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Operation of Commercial Mobile Hydrogen Filling Station

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1. Governmental Measures

(1) METI

The Ministry of Economy, Trade and Industry (METI) will support businesses for their commercialization of hydrogen power generation. To start with, a subsidy scheme will be set up to give financial support of up to two thirds of expense for projects such as oversea hydrogen purchase. The budget bill for FY 2015 includes ¥2 billion for the scheme. They plan to prepare experimental hydrogen power generation systems and safety regulations in order to get the environment ready to provide homes with electricity generated by hydrogen from 2030. There are independent hydrogen power generators in factories, but no commercial hydrogen power stations at a large-scale. In last October, the ministry launched an advisory committee for the commercialization of hydrogen power generation. They will investigate financial and regulatory issues on the introduction of hydrogen generation in this fiscal year to be reflected in policies. One of the issues is that hydrogen is traded in a small market. According to the ministry, hydrogen is traded at the range between ¥20 and under 40/m^3 and the annual supply to the Japanese market is about 300 million m^3. A giga-watt level hydrogen power station requires 2,400 million m^3 each year, and the domestic market is currently insufficient to support the station. (The Nikkei, January 29, 2015)

(2) Cabinet Office

A working group of the Cabinet Office had worked on usage investigation of the most advanced science and technology in the 2020 Tokyo Olympics and Paralympics, and decided a project plan on February 2nd. In the stadium, technology will be used to project stereoscopically-presented imagery from all direction in air. Also wearable robots to assist walking and guide robots for visitors in multi-languages will be placed there. Furthermore, an automatic driving bus will be developed for transport between venues, and many environmentally friendly fuel cell vehicles (FCVs) will be used. In this month, the working group will report this to the Council for Science, Technology and Innovation, and the plan will be used as a governmental policy. Related governmental organizations such as the Ministry of Internal Affairs and Communications will decide actual measures, and research institutes and businesses will develop the technologies. (The Sankei Shimbun, February 3, 2015)

2. Local Governmental Measures

(1) Tokyo

Tokyo has allocated ¥8.3 billion for developing the smart energy city as part of energy related expenses in the budget bill for FY 2015. Also ¥1.2 billion is allocated to expand hydrogen energy use. They aim for 35 locations of hydrogen filling stations by the end of 2020 and 80 locations by the end of 2025, and will support the early preparation of the hydrogen infrastructure. For hydrogen, a ¥40 billion fund has been established from the supplemental budget for FY2014 and the budget bill for FY 2015 to promote FCV use and to prepare hydrogen filling stations. (The Denki Shimbun, January 20, 2015)

Tokyo has held the Tokyo Strategy Conference for Hydrogen Society and compiled a draft report for FY 2014. The report proposes environmental preparation for hydrogen use in the Olympics and future hydrogen society in Tokyo. It also indicates objectives such as achieving a low carbon city and sustaining operation during disasters and stable energy supply at a low cost. (Nikkan Kensetsu Sangyo Shimbun, February 3, 2015)

(2) Yokohama City

In February, Yokohama City will launch a working group in cooperation with Tokyo Gas and Mitsubishi Hitachi Power Systems to investigate the generation of electricity, heat and hydrogen using biogas from sewage sludge. The group will work on developing a system to supply FCVs and electric vehicles (EVs) with locally produced energy from sewage biogas, and encourage a variety of businesses to join the project, aiming at commercialization by the 2020 Tokyo Olympics. Since FY 2013, the city has researched on refining methane extracted from sewage biogas at its North Sewage Treatment Center in collaboration with Tokyo Gas. The previous sewage biogas contained approximately 60% methane and 40% CO_2, but they succeeded in extracting a higher concentration of methane by using a separation membrane to remove CO_2. This gives a similar calorific value to natural gas. On the other hand, Mitsubishi Hitachi Power Systems is developing the world's most efficient fuel cell (FC) for industrial purpose, and plans to use the highly concentrated methane as fuel for the new FC to produce electricity and heat as well as the production of hydrogen from the gas. (The Nikkan Kogyo Shimbun, February 2, 2015; The Nikkei, February 15, 2015)

(3) Kyoto City

Kyoto City will purchase three of Toyota's "MIRAI" in FY 2015 to lend them out. These FCVs will be booked for hourly hire, such as a half day, by residents and tourists through internet. The rate is currently in a decision process. The city is also considering displaying FCV at fairs and events in the city and using them as a leading car at these occasions as well as using them as an emergency power source at disaster drills. Also, hydrogen filling stations will be invited to the city. (The Nikkei, January 30, 2015)

(4) Osaka Prefecture

On January 29th, Osaka Prefecture announced a plan to prepare hydrogen filling station at "Osaka FCV Promotion Conference" which consists of automakers including Toyota Motor, energy providers such as the Kansai Electric Power Co. and Osaka Prefecture University. The plan includes targets of a total of nine hydrogen filling stations near the Osaka International Airport, the Suita Junction of the Meishin Expressway and Mihara Junction of the Hanwa Expressway as well as in Osaka City to suit the traffic in the prefecture by FY 2017. According to the prefecture, hydrogen filling stations are installed or being planned only at four locations in Ibaraki City and Izumisano City of Osaka Prefecture, Amagasaki City of Hyogo Prefecture and Otsu City of Shiga Prefecture (planned) in the six Kansai prefectures. Because this hydrogen filling network leaves a blank area in the middle of Osaka Prefecture, the prefecture allocated ¥72.16 million for a project to construct its third hydrogen filling station at Morinomiya, Joto-ku of Osaka City to be operated as a business in the budget bill for FY 2015. An information center is also planned to be open to promote hydrogen energy. (The Asahi Shimbun, January 27, 2015; The Yomiuri Shimbun & The Nikkei, January 30, 2015)

(5) Hyogo Prefecture

Both Kobe City and Amagasaki City of Hyogo Prefecture will purchase MIRAI for official use this spring. These FCVs will be displayed at events as promotion as well as used as official cars. Kobe City will prepare a hydrogen filling station and start a subsidy to support FCV purchase by businesses in FY 2015. As purchase support, FCV will be added to "Next Generation Promotion Subsidy Scheme" of the city. Amagasaki City is considering subsidizing FCV purchase by private firms for business use in its area. (The Nikkei, January 30, 2015)

3. FC Element Technology Development and Business Plans

(1) Max Planck Institute for Chemical Energy Conversion

A team of Japanese researchers at Max Planck Institute for Chemical Energy Conversion has for the first time found out how hydrogenase breaks hydrogen apart by data analysis. Hydrogenase is an enzyme expected to be a material for FCs by separating ions to produce electric power. This enzyme is a protein which catalyzes hydrogen to break down or join together, and is mainly found in microbes. Commercial synthesis of the enzyme requires a detailed investigation into its hydrogen break down mechanism. A team member Dr. Koji Nishikawa, currently Specially Appointed Assistant Professor of the University of Hyogo, explains "hydrogenase can break hydrogen very efficiently and

be developed to be a cheaper synthetic catalyst". The team produced a high purity of a hydrogenase crystal in a state without oxygen. For analysis, the crystalline structure was investigated using X-rays at radiation light facility in Germany. The results show how a hydrogen molecule splits into protons and electrons. (The Nikkan Kogyo Shimbun, January 29, 2015)

(2) Nichias

Nichias is trying to expand sales of "Roslim™ Board" which is an inorganic thermal insulation board easily processed and manipulated for high temperature operation. The board has high durability and super low heat conductivity. Because the product withstands processes to be made into complicated forms, its usage has expanded to domestic FC systems which are currently reducing their size. As new usage, the manufacturer aims at industrial furnaces for sintering ceramics or annealing steel sheets as well as insulation enhancement of tight space in established factories in order to improve safety. (The Chemical Daily, February 6, 2015)

(3) Toda Kogyo Corp.

Toda Kogyo Corp. will increase the production capacity of FC catalysts to eight times that of current capacity. Although ruthenium is commonly used in catalysts to extract hydrogen from natural gas, they sell catalyst which uses nickel and performs at the same level of a ruthenium one. Their production system will be upgraded to meet demands of FC manufacturers who want to reduce costs of FCs aiming to cut catalyst cost to half. (The Chemical Daily, February 6, 2015)

4. Hydrogen Infrastructure Related Element Technology Development and Business Plans

(1) Chiyoda Corporation

Chiyoda Corporation plans to start a test of a technology to separate hydrogen and CO_2 by 2018, and aims to commercialize the technology in two years. CO_2 coming from the hydrogen production process can be sold to inject into oil well to increase crude oil production. This income allows reducing hydrogen production costs. The firm has a technology to react hydrogen with toluene to transport hydrogen in a liquid form which enables it to be shipped in a large volume at a normal temperature and pressure. This diversifies procurement channels of hydrogen, which contributes to reduction in price by stabilizing supply. (The Nikkei, January 27, 2015)

(2) KHI

Kawasaki Heavy Industries (KHI) will talk with J-Power on development of a plant to gasify lignite, a low grade coal, to extract hydrogen. This development will be a combination of J-Power's efficient gasification technology of coal and KHI's expertise on plants design. Currently they are investigating the commercialization of this business and plan to start the development in 2016. Australia has plenty of lignite. These firms plan to use the energy source which is considerably cheaper than normal coal to produce hydrogen in order to import the gas to Japan. Each year in Japan 36 billion m^3 of hydrogen comes out from the production of steel and chemical products as a by-product, and is also extracted from oil or natural gas. The majority of hydrogen is used as fuel at steel works and petrochemical plants. However, hydrogen supply is expected to be short of demand in 2020 once FCVs are widely used. The government plans to bring FCV fuel cost down to the level of hybrid vehicles (HVs). To achieve this, major hydrogen suppliers aim at ¥30/m^3, half that of current wholesale prices, as well as a stable hydrogen supply. (The Nikkei, January 27, 2015)

KHI will operate a hydrogen power station at its Akashi Works from April. The Akashi Works has a small turbine of 1.7 MW output, and this will be converted to be able to combust a mixed fuel with hydrogen gas. The firm will start selling the turbines aiming for hydrogen filling stations as well as the preparation of fuel supply infrastructure. The gas turbine potentially requires hydrogen for a couple of thousands of FCVs for its power generation each year. This may contribute to reducing hydrogen price by the volume effect. (The Nikkan Kogyo Shimbun, February 2, 2015)

(3) Osaka Gas

Osaka Gas has started selling its hydrogen production facility "Hyserve- 300P" using liquefied petroleum gas (LPG) as fuel. The product is suitable for hydrogen filling stations in areas where natural gas is unavailable for fuel, as well as for production of hydrogen for processes of thermal treatment of metals, glass and electrical parts. The facility can fill six FCVs per an hour. Hydrogen is extracted from LPG using a

catalyst, and energy conversion efficiency is 75.6%, which is the top level in the industry. The dimensions are 3.8 m high, 7.5 m wide and 3.0 deep. The product will sell for just under ¥200 million excluding tax. (The Nikkan Kogyo Shimbun, February 2, 2015)

(4) Orion Machinery

Orion Machinery, an industrial machine manufacturer in Nagano Prefecture, is trying to develop a smaller chiller. Their expertise on designing and producing chillers to keep the temperature of industrial machinery down at a certain level will be used for the development. The development will be carried out in cooperation with Shinshu University and revise the internal shape of chiller and joining method. The new chiller is expected to be up to a hundredth in volume comparing to conventional method, the production cost may also be a third. They aim to commercialize the product by FY 2016 (The Nikkei, February 2, 2015)

(5) Sanno Co.

Sanno Co., a JASDAQ listed surface processing firm in Yokohama City, will start developing a technology to cut down the price of permeation membranes to extract high purity hydrogen at a couple of tenths of the price of a conventional product in cooperation with Tokyo Institute of Technology and National Institute of Advanced Industrial Science and Technology (AIST). Common hydrogen permeation membranes are made of ceramics and palladium. However, the firm aims to reduce thickness of the membrane from 50 μm to a couple of micro meters by replacing ceramics with porous nickel. This allows a cutting down in the amount of expensive materials such as palladium, which contribute to significant reduction in price. The firm aims to commercialize the product in three years. (The Nikkei, February 2, 2015)

(6) Mitsubishi Kakoki

Mitsubishi Kakoki will operate a hydrogen filling station at the Central Sewage Treatment Center of Fukuoka City. Sewage sludge will be fermented to produce biogas, and hydrogen will be extracted from the gas. Hydrogen production is expected to be 3,300 m^3 which can supply 60 FCVs a day. The production cost is around ¥80/m^3, and this gives the potential for FCV fuel cost to be leveled with that of HVs. By adding experience, the manufacturer aims to expand sales of its small hydrogen production facility to filling station operators. (The Nikkei, February 15, 2015)

(7) Metawater

Metawater, a major manufacturer of water treatment equipment, will install more FCs at the sewage treatment. They have already installed FCs at five sewage treatment works in Japan, and currently these FCs use hydrogen extracted from biogas to generate 1,500 kW. The firm will increase the number of FC systems to eight by the end of 2015 to bring up the total generation capacity to 2,700 kW. FC generation systems using hydrogen produced from sewage sludge allow sewage treatment operators such as local governments to be energy self-sufficient or even able to sell electricity. FCs have better generation efficiency than turbine generators burning biogas. (The Nikkei, February 15, 2015)

(8) SMFG

Sumitomo Mitsui Financial Group (SMFG) has committed to hydrogen related businesses. Mobile hydrogen refueling facilities, hydrogen filling stations, will be leased, and low interest loan will be provided for research and development and capital investment for hydrogen business. The financial group seeks future profit making opportunities by financially supporting FCVs. Sumitomo Mitsui Finance and Leasing Company will start leasing mobile hydrogen filling stations in the end of March. As a start, a total of five mobile stations will be purchased from Iwatani and Taiyo Nippon Sanso, and these stations will be leased to hydrogen filling station operators which have been jointly established by Iwatani Taiyo Nippon Sanso and Toyota Tsusho for eight years. They will consider smartphone payment of the Sumitomo Mitsui Card Company for consumer hydrogen purchase. Sumitomo Mitsui Banking Corporation (SMBC) will finance hydrogen businesses at a lower interest rate. The Bank of Japan supplies money to banks, which increase their amount of lending out, at a low interest rate. SMBC will use this scheme, and finance projects from minimum of ¥300 million. The loan can also be used for running costs of hydrogen businesses as well as capital investment and, research and development. For the first project, the bank will lend out a couple of billion yen to a hydrogen power generator in March. (The Nikkei, February 16, 2015)

5. Ene-Farm Business Plans

(1) Osaka Gas

On January 21st, Osaka Gas announced a dedicated application "Ene-Farm App" to operate Ene-Farm and see information thorough TVs using a set-top box "Hikari BOX+" sold by NTT West. This free application can be downloaded on the website of "Hikari BOX+" which allows internet access through TV in order to be connected to Ene-Farm's remote control. (The Denki Shimbun, January 22, 2015)

(2) Tokyo Gas

On January 28th, Tokyo Gas announced that they aimed to sell Ene-Farm to 15,110 established houses sold as "Fine-Court" by Mitsui Fudosan Residential in its business area such as Tokyo, Kanagawa, Chiba and Saitama Prefectures. In March 2014, the utility firm and real-estate developer agreed to install Ene-Farm to all new Fine-Court brand houses as a standard feature, and the figure is a total of 763 houses with Ene-Farm which have been built since or are currently planned. Tokyo Gas introduced Ene-Farm for houses in January 2014. The power output is between 200 and 700 W, and the system archives 85.8% higher heating value (HHV). Compared to a combination of electricity from thermal power plant and natural gas water heater, household utility bills can be reduced by ¥50,000 to 60,000 each year. (The Denki Shimbun, January 29, 2015)

On February 4th, Tokyo Gas and Panasonic announced that new Ene-Farm had been developed. The new product will offer about 15%, ¥300,000, cheaper price than that of the current model by reducing the number of parts and amount of precious metal while keeping the basic performance such as generation efficiency. The utility firm will start selling the FCs for ¥1.6 million excluding tax on April 1st, and it aims at 17,500 units in its supply area for the first year. A separable unit product will also be available targeting houses which have limited land. For the existing model, an independent start-up function during power cuts was optional. New product range will offer the function built-in, and sell for ¥1.67 excluding tax. The governmental subsidy will bring down the consumer costs including the product and its installation to around ¥1 million. (The Nikkan Kogyo Shimbun, February 4, 2015; The Mainichi Newspapers & The Nikkei, February 5, 2015)

(3) Toho Gas

On February 4th, Toho Gas announced that Panasonic's new Ene-Farm would be available from April 1st. The new product requires 30% less installation area compared to the existing model, which enables properties with limited land to have it. Also the gas supplier offers suggested retail price of ¥1.66, cut down by 20%, excluding tax and the installation cost. The power output is between 200 and 700 W with 95% of lower heating values (LHV). The product contains a water storage unit of 140L with a backup water heater integrated to make its package design simpler and easy to install, while the existing model has a separate backup water heater. (The Denki Shimbun, February 6, 2015)

6. Cutting Edge Technology of FCVs and EVs

(1) BYD

On January 21st, BYD, a Chinese-based major automaker, released a new plug-in hybrid vehicle (PHV) "Tang". This new sport utility vehicle (SUV) will sell for 300,000 CNY (approximately ¥5.7 million), and drives 100 km on 2 L of gasoline. (The Nikkei, January 22, 2015)

(2) EV Japan

Electric Vehicle Japan was jointly established by eight automobile service providers in Toyonaka City, Osaka Prefecture in 2011. Their four originally developed small EVs were delivered to "Huis Ten Bosch", a theme park in Sasebo City, Nagasaki Prefecture to be used inside the premise. The firm plans to sell its products more to theme parks and other parks. This small EV truck is 2.5 m long, 1 m wide and 2 m high, and drives at a maximum of 15 km/h. The recharge period is between four and five hours using a domestic wall socket, and the car can drive about 30 km on it. Huis Ten Bosch posted orders to EV Japan to develop the original EVs last summer. The EV can take two people in the park, and its specifications allow it to be driven on certain public roads with a registration number as a single-seater motorized four-wheeled vehicle. Mr. Chotaro Nishida, the president of the firm, says "We can see demands from remote places where gasoline filling stations are very sparsely distributed". (The Nikkei, January 23, 2015)

(3) Meimon Taiyo Ferry

New passenger ferries will be brought into commission. Operating between Osaka and Kitakyushu, Meimon Taiyo Ferry, Osaka City, expects EV user increase, and will introduce two new ferries with EV chargers in 2015. Although charging infrastructure preparation on land is still in progress, they advertise EVs can be recharged on these ferries to drive further once landed. (The Nikkei, January 24, 2015)

(4) BMW & VW

German-based BMW and Volkswagen (VW) have reached agreement to prepare quick chargers for EVs at 100 locations in the US. These two automakers started EVs in 2013. In the US, eco cars are expected to grow due to tightening environmental regulations, and they will cooperate for infrastructure preparation to promote the sales. ChargePoint, a US-based major charger operator, will join hands with them to install chargers for EVs and PHVs on major roads in the West and East Coasts. Their direct current charger can recharge 80% in 20 minutes. As well as BMW "i3" and VW "e-Golf", the new chargers will take other EVs. California has introduced the "ZEV Regulation" in the US, and VW and BMW will be controlled under the regulation from 2018. Other states plan to follow California in the US, and these two firms will jointly prepare infrastructure. BMW is developing a wireless charging technology together with German-based Daimler (The Nikkei, January 27, 2015)

(5) Hon Hai

Hon Hai Precision Industry, a major electronics contract manufacturing company in Taiwan, plans to work seriously on the automobile business. In 2014, their group members started automobile component business. Hon Hai disclosed an intention to invest in EVs in China in September. As their entry to the automobile industry in 2005, a Taiwanese auto parts manufacturer was acquired. The manufacturer currently supplies US-based Tesla Motors with parts. Hon Hai plans to build expertise by producing parts, and aims to eventually move on to contract production of final products. Their CEO declared at the shareholder meeting last June that "EVs would be added to our key businesses". In September, US-based Tesla Motors started delivering its luxury sports EV "Model S" in Japan which sells from ¥8 million. However, the CEO said that "we can produce it at $15,000 (approximately ¥1.77 million) or less." (The Nikkei, January 27, 2015)

(6) Hyundai Motor

By February 3rd, Hyundai Motor considerably reduced the price of its FCV in South Korea, which uses SUV "Tucson" as the base, from ₩150 to ₩85 million (approximately ¥9 million). (The Nikkei & The Nikkan Kogyo Shimbun, February 4, 2015)

(7) Kyushu University

Kyushu University will use FCVs as official cars. One vehicle of Toyota MIRAI is planned to be purchased, and it will also be used for a hydrogen filling station experiment. (The Nikkan Kogyo Shimbun, February 4, 2015)

(8) Shenzhen

Shenzhen, Guangdong Province, announced that it will contribute 5 billion CNY (approximately ¥94 billion) to supporting sales of new energy cars such as EVs aiming for annual 15,000 vehicle sales according to "National Business Daily of China" on February 3rd. (The Nikkei, February 4, 2015)

(9) Hitachi Metals

On February 9th, Hitachi Metals announced that it would talk with a local firm in China to jointly establish a rare-earth magnet manufacturer. This magnet is used in motors for EVs and HVs. The new manufacturer will operate material procurement, production and sales to meet increasing demand in China. This joint venture will be launched in cooperation with Beijing Zhong Ke San Huan High-Tech, Beijing, and Hitachi Metals plans to invest over half. China takes an over half share in the global dysprosium production. Since a Chinese fishing boat crashed into patrol boats of the Japanese Coast Guard near the Senkaku Islands in 2010, China restricted export of rare earths to Japan. This pushed rare earth price up. After this, Japanese manufacturers have been developing production technologies to reduce amount of rare earth in magnets to be more competitive. (The Nikkei, February 10, 2015)

(10) Beijing Automobile Works

On February 9th, Beijing Automobile Works announced that a joint venture had been established with MBtech, a German engineering firm. These two firms will cooperate for research and development of own brand cars such as an EV and core components.

(The Nikkei, February 10, 2015)

(11) Audi

On February 11th, Audi, a member of the VW group, announced that it would acquire patents related to automobile technology owned by Ballard Power Systems, a Canadian major FC manufacturer. The automaker will share these patents between its group members for FCV development. Although they were previously uninterested in partnership with others, Ballard's technologies will be used to catch up. The patents will be transferred from Ballard to Audi for $50 million (approximately ¥6 billion). (The Nikkei, February 13, 2015)

(12) Tesla Motors

On February, 13th, US-based Tesla Motors announced that its joint EV battery plant with Panasonic under construction in Nevada would be operating from 2016. The operation start moved up one year from the initial plan. Tesla plans to introduce a new EV for half the price in 2017, and to prepare supply systems early expecting more demands on the battery. Mr. Kurt Kelty the director in charge of battery technology said in Osaka City that "we planned to reduce production costs by starting the operation ahead of time to get a volume effect early." The new plant will produce high output lithium-ion batteries (LIBs) for new EV "Model 3" to be released in 2017. Tesla plans to invite production centers of automobile parts manufacturers worldwide to the plant. "We have preliminary chosen suppliers", said Mr. Kelty. Panasonic has invested in Tesla, and supplies battery cells for the EVs. The total expenditure of the new plant is up to ¥500 billion, and Panasonic plans to invest ¥150 to 200 billion. The total expenditure of the new plant is up to ¥500 billion. Panasonic plans to invest ¥150 to 200 billion, and will contribute ¥30 billion in 2015. (The Nikkei, February 14, 2015)

On February 13th, Tesla Motors, a US-based EV manufacturer, opened a charger center in Kita-ku, Osaka City. This location is the sixth after Tokyo and Yokohama, and has four quick chargers for EV sedan "Model S". These chargers can charge 16 times faster than common chargers. However, they are only compatible with Tesla's EVs, but operate round the clock. It takes 20 minutes to recharge an EV battery by half. Tesla Motors also have charging centers in Kyoto and Kobe in the Kansai area, and is trying to encourage consumers to buy its EVs by adding another in the center of Osaka. Their plan is to expand the number of charging centers to 30 nationwide. Tesla's "Model S" drives over 500 km on a full charge. This EV was released in June 2013, and sells for ¥8.71 million which is expensive. However, the firm plans to introduce new EV for half the price in 2017. Mr. Sukemasa Kabayama, the president of Tesla's Japan arm, said that "we are preparing the environment for our users to drive their EVs in the Kansai area." (The Nikkei, February 14, 2015)

(13) ZTE Corporation

ZTE Corporation, a major Chinese manufacturer of telecommunications equipment, will invest 3.5 billion CNY (approximately ¥67 billion) in technological development for EV wireless charger over two years. Mr. Sun Zhenge, a vice chairman, revealed this in Hong Kong on February 12th. (The Nikkei, February 14, 2015)

(14) Apple

The Wall Street Journal (WSJ), an American daily newspaper, has reported that US-based Apple had started its own EV development. A group of a couple of hundred will work on developing a mini-van as a secret project. The firm already started headhunting engineers from major automakers as well as EV manufacturers including Tesla Motors. According to WSJ, the development team is planned to expand to 1,000 members in future. British newspaper the Financial Times has also reported that Apple was hiring a large number of automobile designers. The firm has been seeking an opportunity to get into the automobile industry even when its founder Steve Jobs was still alive in mid-2000. A collaborative work was discussed with Tesla in 2013. (The Nikkei, February 14, 2015)

7. FCV Part Development

(1) Toyo Drilube

Toyo Drilube has developed functional coating with an ultimate water repellent effect. Coating product prevents droplets being retain on the surface. The firm will sell the product to automakers and manufacturers of automobile parts as an effective surface processing technology to avoid electricity leak of EVs and FCVs which are expected to grow. (Nikkan

Jidosha Shimbun, January 20, 2015)

(2) Kobe Steel

On January 20th, Kobe Steel announced that its titanium material was used for a core component of Toyota's FCV "MIRAI". The flat-rolled specialty titanium is coated with carbon on its surface to be supplied as a part for the separator panel in FC stacks, the heart of FCV. (The Nikkei, The Nikkan Kogyo Shimbun & others, January 21, 2015)

8. Hydrogen Filling station Technology Development and Business Plans

(1) Toyota Tsusho

On January 19th, Toyota Tsusho held a completion ceremony of two stationary hydrogen filling stations constructed in Aichi Prefecture. Hydrogen business is the core of their energy area, and it stepped forward by launching these filling stations. (The Nikkei Business Daily & The Nikkan Kogyo Shimbun, January 20, 2015)

(2) Nippon Steel & Sumitomo Metal

On January 20th, Nippon Steel & Sumitomo Metal announced that a special stainless steel tube had been developed to supply high pressure hydrogen for filling stations. The metal ratio was adjusted to double the strength of the existing product. The tube can be thin, which gives a more flexible process. This also reduces the costs of final products. The manufacturer aims at over 50% of commercial hydrogen filling stations, which are to be built more, to use its product. (The Nikkei, January 21, 2015)

(3) WELCON

WELCON, a special metal welding company in Niigaga City, has developed a small heat exchanger for hydrogen filling station for FCVs. This heat exchanger is used to refrigerate hydrogen to be supplied to FCVs. Thin metal sheet is welded to make very fine channels, which enable a reduction in the size of the heat exchanger by up to one hundredth that of conventional ones. The firm aims for hydrogen filling stations which are under preparation nationwide. This heat exchanger is used in the process to store hydrogen in a tank and dispense it to FCVs, and has numerous micro channels of 50 μm to 1 mm. Hydrogen and CO_2, a cooling medium, flow in separate channels to exchange heat in order to chill hydrogen. (The Nikkei Business Daily, January 23, 2015)

(4) Saibu Gas

On January 29th, Saibu Gas announced that a hydrogen filling station would be built for FCVs in Higashi-ku, Fukuoka City. This filling station will be equipped with facilities to produce hydrogen from natural gas, and it is the first on-site production hydrogen filling station in Kyushu. As well as refueling FCVs, produced hydrogen will also be sent to other hydrogen filling stations without hydrogen production facilities. The firm will choose a constructor through a tender in early 2015 aiming to start operating in March 2016. (The Denki Shimbun & The Nikkan Kogyo Shimbun, January 30, 2015)

(5) Takaishi Industry

Takaishi Industry, a long-established packing manufacturer for water and gas pipes in Osaka Prefecture, has developed rubber packing for hydrogen filling stations. The new product is to be used to prevent leaks at connections between hoses and dispensers of hydrogen filling stations. Mr. Hideyuki Takaishi, the president, states that common rubber packing "deteriorates when exposed to hydrogen and possibly cracks". "We use our own technology to optimize the rubber compounding and for forming process, and our new product is durable for hydrogen filling stations.", says he. (The Nikkei, February 2, 2015)

(6) Yamato Sangyo

Yamato Sangyo, a manufacturer of valves for industrial high pressure gas in Osaka City, has developed a dedicated valve to contribute to a reduction in the size of the dispenser. By using their expertise on industrial gas, the valve uses clamped connection rather than a commonly used plug-in system such as screwed connection. This contributes to reducing the size of dispensers by shortening the hydrogen path. Plug-in system valves require many parts to be removed and fasten again during maintenance. On the other hand, valves with clamped connection only need a minimum number of parts to be removed, which reduces costs and work. The firm plans to bring up hydrogen filling station as its key business. Their headquarters will be equipped with a hydrogen filling station, and their subsidiary has started selling a self-developed small hydrogen dispenser. (The Nikkei, February 2, 2015)

(7) JX Nippon Oil & Energy Corporation

On February 5th, JX Nippon Oil & Energy Corporation opened a hydrogen filling station in Hachioji City, Tokyo. This is the second for them after Ebina City, Kanagawa Prefecture. The hydrogen sells for ¥1,000/kg. The firm decided to install hydrogen filling stations at 11 locations in four prefectures and Tokyo. (The Nikkei, February 6, 2015; The Denki Shimbun, February 9, 2015)

(8) Kansai International Airport

On February 10th, the New Kansai International Airport Company revealed a FC forklift and dedicated hydrogen dispenser to the media. This is part of the "Hydrogen Grid Project" jointly operated with Iwatani and Toyota Industries, and experimental operation will start from 23rd at Kansai International Airport. "We will become literally the world's most environmentally advanced airport" said Mr. Keiichi Ando, the CEO of the company. A full-scale operation is planned to start in FY 2016. A single forklift to start with, they will replace 200, half that of the current figure, with FC forklifts. This will reduce 300 tons of CO_2 emissions each year. A rechargeable forklift requires six to eight hours to be fully charged. On the other hand, it takes about three minutes to refuel FC forklift, which improves working efficiency. Mr. Akiji Makino, the CEO of Iwatani which supplies hydrogen fuel, said that "this is a large step to open a door to a hydrogen society." The hydrogen supplier also announced that a hydrogen filling station for consumers was planned to be open on the airport premise by the end of 2015. This will be the first hydrogen refueling facility installed in an airport in Japan. (The Nikkan Kogyo Shimbun, February 11, 2015; The Nikkei Business Daily, February 12, 2015)

(9) Toyota, Nissan & Honda

On February 12, Toyota Motor, Nissan Motor and Honda announced that they would together cooperate to prepare hydrogen filling stations to refuel FCVs. The core of this project is subsidized operation costs of hydrogen filling stations, and these three automakers will decide the ratio and amount of contribution by mid-2015. They aim to build a hydrogen refueling facility network earlier by supporting the operation of filling stations by themselves to expand the FCV market. Toyota released retail FCV "MIRAI" last December. Honda is planning to introduce one into the market in FY 2015, and Nissan aims to bring out FCV under development in cooperation of German-based Daimler in 2017. The Japanese government targets for 100 hydrogen filling stations, which are essential for FCV growth, by FY 2015. A hydrogen filling station costs ¥500 million to install. Although the government subsidizes these filling stations, operation of the stations is currently not easy since the FCV has market just started. Incidentally, preparation plans may be delayed. Toyota plans to increase the annual production level of MIRAI to 3,000 vehicles by 2017. However, a hydrogen filling station needs the use of 2,000 FCVs to be financially viable, according to Deloitte Tohmatsu Consulting. (The Nikkei & The Nikkan Kogyo Shimbun, February 13, 2015)

(10) Toyota Tsusho, Iwatani & Taiyo Nippon Sanso

On February 13th, Toyota Tsusho, Iwatani and Taiyo Nippon Sanso announced that the first commercial mobile hydrogen filling station would be operated in Japan. A joint venture will be launched to install and operate hydrogen filling stations as well as hydrogen supply. The first project will operate at Chiyoda-ku, Tokyo, from the end of March. The current plan is two in Aichi Prefecture and one in the greater Tokyo area to increase the number to four. "LLC Japan Mobile Hydrogen Station Service" was launched on February 6th with ¥30 million equally contributed by the three firms. Toyota Tsusho operates the service, and Iwatani and Taiyo Nippon Sanso produce mobile refueling facilities and provide hydrogen. Sumitomo Mitsui Finance & Leasing buys mobile hydrogen filling stations to be leased as a financial arrangement. The mobile hydrogen filling station consists of a trailer with hydrogen tank on board to supply FCVs with fuel. Compared to stationary refueling facility, mobile ones requires a third of land area and the facility preparation period is shorter. The three firms aim for fast infrastructure preparation which is essential for FCV growth. (The Nikkei & Nikkan Jidosha Shimbun, February 14, 2015)

Hydrogen Measuring & Detecting Equipment Development & Business Plan

Murakamigiken, a manufacturer of devices to secure safety in Osaka Prefecture, has developed a new optical hydrogen gas detector with excellent safety

performance “H-10S”. Currently a combustion method is used for hydrogen detectors for hydrogen plants and filling stations, but it has a risk of fire. In contrast, the firm commercialized the world’s first device which optically detects hydrogen using color change, gasochromism, to improve safety. Sales activity has started with a target of annual 100 units. (The Chemical Daily, January 27, 2015)

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