving taking improvement of fuel efficiency of internal-combustion engines into account. (Nikkan Jidosha Shimbun, April 24, 2015)

METI will intensively promote five fields such as next generation cars and an environmentally friendly city for the 2020 Tokyo Olympics. The Olympics will attract visitors and investors from all over the world, and will be used to advance technologies and improve the environment. "Working Group for 2020 Future Development" will be organized with experts in July to produce measures for each field. The measures will be implemented in cooperation of the industries by the Olympic Games. As a next generation field, for example, automatic driving system will be promoted for commercialization alongside of promotion of EVs

and FCVs. Data development for a better electricity payment system for businesses to sell their excess energy will be investigated as a measure of an environmentally-friendly field. The working group will carry out required actions for preparation to attract investors worldwide. An evaluation will be carried out after the Olympics by the group which will be disassembled at the end of FY 2021. (The Nikkei, April 27, 2015)

2. Local Governmental Measures

(1) Osaka Prefecture

On April 21st, Osaka Prefecture and Osaka Gas opened a commercial hydrogen refueling station for FCVs in Ibaraki City, which is the first one for the prefecture. The facility produces hydrogen from natural gas on the premises, and the first on-site production hydrogen refueling station in Japan. The advantage is that it can send hydrogen to other refueling stations, and will supply the station that Osaka Gas plans to open in Kyoto City. Being invested between ¥500 and 600 million, "Kita-Osaka Hydrogen Station" was installed in an established natural gas refueling station operated by the utility firm which is located in a piece of 1,700 m^2 land owned by the prefecture. The facility can supply six FCVs with 300 m^3 of hydrogen in the standard conditions of 0 °C. Hydrogen sells for ¥1,100/kg excluding tax, and users will pay by credit card. The commercial operation started on 22nd, and the business hours are 9 am to 5 pm on Monday through Saturday. Osaka Gas developed highly efficient hydrogen production equipment "HYSERVE-300", and the facility uses the first one for its supply. Mr. Takehiro Honjo, the president of Osaka Gas, and Governor Ichiro Matsui attended the opening ceremony on the day. (The Nikkei, April 22, 2015)

(2) Tokyo

On April 28th, Tokyo revealed its plan to introduce "articulated buses" which use hydrogen as the fuel, and have double the capacity of a normal bus to be installed as a part of bus rapid transit (BRT) in FY 2019, which is a new public transport system connecting the Rinkai area and the central Tokyo. The bus stops will be prepared in the same way as tram stops, and will display real-time traffic information. This measure is included in the basic plan developed by the council of advisers of Tokyo. The articulated bus is two bus carriages with a pleated connection in its middle with a length of approximately 18 m, and takes 140 passengers. According to the local government, this is to be the world first articulated FC bus, and the development has been requested to a manufacturer. The introduction is "expected to be after the 2020 Tokyo Olympics, though depending on the development". (The Sankei Shimbun, April 29, 2015)

(3) Kanagawa Prefecture, Yokohama City & Kawasaki City

"Hama-Wing", a wind power generator of Yokohama City, will be used in a project to investigate low-carbon hydrogen production and full-scale use from this fiscal year. The project will be carried out in cooperation of Toyota Motor, Yokohama City, Kanagawa Prefecture and Kawasaki City. In the project, hydrogen will be produced by electricity generated by Hama-Wing, and FC forklifts will use it at warehouses to investigate problems and solutions. This project is an advanced experiment for hydrogen society. (Kanagawa Shimbun, May 5, 2015)

3. FC Element Technology Development & Business Plans of FCs for Business Use

(1) Toshiba

On April 13th, Toshiba Fuel Cell Systems, Yokohama City, announced that its pure-hydrogen FC system started an experimental operation at "Iwatani Hydrogen Station Shibakoen" in Minato-ku, Tokyo. This FC system uses hydrogen as fuel, and supplies electricity and hot water without producing CO_2. It also eliminates the need of a reformer to extract hydrogen from natural gas which is used as fuel for home FC systems, and can be installed in a smaller place. The results of the experimental operation will be used for further development of the system. Toshiba FC Systems aims to increase the generation efficiency of the FC unit to 55 % after FY 2015. The FC system uses a hot water unit which is designed for Ene-Farm produced by Chofu Seisakusho. A dedicated auxiliary boiler of the hot water unit will be developed for hydrogen fuel. (The Denki Shimbun, April 14, 2015)

(2) Fuji Electric

In FY 2015, Fuji Electric will deliver over 15 units of

non-domestic FCs, which gives a record high in two consecutive years. The feed-in tariff (FIT) scheme for renewable energy is backing up FC sales, and more sewage treatment works have been considering using FCs. The manufacturer aims for continuous growth from FY 2014 with a target of over 30 units for FY 2015. Although the majority of sales are FCs for homes in the Japanese market, non-domestic FCs look like taking off as the public moves towards a hydrogen society and uses more renewable energy. Only Fuji Electric produces and sells non-domestic FCs for cogeneration systems for office buildings as a Japanese manufacturer. The total delivery including oversea sales of Fuji Electric was 48 units as of the end of FY 2013 with an annual pace of six to eight units. Since a FC system for sewage treatment was established and demand has started to increase, the manufacturer delivered 15 units in FY 2014 and orders were placed for 30 units, which is a large leap. Under FIT, utility firms buy electricity generated by hydrogen which is produced from biogas coming out of sewage treatment process. Metawater, an affiliate of Fuji Electric, uses FCs from Fuji Electric for its power generation business for sewage treatment, and installed 10 power generation systems at four sewage treatment works in FY 2014. (The Nikkan Kogyo Shimbun, April 15, 2015)

(3) Gifu University

A research group of Associate Prof. Kayako Hirooka and Specially-Appointed Assistant Prof. Osamu Ichihashi at the River Basin Research Center of the Gifu University succeeded to generate power and phosphorus from livestock waste water, including pig waste using a microbial FC system. The microbial FC system treats waste water at same time, and collected phosphorus can be used for a material for fertilizers. According to the group, this is the first time phosphorus has been collected by a microbial FC in the world. Microbial FCs generate power using electrons released when microbes digest organic matter. An anode and cathode are placed in a cell. Once the cell is filled with waste water, microbes break down organic matter, which separates electrons. Then electrons flow into the electrode. The group focused on the fact that waste water become alkaline around cathodes. This is an advantageous condition to create the compound magnesium ammonium phosphate (MAP). They used actual waste water from a pig farm for their experiment, and proved MAP crystals had been produced around the electrode as a phosphorus collection. The issues for commercialization are scaling-up and reducing costs. "This system adds a function of capturing phosphorus to an energy saving waste water treatment." says Associate Prof. Hirooka. She aims to develop the system including generation function at a commercial level as their final target. (The Japan Agricultural News, April 29, 2015)

(4) Kyocera

Kyocera is trying to create a "new form" of environment and energy business. As an action in the FC related area, a FC system is planned to be developed using expertize from their experience of cell stack production, and to be introduced into the market. The firm supplies cell stacks for a domestic solid oxide fuel cell (SOFC) system available since 2011, and carries out research and development of its own industrial SOFC. An experiment is planned to start in this term. They aim to bring the product out for apartment houses and commercial facilities in FY 2016. (The Chemical Daily, May 1, 2015)

(5) Miura

Miura will commercialize SOFC as quickly as possible. A cell stack is under development in cooperation of Sumitomo Precision Products, and both firms are working on commercialization of 5 kW level SOFC. Their aim is 48 % generation efficiency and a market introduction of the product by FY 2017. They will promote the product as an independent cogeneration system to provide electricity and heat to be used by a wide range of facilities such as restaurants, cafés, apartments and small-scale factories. Miura is currently developing SOFC using component production technologies and advanced technologies and devices to use fuel gas and waste heat gained from its boiler business. Sumitomo Precision Products is working on the cell stack, the generator, and an experiment is carried out as a joint project. The target specifications are 4.2 kW generation capacity, 48.0% of generation efficiency and 3.7 kW of waste heat recovery for a 60°C hot water supply. Heat is to be recovered as hot water, which is expected to give a combined efficiency of 90 %. The unit size is expected to be 500 mm by 1,000 mm by 1,500 mm. (The

Chemical Daily, May 8, 2015)

4. Hydrogen Infrastructure Development & Business Plans

(1) KHI

Kawasaki Heavy Industries (KHI) will work on development of hydrogen combustion technology. Their development will be a hydrogen gas turbine for power generation and a large hydrogen combustion engine for transportation ships, and they aim to establish an efficient generation system with reduced NOx production. These products burn a large amount of hydrogen, and this kind of usage is essential to bring the hydrogen price down. The firm aims to develop a hydrogen supply chain using a liquid hydrogen carrier, and the development of hydrogen combustion technologies are an important part of the chain. The Cabinet office has promoted the Cross-ministerial Strategic Innovation Promotion Program (SIP), and KHI leads a hydrogen combustion technology development of the energy carrier project. The development is carried out in cooperation of Mayekawa MFG, the Tokyo City University, the Okayama University, the National Institute of Advanced Industrial Science and Technology (AIST) and the National Maritime Research Institute. (The Chemical Daily, April 14, 2015)

Liquid hydrogen production is planned on the volcanic island of Iojima, Kagoshima Prefecture using geothermal generation. KHI and Obayashi Corporation will carry out a drilling survey for construction of an experimental plant this fiscal year. Hydrogen energy is planned to be used at the athlete village of the 2020 Tokyo Olympics and Paralympics, and the firms aim to commercialize the technology by then. The typical production method of hydrogen is electrolysis, and uses fossil fuel such as oil as a power source. Since this production creates CO_2, the CO_2 reduction effect of hydrogen energy systems still needs to be improved. To solve this, KHI has planned to produce hydrogen using geothermal power. Iodake is a 703 m high active volcano located in north east of Iojima, which caught the eye of KHI. A number of fumaroles are found around the top, from which erupts high temperature volcanic gas, at about 900 °C, on a steady basis. According to KHI, this gives easy access to high temperature volcanic gas without drilling a deep hole like common geothermal generation plants in Japan. Their plan is to boil water using volcanic gas to create steam to operate a turbine for power generation. Desalinated sea water is to be used for hydrogen production. Hydrogen is to be refrigerated to -253 °C to liquefy for storage in a tank for ferry transport in a container to outside the island. Basic data has been collected in Iojima since FY 2013, and the research shows that 18 tons of liquid hydrogen can be produced each day. This can supply 3,600 FCVs with fuel. In this fiscal year, the drilling survey will be carried out, and these firms aim to start constructing the experimental plant in FY 2016 at the earliest. (The Yomiuri Shimbun, April 21, 2015)

(2) Council for Very-High-Temperature Reactor

A council will be launched in cooperation of the industry, academia and government this month to compile a strategy to commercialize a very-high-temperature reactor (VHTR), a next generation nuclear reactor, and consist of 26 organizations including Toyota Motor and Nippon Steel & Sumitomo Metal. As well as manufacturers of nuclear reactors and fuel producers, automakers will add a user view of hydrogen which is to be produced by VHTR. The council will investigate usage, expansion of usage to overseas, process of research and development and a roll for each organization. Their investigation is to be reported by the end of this year. This investigation could potentially launch development of a system which uses a next generation nuclear power and realizes hydrogen society at same time. The participants are manufacturers of nuclear reactors such as Toshiba and Mitsubishi Heavy Industries (MHI); automakers such as Toyota and Nissan which aim to realize a hydrogen society using FCVs as the key; Iwatani, a hydrogen refueling station producer; JGC Corporation and Chiyoda Corporation, hydrogen plant producers; universities and related governmental organizations. The VHTR to be commercialized by 2030 is a characteristically safer nuclear technology which is expected to utilize heat in various forms such as hydrogen production. The reactor uses 0.9 mm diameter sphere-shape fuel covered with ceramics which withstands over 1,600 °C. The fuel is placed in a structural material of graphite which can stand 2500 °C. The graphite structural material will absorb heat and release heat

to outside the pressure vessel when a cooling system fails like the accident at Fukushima Daiich of Tokyo Electric Power Company (TEPCO). The fuel temperature does not reach 1600 °C, and the core does not melt down. Helium is used as a cooling material to remove heat of nuclear reaction due to its nature as a less reactive element, which eliminates the potential of hydrogen explosions. This element is also stable at high temperatures, which allows production of high temperature 950 °C heat. This heat is planned to be used for power generation and hydrogen production by thermal decomposition at the same time. This technology is expected to contribute to building hydrogen society by preparing a system to stably supply high quality hydrogen at reasonable prices. (The Nikkan Kogyo Shimbun, April 20, 2015; The Denki Shimbun, May 7, 2015)

(3) Toshiba

On April 20th, Toshiba announced that an experimental operation of a hydrogen production and storage system for FC power generation started in Kawasaki City. This system has an advantage of "use of locally produced energy" from hydrogen production to power generation completed in a community, and will be used as an emergency power or supplemental source for very hot days. Water is electrolyzed by solar power to produce hydrogen to be stored in a tank. Then, the FCs generate power as required. The advantage of this system is that no CO_2 comes out all the way through the hydrogen production to power generation. Mr. Hisao Tanaka, the president of Toshiba, emphasized that "this is a large step towards realizing a hydrogen society". This container-type "H2One™" was installed at a facility near the port of Kawasaki. Although conventional FCs use hydrogen extracted from natural gas creating CO_2, this Toshiba's system does not emit CO_2. As an emergency power source, it can supply power and hot water for 300 people for a week. The firm plans to commercialize the system by September aiming to sell it as an emergency power source to local governments and railway companies. Their target for the first year is 50 units. The initial cost is expected to be two thirds of that of a large-scale storage battery. (The Nikkei, April 21, 2015)

5. Cutting Edge Technologies of FCVs and EVs

(1) Toyota

Toyota Motor released FCV "MIRAI" on December 15th, and the total number of orders reached 2,500 vehicles this March. The figure already tripled their target of 700 FCVs for 2015, which indicates high public interest. The total orders reached 1,500 FCVs on January 15th, one month after the release, and another 1,000 was added in just over two months. The breakdown of the orders by the end of March is 55% from governmental organizations and businesses and 45% from the public. (Nikkan Jidosha Shimbun, April 14, 2015)

On April 21st, Toyota announced that an EV would be introduced into the Chinese market this year. The exclusively designed EV Lingzhi for the Chinese market will be rolled out through GAC Toyota, a joint venture with Guangzhou Automobile Group. Since other automakers are working on EVs, Toyota will reinforce its eco car range by adding the EV as well as a locally produced hybrid vehicle (HV) available in China this autumn. This compact EV will be available in limited areas. "EVs are widely promoted under the Xi Jinping regime" says Mr. Hiroji Onishi, a Senior Managing Officer and CEO of the Chinese arm. He also told to the press that the firm was considering bringing out a non-compact EV in future. (The Nikkei, April 21, 2015)

On May 6th, Toyota Motor announced that its FCV "MIRAI" would be available from this October at the eight limited dealers in California including San Francisco as a start. (The Tokyo Shimbun & The Chunichi Shimbun, May 7, 2015)

Toyota and Mazda are in the final stage of discussing a package partnership agreement for environmental technologies. Toyota is to provide its FCV technologies, and Mazda is to offer its own technologies for high power output and energy efficiency for gasoline and diesel engines. As well as environmental technologies, they are to cooperate in the development of business use cars and component procurement. Environmental regulations are tightening up, which has a large impact on the automobile industry. Additionally, a lot of competition takes place in emerging countries. Auto giants are accelerating affiliation for environmental technologies as the key to survive the global race. Toyota and Mazda are discussing to agree the baseline

of the partnership soon. As well as HV technologies, Toyota is to provide technology of FCV and PHV to be charged through domestic wall sockets. California, the USA, has strict environmental regulations, and will ask automakers to increase the sales of EVs and FCVs from 2018. Emerging countries including China also plan to tighten the regulations. Mazda is falling behind other automakers on EV related technologies, and plans to accommodate tightening environmental regulations by affiliating with Toyota. On the other hand, Mazda developed "SKYACTIV" which is a series of Mazda's original technologies with critical acclaims for environment and it is under consideration to be provided to Toyota. Toyota plans to add the technologies to expand its range of fuel efficient gasoline and diesel cars on top of HV and FCV. Through the partnership, Mazda plans to get technologies for next generation eco cars such as FCV which requires a significant amount of development cost, so that it can concentrate its resources to their specialty of smaller and sports cars to survive the intensifying global competition. (The Nikkei, May 9, 2015; The Nikkan Kogyo Shimbun, May 11, 2015)

(2) Shanghai International Automobile Industry Exhibition

On April 20th, Shanghai International Automobile Industry Exhibition, known as Auto Shanghai, started in Shanghai, China. This is the largest motor show in China, and approximately 2,000 firms participate from the automobile related industry in 18 countries and regions worldwide to display a total of 1,343 vehicles including 109 cars making their debut. The exhibition will last until 29th, and one million visitors are expected. Toyota Motor has developed HV in China, and it will be available there from this autumn. Volkswagen (VW) will locally produce over 15 of its latest eco cars including EVs in four years. Also the core components such as batteries and battery systems are planned to be manufactured there. The new car sales were 23.49 million vehicles in 2014 in China. VW and General Motors sold over 3.5 million vehicles. On the other hand, even the largest Japanese seller Nissan was only 1.22 million vehicles, and Toyota's share is only 4%. (The Nikkei, April 20 & 21, 2015)

(3) Mitsubishi Motors

Mitsubishi Motors will bring PHV into the Chinese market in a few years. The Chinese government will tighten regulations on fuel efficiency of cars to the level of developed countries, and has gradually been enforcing stricter regulations by setting standards of average fuel efficiency on whole cars sold in China. The target fuel efficiencies are 6.9 L for 100 km drive by 2015 and 5.0 L by 2020. PHVs, EVs and FCVs are subsidized as "new energy car purchase". Mitsubishi will start a PHV experiment in China at the end of April. To investigate the possibility of PHVs in the Chinese market, 10 of "Outlander PHEV" will be used in Changsha, Hunan where the headquarters of Gac Mitsubishi Motors, a joint venture, is located. Mitsubishi plans to introduce PHVs into the Chinese market in a few years while keeping an eye on tightening regulations and penalties (The Nikkei, April 23, 2015)

(4) Honda

Honda also plans to introduce PHVs into the Chinese market in with fit to the tightening Chinese regulations. Honda has accommodated the current regulations by selling HVs and downsizing cars which have small engine displacement and use turbochargers to supplement power. Mr. Seiji Kuraishi, the Chief Operating Officer in China, shows an intention to introduce PHV into the market sooner. (The Nikkei, April 23, 2015)

(5) Tesla Motors

On April 28th, Mr. Elon Musk, the CEO of US-based EV manufacturer Tesla Motors, told the Nikkei in an interview that Tesla planned to increase the number of free quick charging spots to 30 locations, five times that of the current figure, by the end of this year in Japan. This will allow their EVs to drive throughout the main land Japan. The firm plans to raise the number to a couple of hundred in Japan in the future to promote EVs by reducing worries of power loss. Their main target places are car parks of commercial facilities for charging spots, and solar power will be used as the power source. As well as installing solar panels at the charging spots, the firm will buy electricity generated by photovoltaic generators from others. "We will invest in the facilities over a long period in Japan." said Mr. Musk. He did not mention the amount of investment, but told the paper that their repair service center was only located in Yokohama, and more service centers would be

deployed. He also said that they would request the Japanese government to support installation of parking meters with chargers for all EVs. Tesla's sedan EV can be charged through a domestic wall socket, but it requires overnight to fully charge. On the other hand, a quick charger can recharge half the capacity in 20 minutes, which is convenient for EV users and an advantage for commercial facilities. Currently their chargers are available only in six locations mainly in the greater Tokyo area and the area between Osaka and Kobe. Although the EV maker sells the luxury range EV at nearly ¥10 million now, it is developing a mid-range EV to be introduced into the market at ¥4.2 million by late 2017. The largest issue is the price of the storage battery. Mr. Musk believes that "the storage battery price will go down more than 30% in three years", and is confident to commercialize the mid-range EV. They also plan to bring in an EV at an even lower price to attract a larger range of consumers. He said the new EVs were to be sold under the Tesla brand to increase recognition. (The Nikkei & The Kobe Shimbun, April 30, 2015)

(6) Nissan & Renault

Nissan Motor and French-based Renault plan to extend their EV's driving range to over 400 km, double that of the current range, by 2020. Their plan is to double the capacity of the battery by improving the materials and design to extend the driving range, the weakness, in order to promote the sales. Nissan aims to increase the EV sales which currently stay at just over 1 % in the whole new car sales to 10 % by 2025. The driving range of Nissan "LEAF" is 228 km on a full charge. The improved version with double the battery capacity is planned to be produced at the same cost level or lower. Although Nissan and Renault aimed for a sales total of 1.5 million EVs of by FY 2016, they have extended the period due to falling oil prices. The total sales are 0.2 million vehicles as of December, 2014. Nissan plans to introduce a new EV in FY 2016 or later, and it possibly has the new battery on board. Mainly a joint venture with NEC supplies Nissan with batteries. "We will consider buying from another supplier, if they can stably provide batteries with a good performance at a low price." says Mr. Kazuo Yajima, an Alliance Global Director of Nissan, showing a possibility to purchase from LG Chem which is developing a battery with Renault. (The Nikkei, May 6, 2015)

(7) German-based BASF

German-based BASF, the world largest chemical producer, has kept expanding investment in Asia. New plant construction and plant extension are already in progress in India and China, and the firm is moving on to set up development section. Dr. Kurt Bock, the Chairman of the Board of Executive Directors of BASF, says that "the manufacturer launched research and development centers for electronics materials in Suwon, South Korea, and battery materials in Amagasaki City, Japan." He also explains the point of the joint venture launched with Toda Kogyo in February is to reinforce the range of battery materials expecting EV market growth. (The Nikkei, May 12, 2015)

6. Supply of FCV Parts

On April 16th, Nippon Steel & Sumitomo Metal announced that its titanium film was employed for Toyota's MIRAI. The light film withstands corrosion and can be as thin as 0.02 mm, which are important criteria to be used as a part structuring FCs which then forming a cell stack. (The Nikkan Kogyo Shimbun, April 17, 2015)

7. Hydrogen Refueling Station Business Plans

(1) Next Generation Vehicle Promotion Center

Hydrogen refueling stations for FCVs will be deployed at 10 locations in the Kansai area in FY 2015. Currently only one hydrogen refueling station operates in the Kansai area, but the infrastructure preparation will quickly progress from this fiscal year. The Next Generation Vehicle Promotion Center, Tokyo, has revealed the list of planned hydrogen refueling stations which were awarded with governmental subsidy. The list contains installations of seven locations in six prefectures. Including these installations, the total number of hydrogen filling station will be stretched to 11 locations in the Kansai area by next spring. However, the preparation of hydrogen filling infrastructure started in the Kansai area. Iwatani opened the first commercial hydrogen refueling station in Amagasaki City, Hyogo Prefecture in July, 2014. They will open more hydrogen filling facilities in five locations including Otsu City and

Joto-ku in Osaka City this fiscal year. Osaka Gas also plans to install a facility in Ibaraki City, Osaka Prefecture, as well as a mobile filling facility in Minami-ku, Kyoto City. In addition, local governments show positive attitude for this area. For example, Kobe City has decided to use FCVs as official cars, and Osaka Prefecture is preparing a plan for hydrogen refueling stations. (The Nikkei & The Nikkan Kogyo Shimbun, April 15, 2015)

(2) Osaka Gas

Osaka Gas has set the price of hydrogen at its commercial refueling stations at ¥1,100 (excluding consumption tax) which is the same level as the announced price of other hydrogen suppliers. Osaka Gas will open its first hydrogen filling facility "Kita-Osaka Hydrogen Station" on April 21st as a start of hydrogen sales for FCVs. (The Nikkan Kogyo Shimbun, April 20, 2015)

(3) Toho Gas

Toho Gas started the construction of "Nisshin Hydrogen Station" in Nisshin City, Aichi Prefecture in May, 2014. The ceremony was held to celebrate the completion of the construction on April 20th. The refueling station will offer hydrogen to consumer FCVs, and the operation will start in mid-May. The firm plans to install a commercial hydrogen refueling station at another location in this fiscal year. The hydrogen refueling equipment in Nisshin requires a smaller area, and is installed at an established refueling station offering gasoline, natural gas and liquefied petroleum gas. The firm employed an off-site production system for the station. The station has no hydrogen production facility on the premises, and hydrogen is transported from a production facility. The supply capacity is approximately 30 kg/h, and it takes three minutes to fill a FCV. (The Denki Shimbun & The Chunichi Shimbun, April 21, 2015)

8. Measurement and Observation System Development & Business Plans

(1) German-based S++

German-based venture S++, Murnau, has developed a sensor to analyze current inside FCs in details. The sensor is to be attached between the plate-shaped cells to react hydrogen and oxygen, and measures current flow and temperature change in areas of 3 mm by 3 mm. Since commercialization of FCV is in progress, the firm tries to sell the product to improve generation efficiency to Japanese automakers and material manufacturers. (The Nikkei Business Daily, April 16, 2015)

(2) HyTReC

Hydrogen Energy Test and Research Center (HyTReC) is already booked up for tests for FY 2015. The facility offers a place to test components for FCVs and hydrogen refueling stations. Since hydrogen energy started taking off, many reservations have been made for a long term examinations such as durability tests. Because the test trend of hydrogen energy related parts is also changing, reservations should be made with close contact with the lab. The lab is the only facility to test large accumulators for hydrogen refueling stations up to 500 L and 100 MPa in Japan. Fukuoka prefecture launched HyTReC as a public interest corporation with the world's top level testing facilities. (The Nikkan Kogyo Shimbun, April 28, 2015)

—This edition is made up as of May 12, 2015—

APPENDIX (just for your information)

The 23rd FCDIC Fuel Cell Symposium will be held on May 26 - 27, 2016 at Tower Hall Funabori in Tokyo.

The 22nd FCDIC Fuel Cell Symposium

The 22nd FCDIC Fuel Cell Symposium was held on May 28 - 29, 2015 at Tower Hall Funabori in Tokyo.
The programs of the symposium were as follows.

a. Poster Presentation Program

	Organization	Category	Title
P1	The Univ. of Tokyo	PAFC	$CsH_5(PO_4)_2$ Doped Glass Membranes for Intermediate Temperature Fuel Cells
P2	Ube Industries, Ltd.	PEFC/ Membrane	Development of Novel Conductive Porous Polymer Membranes
P3	Sophia University, FC-Cubic	PEFC/ Membrane	Synthesis and Characterization of Poly(phenylene) Electrolytes with Superacid Groups (V) - Effect of Superacid for Electrolyte Properties -
P4	Sophia University	PEFC/ Membrane	Synthesis of Cage-Forming Silicate Polymers and Evaluation as Electrolyte (I) - Influence of Copolymerization Ratio on Monolith Structure -
P5	Tohoku University	PEFC/ Membrane	Molecular Dynamics Study of Proton Transport Mechanism in Nafion Membrane
P6	AIST, Osaka University	PEFC/ Alkaline	Evaluation of Electrochemical Properties of Copper Complexes in Aqueous Solution
P7	Tohoku University	PEFC/MEA	Molecular Dynamics Study of Oxygen Permeation through Ionomer in PEFC
P8	Tohoku University	PEFC/MEA	Molecular Dynamics Study of Proton Transport Property in Cathode Catalyst Layer of PEFC
P9	Chiba University	PEFC/Cat.	Oxygen reduction reaction on the high index planes of Pt containing kink structure
P10	Chiba University	PEFC/Cat.	Activity for the Oxygen Reduction Reaction and Durability on the Single Crystal Electrode of Ni modified with Pt
P11	Yokohama National Univ.	PEFC/Cat.	Ti-Ni-based oxides as non-platinum cathodes for PEFC
P12	Yokohama National Univ.	PEFC/Cat.	Kinetic study of oxygen reduction reaction on Ti-oxide based catalysts in acidic media with RRDE
P13	Yokohama National Univ.	PEFC/Cat.	Evaluation of durability of oxide-based electrocatalysts as non-platinum and carbon free cathodes for PEFC in H_2SO_4 at 80℃
P14	Kyushu Univ., Kyoto Univ., JST	PEFC/Cat.	Improvement in the Durability of Pt Catalysts Commercially Available by Coverage with Silica Layers
P15	Asahikawa College, Nagaoka Univ. of Technology	PEFC/Cat.	Study of Graphene-Covered Nickel Particles prepared by Microwave assisted Catalytic Decomposition for Oxygen Reduction Reaction
P16	Nagaoka Univ. of Tech., Nakatsuyama Heat Treatment Co.,Ltd.	PEFC/ Separator	The Corrosion Property of Different Heat Treated Nitriding Stainless Steel for Use of Bipolar Plate in PEFC
P17	Nagaoka Univ. of Technology, JST	PEFC/ Reforming	Electrochemical Properties of Polymer Electrolyte Fuel Cell Anode under Carbon Dioxide Environment
P18	Kyoto University, The Kansai Electric Power Co.,Inc.	SOFC	Performance of Ni-GDC Cathode Synthesized via the Spray Pyrolysis and the Mechanical Mixing Methods for CO_2 Reduction
P19	Tokyo University Science	DMFC	Semi-Active Fuel Supply of Zigzag-Type DMFCs with the Channel Paths

b. FCDIC 22nd Fuel Cell Symposium Oral Session Program (1/2)

Time	First day (Thursday, 28 May, Funabori, Tokyo)					
	A Hall (5F Big Hall)			B Hall (5F Small Hall)		
09:00～	Registration (5F)					
09:30-09:55	ENE-FARM, PAFC	1	Sales Strategy of PAFC at Fuji Electric (Fuji Electric Co., Ltd.)	SOFC I	1	NEDO Project on Rapid Evaluation of SOFC Stack Durability (AIST, The Univ. of Tokyo)
09:55-10:20		2	Brand-New Residential Fuel Cell CHP System "ENE-FARM" Released in 2015 (Tokyo Gas Co., Ltd.)		2	Degradation analysis of SOFC stack performance (2)-durability test and verification of improved SOFCs- (CRIEPI)
10:20-10:45		3	Development of New Stationary Fuel Cell Power System "ENE-FARM" (Panasonic Corporation)		3	Durability test of LSCF cathode for SOFC (AIST, The Univ. of Tpkyo)
10:45-11:10		4	Effort to expand the marketing opportunity of ENE-FARM and to adopt to the hydrogen siciety (Toshiba Fuel Cell Power System Corporation)		4	Development status of flattened tubular segmented-in-series type SOFC cell stacks (NGK Insulators Ltd.)
11:10-11:35		5	Development status of SOFC hot module (TOTO Ltd.)		5	Development of high efficiency SOFC power genertion system as the distributed power supply (MITSUBISHI HITACHI POWER SYSTEMS, LTD., MITSUBISHI HEAVY INDUSTRIES, LTD.)
11:35-13:35	<Lunch> Poster Session, Ehbition, Fuel Cell Assembly & Generation Corner (1F Exhibition Hall)					
13:35-14:00	FCV	6	Development of High-Performance and Compact Fuel Cell Stack (Tiyota Motor Corporation)	SOFC II	6	Development and Field Tests of 5kW-Class SOFC-System for Business-Use (MIURA Co., Ltd.)
14:00-14:25		7	Influence of Electrolyte Composition and pH on Pt electro-dissolution in Acidic Media (Nissan Motor Co.,Ltd., Queen's University)		7	Study on hot modules for SOFCs (Tokyo Gas Co., Ltd.)
14:25-14:50		8	Oxygen Concentration Measurement around Fuel Cell Cathode Electrode Using MEA with built-in Oxygen Sensor (Honda R&D Co.,Ltd.)		8	Application of Electrodeposition painting coating for SOFC interconnector with commodity grade stainless steel (Osaka Gas Co., Ltd.)
14:50-15:15		9	Receipts and Expenditures Analysis of Hydrogen Supply Using a Simulation Model for Next Generation Vehicle Diffusion (The Institute of Applied Energy)		9	Effect of High Oxygen Utilization-Rate on Power-Generation and Deterioration Characteristics of SOFCs (Tokyo City Univ.)
15:15-16:20	<Break> Poster Session, Exhibition, Fuel Cell Assembly & Generation Corner (1F Exhibition Hall)					
	A Hall (5F Gig Hall)					
16:30-17:20	Special Lectures	1	Energy Carrier Research Project in the Cross-ministerial Strategic Innovation Promotion Program (SIP) Director for Environment and Energy, Council for Science,Technology and Innovation, Cabinet Office, Government of Japan Hideaki Nakajima			
17:20-17:30			<Break>			
17:30-18:20		2	Honda Fuel Cell Vehicle Development and Toward the Hydrogen Society Honda R&D Co., Ltd., Senior Chief Engineer Takashi Moyiya			
18:20-18:30	<Break>					
18:30-20:30	Award Ceremony & Banquet (2F Event Hall - Togen)					

c. FCDIC 22nd Fuel Cell Symposium Oral Session Program (2/2)

Time	Second day (Friday, 29 May, Funabori, Tokyo)									
	A Hall (5F Big Hall)			B Hall (5F Small Hall)			C Hall (4F Training Room)			
08:55~	Registration (5F)									
09:00-09:25	Joint Session with HESS (The Hydrogen Energy Systems Society of Japan)	10	Direct electrohydrogenation of toluene by a SPE membrane electrolysis for large scale energy transportation of renewables (Yokohama National University)	Overseas Status	10	<Special Invited Talk> R&D status of fuel cell in Korea KIER DooHwan Jung	Cell Analysis, Evaluation & Simulation	1	Large Scale Molecular Simulations of Transport Phenomena of Reactant/Product in PEFC (Tohoku University)	
09:25-09:50		11	Smart Fuel Cell Demonstration Project: Towards realizing a fuel-cell-powered hydrogen society at Kyushu University Ito Campus (Kyushu University)					2	Fdissolution behavior analysis of model for PEFC electrodes using EQCM (KRI Inc.)	
09:50-10:15		12	Development of simulator for location planning of fudrogen infrastructure (KOZO KEIKAKU ENGINEERING Inc., Kyushu University)		11	<Special Invited Talk> Global overview on the hydrogen refueling stations HySUT Fuminori Yamanashi		3	Soft X-ray Visualization of Liquid Water Behavior within PEFC (Tokyo Institute of Technology, Osaka University)	
10:15-10:40		13	<Invited> Hydrogen production and power storage systems utilizing renewable energy TOSHUBA CORPORATIN Johji Kameda					4	Thermodynamic and kinetic parameters of ORR by the first-principles molecular dynamics and current-voltage relations (FC-Cubic, AIST)	
10:40-10:55	<Break>									
10:55-11:20		14	<Invited> Development of Smart Hydrogen Station (SHS) in Honda Honda R&D Co., Ltd. Masanori Okabe	Catalysts I	12	Cathode catalysts with high activity and high durability for PEFC (Univ. of Yamanashi)	Cell Analysis, Evaluation & Simulation	5	First-Principles Analysis of Oxidation Process of CO on $Pt_{22}Ru_{33}$Alloy Nano-Particle Catalyst in PEFC (Tohoku Univ., Iwate Univ., Hokkaido Univ.)	
11:20-11:45		15	<Special Invited Talk> Prospect for the Provision of Hydrogen Infrastructure Iwatani Corporation Jun Miyazaki		13	The performance of the fuel cell of the Pt/C catalyst formed using pulse arc plasma (ADVANCE RIKO, Inc.)		6	Effects of Both Carbon Support Microstructure and Perfluorosulfate Ionomer on the Cathode Performance of Polymer Electrolyte Fuel Cells (University of Yamanashi)	
11:45-12:10					14	Development of Highly Active Silica-Coated Pt Cathode Catalysts by Changing Silica Properties (Kyushu University)		7	Development of the SOFC holder for visualizing temperature distribution (CHINO CORPORATION)	
12:10-13:30	<Lunch> Poster Session, Exhibition, Fuel Cell Assembly & Generation Corner (1F Exhibition Hall)									
13:30-13:55		Keynote Speech	Hydrogen Society and the Energy Structure Change in Japan Tokyo University of Science Takeo Kikkawa	Catalysts II	15	Application of Pt/Pd/C by the hydrogen sacrificial protective method for the Polymer Electrolyte Fuel Cells (PEFC) cathode catalysts (Nippon Steel & Sumitomo Metal Corporation, NIMS)	FC Materials/Separator and miscellaneous	8	Electrochemical Evaluation of Nitriding Stainless Steel Treated by Different Heat Condition for Bipolar Plate of Polymer Electrolyte Fuel Cell (Nagaoka University of Technology, Nakatsuyama Heat Treatment Co.,Ltd.)	
13:45-14:10					16	MEA Performance of Carbon-based Cathode Catalysts Prepared from Polyimide Fine Particles (Tokyo Institute of Tech., Univ. of Tokyo, Toshiba Fuel Cell Power System Corporation)		9	Evaluation of Nitriding Stainless Steel for Bipolar Plates of Fuel Cells (Nagaoka University of Technology, Hitachi,Ltd., Nakatsuyama Heat Treatment Co.,Ltd.)	
14:10-14:35		16	<Special Invited Talk> JARI Activities for the Safety Evaluation on Hydrogen and Fuel Cell Vehicles JARI (Japan Automobile Research Institute) Yosuke Tamura		17	Development of Innovative Technologies for Reduction in Pt Usage: Development of Highly Active and Durable Pt Core-Shell Catalysts for PEFCs (Doshisha Univ., Ishihuku Metal Industry Co., Ltd.)		10	Fuel cell parts development in Nissinbo (Nisshinbo Chemical Inc.)	
14:35-15:00					18	Fundamental Studies on Cathode Catalysts for PEFC (XIV)- Oxide-based electrocatalysts as non-precious metal and carbon free cathodes for PEFC (Yokohama National Univ., Hirosaki Univ., NISSAN ARC Ltd.)		11	Remaining R&D Needs for Viable Automotive Fuel Cell Technology (Ford Motor Company)	
15:00-15:10	<Break>									
15:10-15:35		17	<Special Invited Talk> Realization of Hydrogen Energy Supply Chain Kawasaki Heavy Industries, Ltd. Kazutoshi Oimatsu	FC Materials and miscellaneous	19	Development of Highly Durable Catalyst for Selective CO Methanation (Univ. of Yamanashi, Panasonic Corporation, Mitsui Mining & Smelting Co., Ltd., Tokyo Roki Co., Ltd.)				
15:35-16:00					20	Delivering High-Performance, Durable, Low-Cost and High-Quality Membranes for Pem Fuel Cells (W.L. Gore & Associates, Co.,Ltd., W.L. Gore & Associates Inc.)				
16:00-16:25		Panel Discussion	Theme: What should we do now for the full application of hydrogen & fuel cell technologies? Panelist: T. Kikkawa(Tokyo University of Science), T. Kameda (Toshiba), K.Oimatsu (Kawasaki Heavy Industries), Y. Tamura(Japan Automobile Research Institute), M. Okabe(Honda R&D Ltd.), M. Yoshitake (FCDIC), Chairperson: H. Takagi(Advanced Industrial Science & Technology)		21	R&D for Innovative Perfluorinated Electrolyte Materials (Asahi Kasei E-materials Corporation, Daikin Industries, LTD.)				
16:25-16:50					22	Contribution from the Space Exploration to the Society of Hydrogen (JAXA)				