PEFCs for Base Stations for Cell Phones as an Emergency Power

Arranged by T. Homma

1. Governmental Measures

(1) The Cabinet

On October 26th, cabinet officials decided emergency measures for stimulating the economy which are to be carried out promptly. Prime Minister Yoshihiko Noda had asked the ministers to compile the package. The budget, consisting of state reserve and other funds, is up to ¥420 billion, and the total project expense including local governments' spending is approximately ¥750 billion. The selected package includes; research on tissue engineering with induced pluripotent stem cells (iPS) (¥2 billion), installation subsidy for domestic fuel cells Ene-Farm (¥25.1 billion) and subsidy for introducing renewable energy to local communities. For Ene-Farm, the subsidy will be maximum ¥450,000 per unit to increase its popularity with a target at 53,000 units which is more than the current accumulated figure. (The Yomiuri Shimbun, The Mainichi Newspapers, The Nikkei, Architectures, Constructions & Engineerings News (Daily), The Tokyo Shimbun, The Kyoto Shimbun, The Hokkaido Shimbun, Fuji Sankei Business i, The Chemical Daily, etc, October 26, 2012; The Sankei Shimbun, Kanagawa Shimbun, The Shinano Mainichi Shimbun, The Kahoku Shimpo, etc, October 27, 2012; The Denki Shimbun, The Chemical Daily, October 29, 2012)

(2) METI

The Ministry of Economy, Trade and Industry will lay down operational guidelines for systems and facilities composing smart houses by the end of the FY 2012. The ministry will prioritize eight core facilities including a home energy management system (HEMS) and a smart meter. The core equipment consists of a smart meter, a photovoltaic generator, a storage battery, a FC, an air conditioner, lighting, a water heater, and an electric vehicle (EV)/plug-in hybrid vehicle (PHV). To promote smart houses, METI will clarify where responsibility lies for consumers to avoid a disadvantageous liability, because these houses consist of multiple appliances. The Smart House/ Building Standardization and Business Promotion Study Group of METI has already started to create operational guidelines. The draft will determine an outline such as a demarcation point of business operators, a procedure of engineering operation and a role of customer support. Additionally, "Demonstration Center" will be open in Waseda University on November 1st to examine compatibility between standards of the US and Europe with an eye toward to bring Japanese standards worldwide. (The Nikkan Kogyo Shimbun, October 24, 2012)

(3) Agency for Natural Resources and Energy of METI

The Agency for Natural Resources and Energy will accelerate preparation of the environment for the fuel cell vehicles (FCVs) including subsidies for constructions of hydrogen filling stations with an expectation of a market boost from FY 2015. Easing of the related regulations and standardizing the facilities has been on the way as well as creation of markets such as using FCVs for public transportation. The government aims for 100 filling stations and over 1,000 FCVs in use by FY 2015. The ministry will make a foundation for the FCV market to continue expanding from FY 2015 by developing a cheaper transportation method for hydrogen and assistance for cost reduction of FCV parts, and start the "Subsidy for Hydrogen Supply Facility Preparation" (¥50 billion for the first year) from FY 2013 to raise the number of filling stations. Half the construction cost (two thirds for an accumulator with a new technology) will be assisted as an encouragement to increase the number of the filling stations to 100 from the current 19. At the same time, facility construction and licensing procedures will be reviewed with speed based on the operational results from the existing filling stations. Additionally, the ministry plans to formulate management standards of hydrogen as fuel. (Nikkan Jidosha Shimbun, October 29, 2012; The

Chemical Daily, November 7, 2012)

The Agency for Natural Resources and Energy aims to shorten filling time of hydrogen, for FCVs, from a tank truck to 30 minutes, approximately a tenth of the current time. The temperature standards for piping are currently set by voluntary standards which are confirmed safe, and the standards will be eased. Currently, it takes four hours to load to a tank truck, which is a large time loss. (Nikkan Jidosha Shimbun, November 1, 2012)

(4) Japan Patent Office of METI

METI plans to start a package examination on patent application of differentiated products and projects such as a FCV and personal digital assistance in practice as early as April 2012. The examination procedure and procedural requirements will be developed during the experimental period in FY 2013. The ministry considers extending the applicable range to a group development project of multiple small or medium size businesses as well as single firm. This package examination would be a global first. Japan Patent Office which belongs to METI will start the package examination after trial examinations with the cooperation of major firms in the automobile, electric appliance and machinery industry. A maximum of 10 projects will be examined in FY 2012 to design the system. (The Nikkan Kogyo Shimbun, November 15, 2012)

2. Local Governmental Measures

(1) Fukuoka City

On October 31st, the Island City (an artificial island in Higashiku, Fukuoka city) Promotion Section unveiled "CO_2 Zero Area" where all the houses save and produce electricity to reduce carbon dioxide (CO_2) emission. Fukuoka city plans "Urban Development Area City's Block 5" (64.6 ha) to be a residential zone using renewable energy, in the north east part of the island. The housing development will be carried out by a consortium including Sekisui House (Osaka city) who bought the area from the city. On October 31st, 13 houses were completed, and the construction of all 178 houses will be finished by FY 2015. All 13 houses have large capacity solar panels, natural gas Ene Farm, high insulation and light emitting diode (LED) lighting as well as a HEMS. Based on their CO_2 emission reduction, households will be given Eco Points which are exchangeable for products. (The Nishinippon Shimbun, October 31, 2012; The Nikkei Business Daily, The Nikkan Kogyo Shimbun, The Chemical Daily, November 1, 2012; The Denki Shimbun, November 13, 2012)

(2) Kumamoto Prefecture

Kumamoto prefecture has compiled a total energy plan for FY 2011 to 2020. New energy such as photovoltaic generators, smaller size hydroelectricity, wind power and geothermal will be used more. Also, the energy reduction target by the final fiscal year is crude oil equivalent 600 ML (million liters) by new energy and 400 ML by energy saving, a total of 1,000 ML all together. The plan is to increase number of domestic photovoltaic generation facilities to 17.01%, whereas it was 5.30% in FY2010. The aim is for 50 solar farms, is aimed at 50 currently standing at three. (Kumamoto Nichinichi Shimbun, November 12, 2012)

3. Technology Development of PEFC Related Element

Taisei Kogyo, Osaka prefecture, will promote to extend application of its original absorbent porous metal. The material absorbs liquid with a pore diameter and porosity set to prevent capillary action, which was developed by modifying the surface to improve hydrophilicity. They expect the product to be used for separation of gas and liquid or liquid storage and controlled release such as absorbing water generated from polymer electrolyte fuel cell (PEFC). (The Chemical Daily, October 23, 2012)

4. PAFC Related Technology Development

A study group with Prof Atsunori Matsuda of Department of Electrical and Electronic Information Engineering at Toyohashi University of Technology developed a higher performance electrolyte membrane with a reduced amount of phosphoric acid of phosphoric acid fuel cells (PAFCs). With using the higher hydrogen conductive inorganic compounds, the amount of phosphoric acid additive is reduced to 3 mol, a third of conventional products. A FC with the membrane reached a maximum output of 350 mW/cm^2 at 160 °C without humidification. The key materials are heteropoly acid, an inorganic compound, with tungsten and silicon and cesium hydrogen sulfate powered in a ball mill, and they are mixed with mechanical shocks to induce chemical reaction.

The product's hydrogen conductivity is high due to an activated surface. The conductivity is performed through a wider range of temperatures, which allows a FC to have broader operating temperatures between 20 and 160°C. The inorganic compounds are mixed with solution of polybenzimidazole (PBI), a thermal stable polymer, and then phosphoric acid is added to form the membrane. The FC with the membrane operated continuously for 800 hours with hardly eluting phosphoric acid. Also, the amount of platinum in the electrodes is 0.5 mg/cm^2 which is low. (The Nikkan Kogyo Shimbun, November 1, 2012)

5. MCFC Related Business Plan

Korea Hydro & Nuclear Power, a subsidiary of the Korea Electric Power Corporation, will start the world largest power providing operation by FCs. A total output 60 MW molten carbonate fuel cell (MCFC) power station will be constructed with 320 billion won (approximately ¥ 22.7 billion) at an industrial estate in Hwaseong, Gyeonggi to provide electricity and heat to the neighboring area. The firm estimates 464 GWh and 195 billion kcal of heat production annually. The first operation is aimed at December 2013. POSCO Energy, a subsidiary of the major steelmaker POSCO, will supply facilities and the construction. The firm has produced MCFCs under the license with FuelCell Energy of the US. (The Denki Shimbun, November 7, 2012)

6. SOFC Related Technology Developments

(1) Tokyo Institute of Technology and Kyushu University

A joint study group with Prof. Masatomo Yashima of Tokyo Institute of Technology and Prof. Takumi Ishihara of Kyushu University elucidated the mechanism which leads to an improvement of solid oxide fuel cells (SOFCs). Because the result allows oxygen in air to be taken into the cells more efficiently, performance improvements are expected on SOFCs and FC electrode materials as well as increasing speed of research and development. Also, the study result helps to understand the mechanism of a substance which is a hope to be a material of an oxygen permeation membrane. The crystalline structure of "praseodymium nickel (Pr_2NiO_4) -based oxides" with gallium and copper added was examined with neutron diffraction and X-ray diffraction, and the examination showed a large amount of oxygen between the crystalline lattices. Gallium must actively take oxygen which goes between the crystalline structures. Also copper lets oxygen move by weakening bond in the crystalline structure. The crystalline structure property to allow oxygen through can hopefully be applied to FCs and oxygen permeation membranes, and the analysis leads to a new material development. (The Nikkei Business Daily, October 24, 2012; The Denki Shimbun, The Nikkan Kogyo Shimbun, The Chemical Daily, October 25, 2012)

(2) Fuchita Nanotechnology

Fuchita Nanotechnology, Narita city, completed a commercial aerosol gas deposition (AGD) device which forms a ceramics film at a room temperature. The system creates a 300 mm each way 10 μm thick square zirconia film in a short time of approximately 20 minutes. The AGD method transfers ceramics particles with gas, electrically charges them by triboelectric effect and then injects the mixture through a nozzle at high speed to produce a film at room temperature. Having three 100 mm-film-width nozzles in a row, the commercial device was confirmed to make a 10 μm thick film within 1 μm error range. The speed of film production is approximately 10 times that of the sputtering method. The product uses zirconia, alumina and barium titanium oxide. The price is approximately ¥100 million. Ceramics generally are difficulty as a film material and substrate due to the 1000 °C firing process, although the device makes a film quickly at a room temperature and saves energy. With the advantageous performances, the firm markets aimed at insulator and battery cathode membranes and thermal barrier coating. Usage for SOFC is expected and, an order is targeted by September 2013. (The Nikkan Kogyo Shimbun, November 9, 2012)

(3) Osaki CoolGen

Osaki CoolGen (Hiroshima city), a joint venture of Chugoku Electric Power and J-POWER, will move its headquarters in February 2013 to Osaki-kamijimacho, Hiroshima prefecture, where the Osaki power station is situated. Construction of experiment facilities will start in March for integrated coal gasification combined cycle (IGCC), and verification tests are

planned in three levels to achieve an integrated coal gasification fuel cell combined cycle (IGFC). (The Denki Shimbun, November 9, 2012)

7. Business Plan of Industrial FC

NTT DOCOMO will start utilizing FCs in its base stations for cell (or mobile) phones to prepare for long power cuts due to disasters such as large earthquakes. At present, the base stations have lead–acid batteries as emergency power supplies, and these batteries provide electricity for 24 hours during power cuts. The FC is said to extend the period to 40 hours. The weight of the FC is one-fourteenth of a lead–acid battery, and the volume is half. Therefore, FC can be placed in a base station which does not have an emergency power source at the moment. The FC's price is reportedly similar to lead–acid battery. The firm will install 4.5 kW output PEFCs in Nokia Siemens Networks in FY 2012. The fuel will be 60% or less concentration methanol; however, bio fuel is under consideration in the future. (The Asahi Shimbun, The Nikkei Business Daily, Fuji Sankei Business i, October 26, 2012; The Nikkan Kogyo Shimbun, October 29, 2012; The Denki Shimbun, November 16, 2012)

8. Business Plans of Ene-Farm

(1) Kintetsu Real Estate

On October 30th, Kintetsu Real Estate announced that its first smart model houses would be open in the Kintetsu Ayameike housing estate, Nara city, and orders would be taken from November 3rd. The standard feature includes photovoltaic generation system, Ene-Farm and HEMS as well as a house with an original external wall insulation. (The Sankei Shimbun, October 31, 2012)

(2) Misawa Homes

Misawa Homes, Tokyo, revealed its participation to a smart town project managed by Nakanoyama Land Readjustment Association. Misawa Homes Niigata, who is the actual distributor, has already received 10 orders of smart houses for cold and heavy snow regions from the association, and an experiment will start in FY 2013 to confirm the suitability of the features and planning. The firm aims to improve the efficiency of heating by dividing space with the experimental house as well as the house's high insulation. Heaters will be installed in the washroom and entrance hall to prevent heat shock by temperature difference inside the house. Also, energy is planned to be efficiently used with a photovoltaic generation system, Ene-Farm and HEMS. (Architectures, Constructions & Engineerings News (Daily), November 1, 2012)

(3) Techno Takatsuki

Techno Takatsuki adopted an electromagnetic oscillation structure for the first time in the industry. The firm is a major manufacturer of air pumps for water treatment tanks in Takatsuki city, Osaka prefecture, with approximately 60% of the market share. The air pump is characteristically durable and sends air more efficiently. Providing its product for Ene Farm which is expected to grow, the manufacturer has been trying to expand its business. Once the pump is switched on, diaphragms, which are two pieces of rubber on both side of the rod, start oscillating at a high speed, and the inside expands and shrinks by the oscillation thereby pumping the air. The firm participated in a domestic FC system development of New Energy and Industrial Technology Development Organization (NEDO) in 2005, and created a pump to send gas to the reformer. (The Nikkei Business Daily, November 7, 2012)

9. Cutting Edge Technology of FCV & EV

(1) Fukuoka Strategy Conference for Hydrogen Energy

The Fukuoka Strategy Conference for Hydrogen Energy held a test-ride of hydrogen powered FCVs in Fukuoka city. The conference is formed by industrial-academic-governmental bodies such as Fukuoka city and Kyushu University. FCVs were prepared to give driving experiences and to show the performances for promotion. About 25 people joined the event from firms such as a taxi company and bank in Fukuoka prefecture, and drove a total of four FCVs of Toyota, Nissan and Honda in the Ito campus of Kyushu University. (The Nishinippon Shimbun, November 5, 2012; The Nikkei Business Daily, November 6, 2012)

(2) Kagawa University etc

Next Generation Automobile Technology Research Group (EV research group) will develop a small EV with improved safety for the elderly. The group is

composed of Faculty and Graduate School of Engineering of Kagawa University and auto related firms in Kagawa prefecture. The EV is planned to have a system which applies the brake automatically in an emergency and gives an alarm near a high-accident intersection. A pilot product is aimed to complete by March 2013. Safety concerned vehicles are expected to grow in the market. (The Nikkei, November 8, 2012)

(3) NILIM

On November 10th, the National Institute for Land and Infrastructure Management (NILIM) demonstrated a contactless energy transfer which allows charging an EV during drive. A radio controlled car model was used in a 25 m course this time, and an experiment with an actual EV is scheduled next year. The power transfer uses coils both under road and in the vehicle. Electricity is transferred by magnetic resonating coils in the vehicle from electric current flow in coils buried under the road. Coils would be laid 70 to 90 mm underneath a road surface for commercial use.

"If a coil were buried every 10 km, an EV would automatically charge itself during a drive. EV drivers have no worries of their batteries running down." Hiroshi Obara, a senior researcher of Research Center for Advanced Information Technology at NILIM says. (The Nikkei, November 11, 2012)

(4) GREENLORDMOTORS

On November 12th, a venture auto firm of Kyoto University GREENLORDMOTORS, Kyoto city, revealed "Tommykaira ZZ" which is an EV version of the 90's sports car in the Kyoto prefecture office. The overview was announced at the end of FY 2010, and the vehicle was currently authorized by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to drive on public roads.

"I haven't enjoyed driving for long time but felt a joy today" said Keiji Yamada, the governor of Kyoto, who drove the car. He also praised the result as an industrial-academic-governmental cooperation of Kyoto. Kosaka Kinzoku Kogyo, who designs special metals in Maizuru city, and will carry out commercial production of the vehicle which is aimed to be introduced into the market by next spring. (The Nikkei, November 13, 2012)

(5) Honda

Honda Motor has been seriously expanding its environmental technology. More effort has been made to develop EVs as well as enlarging the range of hybrid vehicle (HV). Also, a FCV will be rolled out in Japan, the US and Europe from 2015. The automaker has released a prototype of a micro EV to the press in a research center in Hagamachi, Tochigi prefecture. Capable of taking one adult and two children, the prototype is 2.5 m long, 1.25 m wide and 1.45 m high, and was advanced from the concept car which was displayed in Tokyo Motor Show last year. The driving range is approximately 60 km, and the maximum speed is 80 km/h. A demonstration experiment is planned on public roads from next year. The firm developed an EV which uses Honda's leading small car Fit (also known as Jazz) as a base, and just started leasing the EVs from the end of August in Japan. That shows Honda's very committed intentions for EVs. (The Asahi Shimbun, November 13, 2012)

(6) Toyota

Toyota Motor developed an underlying technology to more than double an EV driving range to advance to next generation batteries. The product is a material for cathodes in a sodium-ion battery which uses sodium ions to transfer electrons. In a test, a coin size prototype output electricity with a voltage approximately 30% more than that of lithium-ion battery (LIB) at a room temperature; battery voltage is an index of EV's driving range. Although further analysis is needed, Toyota thinks a 500 to 1,000 km driving range has become achievable with this large improvement. Also, a sodium-ion battery could be provided at lower price than LIB which is currently the major battery for EVs. Researching the technology further, the automaker plans to commercialize it by 2020. (The Nikkei, November 14, 2012)

On November 14th, Toyota Motor reported MLIT that 13 types, including a passenger car Prius, total 1,518,098 vehicles were recalled because their steering may fail due to a weak part. According to MLIT, the part connecting the steering wheel and gearbox does not have enough strength in 9 types, total 1,507,454 vehicles. When the steering wheel is turned too hard repeatedly at low speed, the front wheels may not steer correctly. A malfunction was found in the electric water pump motor of HVs and FCV (Toyota FCHV-adv). These vehicles may stop

driving due to a blown fuse or have their alert light illuminated. (The Chunichi Shimbun, November 14, The Asahi Shimbun, The Mainichi Newspapers, The Kobe Shimbun, The Shizuoka Shimbun, The Chugoku Shimbun, The Nishinippon Shimbun, The Shinano Mainichi Shimbun, Fuji Sankei Business i, The Niigata Nippo, Iwate Nippo, The Kahoku Shimpo, November 15, 2012)

10. Technology Developments and Business Plans of Hydrogen Filling Station

(1) JX Nippon Oil & Energy

JX Nippon Oil & Energy developed a technology to produce high-purity hydrogen for FCV more efficiently while separating and capturing CO_2, a by-product. With a characteristic membrane separation, the technology uses hybrid of hydrogen separation membrane and a CO_2 separation membrane, and achieved a 99.999% hydrogen concentration or more and a 90 % CO_2 capture rate. The firm plans to start an experiment with a pilot facility next year and a demonstration experiment at refinery from 2016. (The Chemical Daily, October 29, 2012)

JX Nippon Oil & Energy will start a demonstration experiment of hydrogen production and tank truck transport for FCVs at Central Technical Research Laboratory in Yokohama city from the end of FY 2012. Currently, a total 2500 m^2 area of loading facility including a compressor and gas storage is under construction in spare space at the lab. To reduce costs, the firm plans a demonstration test with an output of 1,500 Nm^3, high pressure and large volume transport with a transport pressure 45 MPa. (The Chemical Daily, October 29, 2012)

(2) Kobe Steel

Kobe Steel developed a system to reduce energy loss at hydrogen filling stations. The start-up time of a device converting natural gas into hydrogen was shortened to 52 minutes, less than a third of conventional products. A FCV will be able to be provided with high-purity hydrogen at same time as the hydrogen filling facility is switched on by refining and storing using a hydrogen storing alloy. The technology will contribute to reducing energy used for start-up as well as a cutting down the size of the whole hydrogen filling system. The required heating for a catalytic reaction in the reformer was changed from a burner to methane combustion which heats the catalyst directly, which reduces time for the thermal transfer and allows the short start-up. The refining equipment, which removes impurities such as carbon monoxide (CO), can store hydrogen temporally in the hydrogen storing alloy applied, which is another advantage. 52 minutes waiting time can be eliminated by providing hydrogen from the alloy while starting up the reformer. The improvement allows a hydrogen filling station to start business at same time as a hydrogen production facility is switched on. The firm aims for the system to be introduced into the market by 2020. (The Nikkan Kogyo Shimbun, November 16, 2012)

11. Technology Development of Energy Storage by Hydrogen

Toshiba will develop a hydrogen energy system to absorb fluctuations in electricity production caused by renewable energy introduction as an alternative to storage batteries. The system will produce and store hydrogen from water using surplus electricity, when production amount of electricity exceeds the demand and goes over the limit of the grid due to growing renewable energy. On the other hand, the stored hydrogen is expected to supply FCVs and to operate a FC for electricity when electricity production is insufficient. With about 10 firms including Cable & Wireless Worldwide of the UK, an experiment will be carried out in the Isle of Wight, the UK, from November for three years. Analyzing data, they aim at commercialization from 2016. The mechanism of hydrogen production by electrolysis is simpler than that of a storage battery, which reduces cost of the system and can be potentially widespread. Toshiba will design the network to connect the grid and a hydrogen storage facility and develop the energy management system. Cable & Wireless Worldwide will create a system to collect data from hydrogen filling stations and FCVs for adjustment of hydrogen supply. Arcola Energy, who develops FCs in the UK, will promote FCVs and hydrogen as energy. (The Nikkei, October 24, 2012)

12. Development of FC & Hydrogen Related Measuring Technology

Mitsubishi Materials (MMC) announced that a development of a thermistor material to measure a wider range of temperature from -40 to maximum 500 °C. The maximum temperature was increased from approximately 250 °C by improving electrical conductivity with firm's expertise on materials. The product allows the accurate temperature detection of engine combustion. MMC plans to target manufacturers of exhaust gas recirculation (EGR) parts, and to advance the product further for high-temperature usage such as FCs. (The Nikkan Kogyo Shimbun, Japan Metal Daily, November 1, 2012; The Chemical Daily, November 2, 2012)

—This edition is made up as of November 16, 2012—

A POSTER COLUMN

1170 Hydrogen Filling Stations for FCV by FY 2025

Fuji-Keizai reported a market forecast for hydrogen filling stations, hydrogen fuels and FCVs which will be commercialized from 2015. The FCV market is expected to spread rapidly from 2020, and estimated to expand to 1,620,000 vehicles by 2025 from 5,000 for FY 2015.

Tokyo, Nagoya, Osaka and northern Kyushu take a leading role in preparation of hydrogen filling stations which are equipment of petrol or gasoline filling stations. The number of hydrogen filling stations is predicted to increase to 1,170 by FY 2025 from 100 for FY 2015 throughout Japan. The amount of hydrogen used as fuel is anticipated to rise to 1650,000,000 m^3 by FY 2025 from 500 m^3 for FY 2015. Also, the related market including hydrogen production and transportation (such as a clustered cylinder) equipment is forecasted to grow to ¥252.9 billion by FY 2025 from ¥19.1 billion for FY 2015.

There are on-site filling stations which produce hydrogen on location, and off-site filling station which are provided with hydrogen by transportation from elsewhere. The firm believes off-site filling stations which have smaller capacity for supply are likely to take the larger share in the market in the immediate future, and on-site filling station are to take less than 20% share for 2015. The shipping amount of hydrogen production equipment is estimated ¥0.9 billion for FY 2015 and ¥7.2 billion for FY 2025. On the other hand, clustered cylinders to transport hydrogen to filling stations are estimated to rise to ¥10.5 billion by FY 2025 from ¥1.9 billion for FY 2015. (Nikkan Jidosha Shimbun, November 10, 2012; The Chemical Daily, November 13, 2012; The Nikkan Kogyo Shimbun, November 15, 2012)

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