Alliance to Commercialize Solid Hydrogen-Source FC

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1. Governmental Measures

(1) Government

On December 24th, the Japanese government decided the budget bill for FY 2014. Increases were approved in social security, public projects and defense. The total amount of the general account is ¥95.8823 trillion which is a 3.5% rise on the initial budget for FY 2013, and the largest ever for the country. (Nikkan Jidosha Shimbun, December 25, 2013)

On December 27th, the government announced that a report consisting of a reduction target of greenhouse gases and actions to achieve the target has been submitted to the United Nations. The report contains Japan's 3.8 % reduction target on that of 2005 and actual plans to realize this objective. As the measures, the government plans to increase the sales of next generation cars including hybrid vehicles (HVs) and electric vehicles (EVs) to 50 to 70 % from the current 20% of the new car sales. Also, the number of domestic fuel cells (FCs) is to hit 1.4 million units by 2020 and 5.3 million units by 2030. (The Yomiuri Shimbun & The Nikkei, December 28, 2013; The Kobe Shimbun & The Shizuoka Shimbun, December 29, 2013; The Mainichi Newspapers, January 10, 2014)

The government intends to use its Official Development Assistance in order to promote Japanese technologies as well as selling Japanese standards. In the end of March, Japanese EVs and advanced medical equipment will be provided for emerging nations in Asia and North Africa as grant aids. Also the Japanese system will be taught as technical assistance later. A total amount of ¥12.5 billion from the supplemental budget of FY 2013 and the initial budget of FY 2014 will be invested for the projects. (The Nikkei, January 11, 2014)

The government is investigating using public transport such as buses and taxis as a promotion of fuel cell vehicles (FCVs). A subsidy scheme and preparation of hydrogen filling stations are under consideration for major cities including Tokyo which will have the Olympic Games in 2020. Because busses and taxis run for longer in a day than private vehicles, this should support hydrogen supply businesses to improve their profitability as well as a price reduction by volume effect. The details of measures will be included in the road map of hydrogen and FCs which is to be drawn by the end of FY 2013. (Nikkan Jidosha Shimbun, January 15, 2013)

(2) METI

The general account of the Ministry of Economy, Trade and Industry (METI) has risen to ¥341.1 billion, a 3.4% increase on the initial budget of FY 2013, for FY 2014, and the total amount makes ¥1,543.9 billion, a 7.4% rise on the initial budget of FY 2013, including special accounts for energy measures. They secured ¥30 billion, which is the same amount for FY 2013, for the Subsidy for Purchasing Clean Energy Vehicle to promote EVs and plug-in hybrid vehicle (PHVs). The budget for the subsidy scheme for preparation of hydrogen filling stations for FCVs increased to ¥7.2 billion from about ¥4.6 billion of the previous year. Lithium-ion batteries (LIBs) and highly efficient motors are essential to improve electric eco cars' function, and the grants for these areas of research and development also stayed the same level as for FY 2013. (Nikkan Jidosha Shimbun, December 25, 2013)

The Agency for Natural Resources and Energy of METI will encourage businesses to get involved in hydrogen filling stations for FCVs. In Feburary, a meeting will be held in Osaka to explain specifications of related facilities including hydrogen production equipment and the demands of the manufacturers in order to inspire firms to look into development and production of these products. The agency expects a cost reduction of hydrogen filling stations by increasing the number of participants with technologies in the market to accelerate the preparation of a hydrogen infrastructure network. (Nikkan Jidosha Shimbun, January 10, 2014)

(3) MLIT

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has ensured ¥4 million for a preparation of building standards on liquid hydrogen carrier ship. Demand for liquid hydrogen transport is expected to expand as FCVs grow. (The Japan Maritime Dairy, December 25, 2013)

MLIT will fully start a preparation of liquid hydrogen carrier ship to be in practice. Actual safety standards have been the subject of talks between Japan and Australia, which is to be the shipper to start with. Hydrogen will be transported at a very low temperature of −253°C, and the ministry is trying to make the safety standards be developed specifically for the global market conditions. The budget bill was decided on December 24th, and ¥7 million was allocated for the activities. Japan and Australia have cooperated in a project to produce a large amount of hydrogen from lignite, which is a lower grade coal, at a cheap rate, and liquefy it for transportation to Japan. (The Japan Maritime Dairy, December 27, 2013)

(4) MOE

The budget allocation including the general and special accounts of the Ministry of the Environment (MOE) has become ¥804.2 billion which is a 17% decrease on the initial budget for FY 2013. For the low carbon society field, ¥5.3 billion is allocated to create a community of low carbon, recycling and coexistence with nature. Others are ¥1.2 billion designated to promote zero carbon electricity using carbon dioxide capture and storage (CCS) technology, ¥0.6 billion for development of ultrahigh efficient devices to support the technological advance of FCs, and ¥0.55 billion for the commercialization of tidal power technologies in order to extend the usage of oceanic energy. (The Chemical Daily, December 25, 2013)

2. Local Governmental Measures

(1) Kyoto City

In Kyoto, there are activities to promote the hydrogen FCs developed by Kyoto University and Rohm. The team of Prof. Kazuyuki Hirao at the Graduate School of Engineering of Kyoto University established a technology to produce hydrogen by reacting aluminum with calcium hydroxide, which is delivered after generation. The technology allows the making of hydrogen for 24 hours continuously, and is expected to be applied to stationary generators. On January 9th, 2014, a joint association "Kyoto FC Alliance" will be organized by about 20 businesses, local governments and supporting bodies to aim for the commercialization of a solid hydrogen-source, calcium hydride, FC. The alliance's office will be situated at the "Kyoto City Growing Industry Creation Center (ACT Kyoto) which was opened in November, 2013 in Fushimi-ku, Kyoto City. To promote the solid hydrogen FCs, the alliance will study unified standards for fuel containers and patent strategies, and plans to start a large scale production to introduce the FC into the market in FY 2015. (The Kyoto Shimbun, December 26, 2013; The Nikkei, The Sankei Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, Dempa Shimbun, The Kyoto Shimbun, The Kochi Shimbun, The Kitanippon Shimbun, Akita Sakigake Shimpo & Fukushima-Minpo, January 10, 2014; Dempa Shimbun, January 13, 2014, The Chemical Daily, January 14, 2014)

(2) Yamaguchi Prefecture

Yamaguchi Prefecture will experiment with a rotary engine of Mazda, Fuchu City, using hydrogen as a fuel, in Ube City from March, 2014. Sales of FCVs will start in 2015, and hydrogen related business is estimated to grow quick. Through the experiment, related businesses in the prefecture aim to obtain expertise for their market entry. The primary targets are a development of a hydrogen generation system in the prefecture, and three firms of the prefecture to establish maintenance methods. (The Chugoku Shimbun, January 6, 2014)

(3) Fukuoka City

Fukuoka City will establish "Fukuoka Smart City Community Creation Council", a cooperative organization of industry, academia and government, on January 23rd to realize a smart city there. The council aims to develop technologies for smart community and commercialize them by promoting collaboration of industry, academia and government. In the council, their working groups will study livelihood support using information technologies, FCs and human development. The number of participants is expected to be from 20 to 30 organizations to start with. (The Nikkan Kogyo Shimbun, January 10, 2014)

Fukuoka Prefecture will form an organization dedicated to promote FCVs with local firms and employers' associations as earliest as this spring. They will study the advantages and disadvantages of FCVs as well as possibility of launching a website for FCV promotion. The FCV demand of businesses and residents in the prefecture will be sought by private and governmental cooperation. "FCV Club" is being considered as the name of the organization but as yet is undecided. (The Nikkei Business Daily, January 17, 2014)

3. Technology Developments of FC Related Elements

(1) The University of Tokyo

A research team of Associate Prof. Teruyasu Mizoguchi at the Institute of Industrial Science of the University of Tokyo has developed an analysis method to estimate the dynamic behavior of molecules in a specific part of a liquid. The method entails spectroscopy using a transmission electron microscope with a nano level resolution as its base, and combined with other calculations. The estimation of molecular vibration and rotation were confirmed with this method. Because liquid can be analyzed at a nano level, the method potentially contributes to accurate designing of FC catalysts of which the important reaction occurs on the interface between a liquid and solid. The method employs electron energy-loss spectroscopy (EELS) which measures absorption spectrums using a transmission electron microscope with electron beams. The team focused on the electron energy loss near edge structure (ELNES) which is a spectrum influencing atomic binding and configuration. Molecular dynamics simulations which calculate atomic and molecular structures by using the potential energy of atoms are combined with first-principle band-structure calculations which examine electron structure. With these methods, the carbon K-edge of liquid methanol, which is used in FCs, was calculated and the molecular dynamics of the liquid were estimated. (The Nikkan Kogyo Shimbun, December 25, 2013)

A team of Associate Prof. Naoya Shibata and Prof. Yuichi Ikuhara at the University of Tokyo has discovered a method to keep the performance of a platinum catalyst for a longer period. The catalyst is used in FCs and vehicle exhaust systems to remove pollutants. According to the study, the more platinum atoms which go into the oxygen vacancy on the surface of titanium oxide during the vapor deposition of platinum, the longer the catalyst performs. The team confirmed that platinum atoms were absorbed on the titanium oxide surface by comparing transmission electron microscopy images of titanium oxide and theoretical models. Generally a couple of hundred of platinum atoms form a particle. A larger particle sticks less strongly on to the titanium oxide surface. Their study suggests that a larger number of oxygen vacancies available for platinum atoms, and very small groups of platinum atoms, makes the platinum last longer, and the catalyst maintains its performance for longer. Also the technology can contribute to a significant reduction in platinum usage. (The Nikkei, January 7, 2014)

(2) Stanford University

The team of Hirohito Ogasawara, a staff scientist at SLAC National Accelerator Laboratory operated by Stanford University, has discovered that water molecules around platinum, a catalyst used for FC, were important for improvement of FC performance. There are two types of hydroxides around platinum; one is a non-hydrated hydroxide which is bonded only with platinum, and the other is a hydroxide which is bonded with both water molecules and platinum. The team found out that a higher electromotive force and output were produced when fewer water molecules were bonded with platinum. Platinum catalyst is required to be reduced for FC commercialization. This study suggests that controlling the amount of water molecules around platinum catalyst should enhance the performance and save amount of catalyst. The team successfully observed the behavior of oxygen such as oxygen atoms, hydroxides and water molecules bonded with the platinum catalyst of a cathode during redox reactions by using soft X-rays. The findings proved that the hydroxides are the intermediate of the redox reaction as expected. They also discovered that a non-hydrated hydroxide which is bonded only with platinum and a hydroxide which is bonded with both platinum and water molecules in atomic surface of the platinum catalyst. (The Chemical Daily, December 27, 2013)

4. Development & Business Plan of Industrial FC

Tokuyama will change its research and development policy. The majority of the capital for research will shift from the electronics and information technology fields to life science and medical and environment and energy fields. For the energy field, a hydrocarbon membrane was developed as a FC material, and they have started a field test abroad using it as a material for backup power sources for cell phone base stations. (The Chemical Daily, January 6, 2014)

5. Ene-Farm Business Plans

(1) JX

For the electricity liberalization coming in 2016, JX Holdings decided to operate agencies where consumers can choose their electricity provider. JX Nippon Oil & Energy, a member of JX Holdings, will provide the service that suggests the best choice of electricity including its own and the other electricity service for each consumer at its 11,100 gasoline filling stations nationwide. The firm has about 700 "Energy Analysts" for home energy saving, and the number of the analysts will be increased to 1,000 soon. The analysts also give advice on energy saving and Ene-Farm developed by JX. (The Yomiuri Shimbun, January 1, 2014)

(2) Misawa Homes

On January 10th, Misawa Homes announced that its Kumagaya Smart Cocoon Town under development in Kumagaya City, Saitama Prefecture, was chosen as a "Leading Project of CO_2 reduction for Houses and Buildings" of MLIT. The development cost will be subsided by the state. The town will contain 73 houses and each house will be equipped with a photovoltaic generator and a FC. Also, wind flows and sunlight are taken into account for the whole town design. The land area for the development is 18,600 m^2 which was unused and bought from Kumagaya City. The firm plans to sell the houses from this summer. The photovoltaic generators and FCs of the houses can supply most of the electricity consumption their households need. (The Nikkei Business Daily, January 14, 2014)

6. Cutting Edge Technologies of FCVs and EVs

(1) Oita Prefectural Technical High School

Oita Prefectural Technical High School has developed a hybrid car combined with a FC and photovoltaic generator. Since the school was appointed for the Support Project for Education on Energy of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as the first school in the prefecture, the study has been carried over by the students to finish the car in five years. The main point of the study is that the vehicle has no storage batteries and the photovoltaic generator and FC power the car. The students found that a FC could only stand a weak current load. This stopped the motor to starting without a battery when setting off, and was the biggest problem in the development. To solve it, the students enlarged the capacitor, which can store electricity, to complement the FC in the FY 2011 experiment. During a test run, last December, the car drove about 12 km on a course of a driving school in Oita City as a test. The power outputs were found to be approximately 43 kWh for the FC and approximately 8 kWh for the photovoltaic generator. (Oita Godo Shimbun, December 25, 2013)

(2) Honda & GM

Honda and US-based GM are considering a joint production of a FC system which is the heart of FCVs. They aim to reduce the cost of the expensive core component by volume effect in order to make their cars cheaper and lead the market of next generation eco cars. Currently the production cost of a FCV is about ¥10 million per vehicle. Their target is to bring it down to an affordable level of a couple of million yen for consumers. In July, 2013, the automakers signed for the cooperation of developments of FCV parts. Their engineers have interacted with each other to introduce a new FCV to the market by 2020. (The Yomiuri Shimbun, January, 4, 2014)

(3) Toyota

Toyota Motor will establish a dedicated team in FY 2014 to show the motorized society of future at the 2020 Olympics in Tokyo. Considering actual projects, the automaker, with the team, plans to popularize FCVs and to commercialize a self-driving technology for its cars to cruise on expressways almost autonomously. Their brand new FCV model will be available from 2015, and its sales expansion period is expected to be in the 2020's. Also a FC bus is under development, and it will hopefully be used for transporting athletes and audiences of the Olympics. (The Tokyo Shimbun & The Chunichi Shimbun,

January 5, 2014)

From January 10th to 16th, Toyota Motor Kyushu, Fukuoka City, will have a test of FC bus around the Ito campus of Kyushu University. The aim of the experiment is to examine the CO_2 reduction of driving on public roads. Accommodating 25 people, the bus will run between the campus and JR Kyudai-Gakkentoshi Station for four round trips a day. The experiment is a project of MOE. (The Nikkan Kogyo Shimbun, January, 10, 2014; The Nishinippon Shimbun, January 11, 2014; Saga Shimbun, January 14, 2014)

(4)Eco Car Production & Sales in China

Global auto giants are preparing for production and sales of eco cars in China. The Chinese government is raising its regulatory level for fuel and exhaust gas emissions to the developed countries', and the automakers are required to make more highly environmentally friendly cars for the market. German-based VW will start its EV and PHV production in China in 2016. These vehicles will be produced, including their core components of the batteries and drive motors at the Foshan plant, Guangdong, which is a joint facility with the FAW Group Corporation. The annual production level is expected to be a dozen of thousand to start with. Their joint venture plans to introduce a total of 10 locally produced vehicles by 2020 as well as development of an EV exclusive to the Chinese market.

US-based GM will start fundamental research for batteries and motors at its base in Shanghai. By developing and producing an EV exclusive to the Chinese market with the SAIC Motor Corporation they aim to introduce the model as soon as possible. A US-based EV venture Tesla Motors will open its first own outlet in Beijing in December. From 2014, a strong sales promotion of their sports EV will be carried out targeted at the rich. Becoming the largest market in the world, the Chinese auto sales reached approximately 21.5 million vehicles in 2013. The Chinese government plans to introduce a total of 5 million PHVs and EVs combined by 2020. (The Nikkei, January 8, 2014)

(5) Myway Plus

Myway Plus Corporation which provides evaluation on hybrid vehicle motors in Yokohama City and Tokyo R&D which develops automobile bodies in Tokyo will establish "Myway Pues", a joint venture to develop and analyze components for eco cars. The venture will go between automakers and other ventures and electronics manufacturers who know little about eco cars to enter the market. (The Nikkei Business Daily, January 10, 2014)

(6) Mitsubishi Motors

Mitsubishi Motors will expand to three its range of PHVs, which can be charged by domestic wall sockets. As well as a sport utility vehicle (SUV) "Outlander", a large SUV "Pajero" and small SUV "RVR" will be added in the range. The automaker will double the production ability to 60,000 vehicles, and also ship some vehicles to the US. Their main manufacturing facility Nagoya Plant will gradually improve its production line by May 2015 with capital of approximately ¥5 billion. The battery pack assembly requires manual labor and that will move to the main production line for more efficient production of PHVs. Quick chargers are expected to spread nationwide, and the firm decided to scale up the production level with the expectations. (The Nikkei, January 11, 2014)

(7) GLM

Green Lord Motors (GLM), Kyoto City, which is an EV development venture from Kyoto University, has signed an agreement to use the ex-runway of Maishima, an artificial island, which Osaka Prefecture and City letting businesses use as a test run course to support EV development. Being partially used as a test course, the runway was originally developed by Osaka City for light aircraft events in 1994. GLM plans to reduce the cost and time of travel by using the test course. Their booth in "Grand Front Osaka" displays their car, and the test course is convenient for them to offer a test drive to their potential customers. The venture was established by master students of Kyoto University in 2010, and it brought Tommykaira ZZ back as an EV. Tommykaira ZZ was originally developed by a manufacturer in Kyoto in 90's, and ran on gasoline. Having a good acceleration, the new EV can reach 100 km/h in 3.9 seconds. It takes 30 minutes to charge the battery to nearly full. The 120 km driving rage specification will sell for ¥8 million. Having all sold out already, the first shipment of 33 vehicles starts this spring. GLM will start taking orders for another 33 vehicles within January for the second shipment.

Also, the chassis of the EV interests firms in Europe and Malaysia. (The Nikkei, January 15, 2014)

(8) Shinshu University

The study group of Prof. Wataru Sugimoto at the Faculty of Textile Science and Technology (Materials and Chemical Engineering Department) of Shinshu University has been developing a high function catalyst for FCVs in collaboration with Aisin Seiki and Toyota Central R&D Labs. The group aims to improve the function of the platinum catalyst. In a FCV, catalysts are used in the severe conditions of acceleration and braking, which promotes oxidization of the platinum and deterioration. Therefore, FCV batteries have a performance problem in the long term. For this joint development, the group uses a ruthenium oxide nano sheet which was developed by Prof. Sugimoto in 2003. Being liquid, the material can be mixed with particles of platinum catalyst. This gives the catalyst much better durability than conventional platinum catalysts as well as improving the catalytic performance. The higher catalytic performance contributes to a price reduction of FCVs by cutting down the platinum usage. Also Nissan Motor joins the development and the group aims to establish a commercial production method of the catalyst by 2015. (The Shinano Mainichi Shimbun, January 16, 2014)

(9) London's policy

On January 16th, the Mayor of London, Boris Johnson, announced that newly registered taxis in London would be all zero emission cars such as EV and PHVs from 2018. These cars are required to drive in the city center on electricity. The City of London are preparing chargers inside the city quickly, and aim to increase the number to 6,000, over four times of the current figure, by the end of 2018. EV taxi development is in a race with five automakers including London Taxi Company which is famous for its black cabs and owned by China-based Geely Automobile, Nissan and German-based Mercedes-Benz. Nissan plans to introduce its e-taxi using NV200, its multipurpose vehicle sold worldwide, as the base to London by 2015. (The Nikkei, January 17, 2017)

(10) EV Charger Preparation in US

EV manufacturers including German-based BMV and Nissan will install more quick chargers and add universal charging specifications to their cars. Introducing its EV into the states in May, BMW will install quick chargers in cooperation with an electricity provider and a real-estate developer. Nissan will also speed up its quick charger installation cooperated by a real-estate developer in 2014. The number of quick chargers prepared in 2013 by Nissan was increased to 500, triple that of 2012, and the firm will add more. US-based Tesla Motors installed a belt of chargers at 60 points with own charging standards across the States, which made its EV can traverse the States. The number of their charging points is planned to increase by over 10 times that of the current figure in 2015. A US-based EV venture Via Motors plans to enter the market for consumer large EVs such as pickup trucks in 2014. Since the federal and state governments have introduced a number of promotions for EV manufacturers and consumers, and the market is expected to expand. (The Nikkei, January 19, 2014)

7. Hydrogen Filling Station Related Technology Developments & Business Plans

(1) KHI

Kawasaki Heavy Industries (KHI) intends to accelerate its technological developments to be used to build a hydrogen supply chain. Their long time experience in liquid hydrogen has given them considerable expertise and knowledge. Planning to establish the development quickly, the firm will use the expertise in the new technologies mainly for a hydrogen transport and storage system including a hydrogen tanker truck. Also the technologies aim for a wide range of end usages such as hydrogen filling stations and hydrogen gas turbines. KHI intends to make unique technologies to be fully commercialized for various industries. (The Chemical Daily, January 26, 2013)

(2) JX Holdings

JX Holdings will provide hydrogen at a low cost for FCVs. JX Nippon Oil & Energy, the core member of the group, developed a technology which allows it to sell hydrogen produced in its refinery. With the technology, hydrogen is mixed in toluene as a liquid for transportation in tanker trucks to hydrogen filling station under normal pressure and at normal temperatures. At a filling station, hydrogen is

separated from the mixture with an originally developed catalyst, and gasified again for refueling. The liquefying technology eliminates the need of very strong carbon fiber cylinders and facilities to prevent explosions. Also tanker trucks and tanks for gasoline can be used with the technology. The estimated cost of a hydrogen filling station with the technology, is ¥200 million which is half that of conventional methods. Because the liquid form reduces the volume of hydrogen, a tanker truck can take double the amount of hydrogen at once. The current hydrogen production and distribution cost is ¥145/m^3. Once a hydrogen distribution system is established with the new technology, the cost can be ¥100/m^3 or less which is the level for FCVs to expand. The firm aims to start preparation of a distribution network with the technology by 2020. (The Nikkei, January 15, 2014)

(3) Toyota

On January 6th, Toyota Motor revealed a deployment estimation of hydrogen filling stations. According to the report, 68 hydrogen filling stations are required to support 10,000 FCVs in major cities of California, US. California plans to prepare 40 hydrogen filling stations by 2016. Timing with this preparation, the automaker will introduce its FCV into the US market in 2015. (The Nikkei, January 7, 2014; Fuji Sankei Business I, January 8, 2014)

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