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Fukushima Hydrogen Energy Research Field. Photo courtesy of NEDO.

FUELING THE FUTURE

JAPANESE INVESTMENT IN HYDROGEN TECHNOLOGY AIDS GLOBAL CARBON-NEUTRAL EFFORTS

If you live here in California, you may have noticed a futuristic Toyota car called the Mirai on our roads recently. It's the world's first dedicated mass-produced fuel cell vehicle, running on zero-emission hydrogen fuel. And, like so much cutting-edge hydrogen technology, it's from Japan.

Japan's passion for hydrogen as carbon-free energy carrier began half a century ago. The country was ahead of its time in recognizing hydrogen's potential in its 1974 "Sunshine Project," which also included research and development of solar and wind power.

The Japanese government has been investing in hydrogen ever since, including founding its New Energy and Industrial Technology Development Organization (NEDO) in 1980. The goal is to diversify Japan's energy sources, foster more domestic energy production and security, and to reduce greenhouse gas (GHG) emissions, while strengthening industrial competitiveness.

"Hydrogen can be used for not only the energy sector, but also the transportation sector and industry sector," said Eiji Ohira, Director General of the Fuel Cell and Hydrogen Technology Group within NEDO. "It's not the only solution, but it is a key technology for carbon neutrality."

As the most abundant element in the universe, with the highest energy density value of any substance, hydrogen holds enormous promise for a carbon-neutral future. Unlike traditional combustion technologies, the chemical process in hydrogen fuel cells produces only electricity, water and warmth; there are no carbon emissions.

Prime Minister Suga has declared that Japan will be carbon-neutral by 2050, with \$2 billion per annum committed to green energy technology over the next decade. In 2017, Japan became the first country to adopt a "Basic Hydrogen Strategy."

Hydrogen is a centerpiece of its goals of reducing GHG emissions by 26% of their 2013 levels by 2030, and by 80% by 2050.

Indicative of its leadership in the field, the Japanese government hosted the inaugural Hydrogen Ministerial Meeting in Tokyo in 2018; the first ministerial-level meeting focused on the realization of a hydrogen-powered society. As the cost of producing hydrogen fuel decreases (a 2020 California Energy Commission study concluded that it could be as cheap as gasoline within five years), the international community is increasingly considering hydrogen-based energy solutions, with China, South Korea, Australia, and the European Union all recently announcing hydrogen strategies.

Toyota's Mirai debuted in 2014, and Japan boasts the world's largest network of hydrogen filling stations. Yet these impressive milestones offer only glimpses of hydrogen's vast potential. Reliable, durable, stackable, and boasting ten times the energy-to-weight ratio of lithium-ion batteries, hydrogen fuel cells could power everything from laptops to multi-megawatt power stations.

"The next stage is scaling-up ... including [hydrogen-fueled] gas turbines," said Ohira.

Power plant turbines can already use fuel blends containing hydrogen. But an expanded role for hydrogen in power generation is crucial to its mass adoption as an energy source.

Japan's commitment to hydrogen is manifested in its Fukushima Hydrogen Energy Research Field (FH2R), the world's largest renewable hydrogen plant. Opened

last March by a consortium comprising NEDO and private-sector corporations, the 10-megawatt electrolysis uses power from its 45-acre solar farm, alongside grid electricity, to produce "green" hydrogen through water electrolysis. FH2R's hydrogen will be used in stationary fuel cell systems and in fuel cell vehicles.

To showcase its promise to the world, hydrogen from FH2R will be used in fuel cell vehicles at the Olympic and Paralympic Games Tokyo 2020 this summer. Part of the Olympic Village will also be hydrogen-powered, with fuel cells generating electricity for lights and air conditioning. For the first time ever, hydrogen will fuel the Olympic flame cauldron and relay torches.

FH2R is additionally researching the viability of using green hydrogen to balance the electrical grid: generating hydrogen fuel when excess renewable electricity resources, which are subject to significant fluctuations, are available, and then generating electricity for the grid with the stored hydrogen when needed. The chief challenge is achieving the optimal combination of production and storage of hydrogen and power grid supply-demand balancing adjustments, without the use of storage batteries.

Japan's other challenge is to build a global hydrogen supply chain. Japan and Australia are collaborating on such a network within the Asia-Pacific, with plans for trial shipments of liquefied hydrogen from Australia to Japan later this year. The world's first hydrogen carrier, the 380-foot Suiso Frontier, attracted a 4,000-strong crowd for its launch in Kobe, Japan in 2019.

Like Japan, California has ambitious GHG goals which have spurred enthusiastic exploration of hydrogen technologies. Japanese hydrogen powertrains propel semi-trucks used at the ports of Long Beach and Los Angeles, with the latter also



Eiji Ohira, Director General, Fuel Cell and Hydrogen Technology Office Advanced Battery and Hydrogen Technology Dept., New Energy and Industrial Technology Development Organization. Photo courtesy of NEDO.

considering on-site hydrogen production using renewable biogas from California dairy farms. Los Angeles Department of Water and Power is leading an effort to convert coal-burning electric generating turbines to hydrogen-burning, using Japanese technology. And more than 6,000 Mirais are already on California roads, supported by a growing hydrogen fuel infrastructure.

"We in Japan have been happy to share our experiences in other countries, to accelerate these [hydrogen] technologies," said Ohira.

With its unique governmental commitment and historical expertise, Japan is poised to remain a global leader in hydrogen energy innovation and promotion for the foreseeable future.

— Paul Rogers, Brand Publishing Writer