## Why a Hydrogen-powered Society Is Worth Striving For



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Practical use of hydrogen is well underway in Japan. Fuel cell vehicles have been put on the market, and filling stations where hydrogen gas can be purchased are going up across the country, in line with the government's energy roadmap.

Special

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The Ene-Farm household fuel cell, which has been on the market since 2009, has now sold more than 100,000 units. By 2030, the government aims to have the system, which supplies both hot water and electricity, installed in 10% of all households. Some forecasts predict fuel cell power generation systems with capacities greater than the current home-use models will reach the market by 2017.

These developments effectively mark the start of the "hydrogen era". But what will a truly hydrogen-powered society look like, and what are the challenges to achieving it?

## **Freedom from Crude**

Japan has few energy resources. Securing cheap, stable sources



The Japanese government and manufacturers are promoting Ene-Farm home-use fuel cells.

of electricity, heat and automobile fuel is the core objective of the country's energy policies. According to statistics from the Ministry of Finance, Japan's trade deficit has expanded in recent years, largely due to a surge in energy imports. In both 2013 and 2014, the value of fossil fuels such as natural gas, oil and coal reached some 27 trillion ven (\$225 billion).

Fossil fuels account for around 90% of the electricity Japanese society consumes for daily activities and industry. For the time being, this is unavoidable. But hydrogen, the most abundant element on Earth, promises to help free the country from that dependence.

Hydrogen gas can be produced in a variety of ways. For example, it is possible to take the hydrogen that is a byproduct of oil refining. steel milling and soda electrolysis and supply it as a fuel for vehicles.

It is also possible to extract hydrogen gas from hydrocarbon fuels, using the existing energy supply network for city gas, liquefied petroleum gas and so on. And since fuel cells offer high energy conversion efficiency, using them to generate electricity would reduce the volume of fossil fuels needed to produce the same amount of power. This would help to cut down on carbon dioxide emissions. Wide adoption of hydrogen as a fuel for cars would help Japan to avoid relying on one specific resource to get around crude oil — and enhance the nation's energy security.

Of course, the advantages of producing electricity efficiently are not limited to homes and cars. They apply to the commercial and industrial sectors as well, on scales of several kilowatts to several hundred kilowatts. Progress is being made toward hydrogen technology usable in compact mobile devices, as well as aerospace systems.

As international pressure grows for massive reductions in carbon emissions, the world is likely to shift to full-fledged use of CO2-free pure hydrogen gas. With methane gas from sewage treatment plants, renewable electricity that is not sent through the power grid, and hydrogen produced from unused resources, a carbonless motorized society will no longer be just a dream.

Renewables are generally dependent on the weather, and fluctuations in output can be significant. But work is being done on a system that accumulates energy in hydrogen form, through electrolysis of water using surplus power. If hydrogen can be used as a means to stockpile energy, it could become a pillar of storage infrastructure, alongside batteries and pumped-storage power plants. This would further encourage the use of renewable sources.

Hydrogen could also promote a shift toward local energy production for local consumption. The cost of energy, which until

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now has flowed away from the places it is used, could instead be kept at home and contribute to revitalizing regional economies.

All that said, utilizing renewable energy sources requires careful study of the total cost, efficiency and implications for carbon emissions. The potential of hydrogen and fuel cells is huge, but realizing it will entail changing the very foundation of society's energy system. This, naturally, will take time.

## **Public-Private Imperative**

Numerous issues need to be addressed. First and foremost, it is important to build hydrogen infrastructure with public- and private-sector involvement. To convince drivers to switch to fuel cell vehicles, it is necessary to establish a network of hydrogen filling stations. In the near term,



A JX Nippon Oil & Energy hydrogen fuel station

government support will be vital. The cost of setting up those stations needs to be reduced.

In addition to hydrogen filling stations modeled after conventional gas stations, other means of producing, storing and selling hydrogen are being considered. They include energy convenience stores that can supply fuels, electricity and heat; methods to use surplus power from alternative sources; and generation/sale of hydrogen gas made from biogas, which is generated in sewage treatment and waste processing.

The second step would be to increase the use of fuel cells, which are considered the next big thing in power generation because of their high efficiency. Japan's liberalization of its electricity and gas markets should facilitate their use. It is theoretically possible to build a fuel cell-based power generation system using natural gas, with conversion efficiency in excess of 70%. It could also be possible to change coal, which is readily available, into a gas for use with fuel cells. Again, turning fossil fuels into electricity more efficiently would reduce both carbon output and energy imports.

In addition to public subsidies for the introduction of fuel cells, it will be important to consider an arrangement for recouping the cost of developing highly efficient power generation systems and updating aging fossil fuel power plants. The key: future reductions in fuel costs and CO2 emissions.

Even if fossil fuel consumption can be reduced just a little, this would translate into trillions of yen worth of benefits in Japan alone. Further efficiency gains and cost cuts could prompt the nation, municipalities, energy producers, consumers and investors to invest in such technologies.

It is critical to let the public know what a hydrogen society would look like, including safety, in order to get people to use the gas with confidence. The Tokyo Olympics and Paralympics in 2020 present a wonderful opportunity for Japan to demonstrate its leading-edge technology to the world. Smart communities are expected to show off renewables-linked hydrogen systems and field research on largescale fuel cells — exhibiting the economic viability and environmental superiority of such technology.

The development of new energy systems often takes decades. But these efforts will create business opportunities, including in maintenance, for decades to come. The favorable ripple effects will spread to a range of fields. While working on the latest technology, it is also important to continually look to what will come next. Human resources must be nurtured so that they can not only polish current technology but also handle future innovations.

To that end, Japan needs to foster young engineers as part of the country's growth strategy. Future doctorate holders could help lead the way toward a global hydrogen society, strengthening Japan's international competitiveness.

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