



Hydrogen and Ammonia Development in Japan

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Today's Topics

- 1. Importance of Hydrogen and Ammonia
- 2. Japan's Policy and Hydrogen Basic Strategy
- 3. Technology Development (examples)
- 4. International Cooperation

Why Hydrogen and Ammonia?

- Recently attracting huge attention as:
 - Clean energy; a key to achieving Carbon Neutral.
 - > Natural gas alternative/replacement. Phasing-out Russian gas.

> **Opportunity to economic growth**. New industries. Employment. Export potential for the renewables-rich countries.



Build an energy supply-demand structure that is resilient

to crises by moving away from excessive dependence on fossil fuels.

Various production sources and use cases

- Hydrogen not only <u>contributes directly to the decarbonization</u> of the electric power sector, but also allows <u>the potential of zero-emission power sources such as renewable energy to</u> <u>be maximized</u> by converting surplus electricity to hydrogen for storage and use.
- Ammonia and synthetic fuels produced from hydrogen are also expected to be utilised according to their characteristics



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Japan's Policy Moves

- Historically Japan started hydrogen/fuel cells R&D back in **1973** (before the oil shock started).
- The first country to have formulated a national hydrogen strategy (2017).
- The Prime Minister set "2050 carbon neutral" declaration (2020). \$15bn Green Innovation Fund.
- Positioned **hydrogen as one of the priority areas** in the Green Growth Strategy.
- Key part of achieving green transformation economy plan (2023).

Milestones						
	2017 Basic Hydrogen Strategy	2020 PM's 2050 CN Declaration Green Growth Strategy	2021 Green Innovation Fund Revised Strategic Energy Plan	2023 GX Promotion Act <u>Basic Hydrogen Strategy</u> <u>updated</u>		
Targets (Set in the Basic Hydrogen Strategy on Dec. 26, 2017 – updated in 2023)						
□ Supply & Demand volume: Current (Approx. 2Mt) → 2030 (<u>Approx. 3Mt</u>) → 2040 <u>(Approx. 12Mt)</u> → 2050 (<u>Approx. 20Mt</u>)						
□ Hydrogen cost: Current (JPY100/Nm3) → 2030 (<u>JPY30/Nm3</u>) → 2050 (<u>Less than JPY20/Nm3</u>) station retail price (=USD2.6/kg-H2*) (=USD1.7/kg-H2*) <u>*USD1=JPY1</u>						

Background

- The initial scenario was to promote and develop domestic market by utilising the various "home-grown" technologies such as FC, then explore the global market.
- Government decided to <u>update the strategy</u>, taking the changes in environment into account (e.g. CN declaration, energy crisis caused by war in Ukraine), and <u>published the new version in June 2023</u>.
- The strategy is to be updated in around five years' time.

Highlight of the 2017 Strategy

- Presented vision for the year 2050 and action plan to 2030.
- Positioned hydrogen as an option of new energy alongside renewable energy.
 - \Rightarrow To lead the world's decarbonisation with Japan's cutting-edge hydrogen technology.
- Showed the cost target to be competitive with counterfactual fuels (Current: JPY100/Nm³ \Rightarrow 2030(JPY30/Nm³) \Rightarrow 2050 (JPY20/Nm³)

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Efforts are needed for both supply and utilization	[Supply] [Demand]	<pre> { Low-cost input energy and/or raw materials (=utilize surplus renewable energy and lignite coal) Establish supply chain of a scale Large use (automobiles ⇒ Power generator ⇒ Industry) </pre>				

Highlight of the 2023 Basic Hydrogen Strategy

- To introduce hydrogen having well regard to the S+3E principles (Safety, Energy security, Economic efficiency, Environmental compatibility) and industry competitiveness.
- The scope of strategy includes hydrogen and its derivatives such as ammonia, synthetic methane, synthetic fuels, etc., taking into consideration of the challenges and timelines surrounding these products.

Basic Strategy

Expanding Supply

- (a) A new volume target at 12 Mt/p.a. by 2040.
- (b) Leading to low-carbon hydrogen by introducing:
 - <u>carbon intensity-based criteria</u>, not "colour" based;
 aviding requirements
 - 2 guiding regulatory requirements.
- (c) Promote domestic production and supply chain. Target share of <u>electrolysers</u> (domestic and overseas) that involve Japanese element (including parts and materials) <u>by 2030 is set</u> <u>around at 15GW</u>.
- (c) Strengthen relationships with exporting countries, develop transportation technologies and expand financing capabilities.

Creating Demand

(a) Power generation

A wide range of use in power sector, including co-firing and single-firing.

(b) Fuel cells

Deploy FC stack technology in a variety of applications such as commercial vehicles, rolling stocks, vessels, heavy-duties, agri machinery as well as use for decarbonising ports and airports.

(c) Industrial use

Heat use such as boilers and other equipment in the hard-toabate factories. Develop technologies to utilise as raw material in the fields of steel and chemicals.

(d) Home use

Promote high performance and low-cost residential FC.

To introduce various support schemes with a view to setting up large-scale, resilient supply chains:

- a. Producer support scheme (price gap subsidy)
- b. Cluster development support

Others:

①Promote regional use and consumption and engage local governments
 ②Cross-border cooperation for standardisation and other activities
 ③Raise public awareness and acceptance

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Hydrogen Industry Strategy

• Aim to **expand the use of hydrogen both domestically and internationally** by determining areas where the market is expected to emerge relatively quickly, where the market size is large, and where Japanese companies are thought to have technological advantages.



1 Hydrogen Supply : Production

- Water electrolysers are key products for (1) utilizing inexpensive surplus renewable energy, etc. (producing hydrogen derived from renewable energy) at the time of mass introduction of renewable energy, and (2) promoting decarbonization of the non-power sector.
- Currently, a larger demonstration project is underway to further increase size, improve operation and reduce costs.

Alkaline electrolyser plant in Fukushima



& Solutions Corporation

10MW Water Electrolysis System Source: ASAHI KASEI



Source: Yamanashi Pref

② International Trade: Maritime Transport

MCH (Methylcyclohexane)

MCH as the hydrogen carrier in the demonstration project was completed in June 2020. (Brunei-Japan)



Liquefied Hydrogen

Liquefied Hydrogen Carrier completed the world's first maritime transport (Australia→Japan) in February 2022.



2 Liquefied hydrogen carrier vessel

- The world's first and only liquefied hydrogen carrier vessel "Suiso Frontier" built by HySTRA (funded by NEDO).
- Offer opportunity to board the vessel at some of the major international meetings.

The "Suiso Frontier" tour at Otaru Port and at Itsukaichi Port, hosted by Kawasaki Heavy Industries and METI.



G7 Sapporo Excursion (at Otaru Port)



G7 Hiroshima Excursion (at Itsukaichi Port)







2 Decarbonising Power Sector

- Japan has been a <u>world leader in hydrogen power generation technology</u>. Demonstration projects are underway for <u>both large and small turbines.</u>
- Japanese companies have already received orders for specific large-scale hydrogen power generation projects in the U.S. and other countries, and <u>the company aims to participate in</u> <u>overseas projects</u>.



1MW class

Achieving combined heat and power supply to urban areas using hydrogen exclusively in 2018. High-efficiency dedicated hydrogen single fuel power generation is under progress.



Hydrogen power generation facility (hydrogen CGS) constructed on Port Island in Kobe City

③ Fuel Cells : Mobility

- Currently approx. <u>7,800 FCVs, 135 FC busses, 400 FC forklifts</u> have been sold and <u>180 hydrogen</u> refueling stations (HRS) installed (as of July 2023).
- FC trucks and FC trains are under demonstration.
- Hydrogen and ammonia (for FCs/engines) are expected to be used in ships and airplanes in the future.

FCV and Hydrogen station



[Major Players in Japan]

- HRS : Air Liquide Japan G.K., ENEOS Corporation, Iwatani Corporation, etc.
- FCV : Toyota, Honda, etc.
- FC Truck :
 - CJPT(Commercial Japan Partnership Technologies) <Toyota, Isuzu, Hino, Suzuki, Daihatsu, etc.>

Widespread use of commercial FC vehicles Diversification of hydrogen stations

Widespread use of commercial FC vehicles

Fukushima Prefecture and TOYOTA are preparing to <u>start FC truck</u> <u>demonstration project</u> including refueling timing management.



Diversification of hydrogen stations

- Laying of <u>pipelines from</u> <u>hydrogen</u> ST to Woven City (where hydrogen was used for consumer use)
- FC generator installed at hydrogen stations in the case of power outage



④ Heat Use at Factories

 Several efforts are underway to <u>decarbonize heat demand in industrial processes</u> by utilizing <u>hydrogen produced onsite using water electrolysers</u>, and the government and others are supporting these demonstrations, etc.

Efforts at UCC Ueshima Coffee

UCC Ueshima Coffee has started demonstration project for hydrogen heat-use at their factory line in cooperation with Yamanashi prefecture, TEPCO Energy Partner, Toray and TOMOE.

Efforts at DENSO Fukushima

DENSO has started demonstration project for electric heaters and hydrogen burners in their production line



(5) Hydrogen Derivatives : Ammonia

- Ammonia (co-)firing is a realistic technology to reduce GHG emission from the existing power assts, whilst not jeoparadising the power supply capacity.
- As Japan's original technology, stable combustion and reduced NOx emissions with 20% of ammonia co-firing have been already achieved. The demonstration with actual largescale equipment (1GW power plant) is expected to be completed in 2024FY.



Source: JERA press release

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International Cooperation

- Capacity building, awareness, sharing objectives and challenges.
- Objective analysis on world's energy outlook (e.g. carbon intensity, cost estimate)
- Advocate for Japan's cases, whilst accommodating views from various countries.







International Partnership for Hydrogen and Fuel Cells in the Economy

















Hydrogen Energy Ministerial Meeting (HEM)

- Annual ministerial meeting in Japan exclusively on hydrogen since 2018 (usually in cooperation with the IEA).
- HEM 2023 will be held on 25 September as part of the Tokyo GX Week.
- * Tokyo GX Week: <u>https://www.meti.go.jp/policy/energy_environment/global_warming/roadmap/tokyo_gx_week/</u> *Archive videos of 2022 HEM are available via HEM website: <u>https://hem-2022.nedo.go.jp/_en/archive/</u>







Ministerial Speech Session



Industrial Session: Hydrogen Industrial Applications (Steel, Heat and Chemicals)

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Industrial Session: Water Electrolysis



Industrial Session: Methodology for determining the GHG emissions associated with the production of hydrogen

19

Ministerial Meeting Session

Thank you for listening!!