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Hydrogen Demand In Japan

Report By Japan NRG

Research Partner

JAPAN NRG

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Welcome Letter from Japan Energy Summit & Exhibition and Japan NRG

Dear Industry Colleagues,

As we delve into the everchanging dynamics of Japan's energy industry, we find ourselves at a critical juncture. Japan stands at the forefront of energy innovation, navigating a landscape shaped by technological advancements, regulatory shifts, evolving energy sources, and ambitious net-zero goals.

Coming to Tokyo this 3-5 June 2024, the Japan Energy Summit & Exhibition serves as a premium platform for global energy leaders, policymakers, solution providers, innovators, and industry experts to convene and make an impact in accelerating Japan's energy transition. This year, Japan Energy Summit & Exhibition welcomes Japan NRG as the event's dedicated Research Partner to ensure that attendees get the latest insights into the energy landscape even before the event date.

This 'Hydrogen Demand in Japan' report is a comprehensive exploration of the pivotal role hydrogen plays in Japan's energy transition. Developed with METI's Basic Energy Strategy as a starting point, the report covers its applications across industries and hydrogen's potential as a clean energy solution, promising to provide invaluable insights for stakeholders across the energy value chain.

We eagerly anticipate the opportunity to engage with you further at the Japan Energy Summit & Exhibition, from 3-5 June 2024 at Tokyo Big Sight. Together, let us chart a course towards a more secure, sustainable, and affordable future of energy.

Warm Regards,

MARTYN COX
Event Director
Japan Energy Summit & Exhibition

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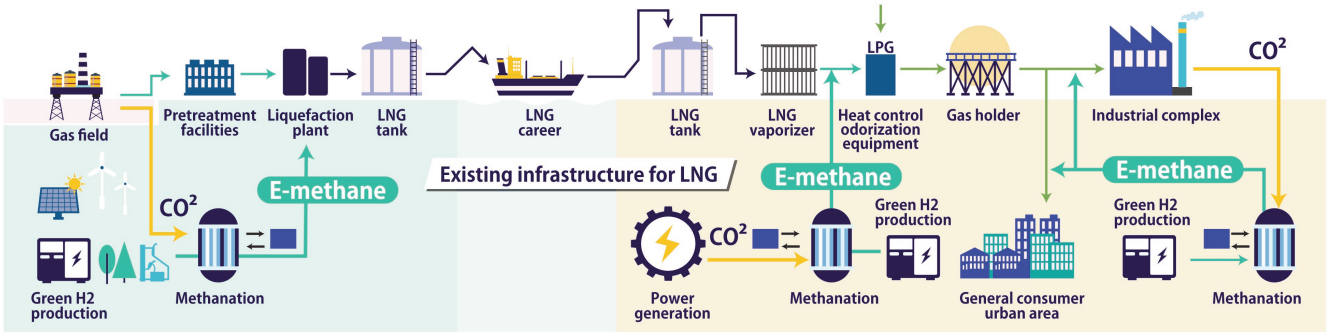
Update of Hydrogen Policy Sparks Interest from More Sectors



Japan Aims to Connect the Dots from LNG to Hydrogen to Synthetic Fuels (Source: IHI and Japan NRG)

In June 2023, METI updated the Basic Hydrogen Strategy that was first announced in 2017. While it was always understood that the Strategy would need to be updated periodically to align with new developments in the energy sector and global markets, in recent years the changes have been particularly pronounced, especially in the targeted timeframes for the energy transition.

So, it was no surprise that the Strategy shifted emphasis more towards renewables-produced hydrogen. More than that, the 2023 update expanded the role that clean-burning gas might play. If in 2017 gas was portrayed merely as fuel, today, it is seen also as a component – an essential raw material for carbon recycling, synthetic fuels and even for ammonia.

Importantly, the key area of pricing targets was not changed in the Strategy update. The 2030 goal for hydrogen cost remains at ¥30/Nm3; while the 2050 goal remains at ¥20/Nm3. Also, there's the 2030 goal for 800,000 units of fuel cell vehicles.

In private, the government understands that as of 2024, the weak yen and global inflation has rendered such numbers "highly, highly ambitious", admits a senior official at a state lender involved in hydrogen projects. There is much more flexibility on the cost numbers when reviewing actual projects and as much focus on feasibility as cost, the banker says. But, at least on paper, the numbers remain unchanged.

Immediate Impact

Since the release of the Hydrogen Strategy update, industries have been impacted significantly. An increasing number of power utilities have begun to study coal-ammonia co-firing or plan to soon do so. The use of hydrogen as a future transport fuel and for methanation has also ramped up, suggesting potential new demand centers outside of the industrial gas and utilities sector.

- In late March, JERA began 20% co-firing (coal 80%, ammonia 20%) at a 1 GW unit at the Hekinan Thermal Power Plant in Aichi Prefecture
- Engineering major IHI Corp, trading house Sumitomo Corp and Taiwan Power inked an MoU to explore 5% co-firing at the Talin Power Plant in Taiwan (two 800 MW coal-fired units)
- Taiwan became the seventh Asia-Pacific nation to study the use of ammonia co-firing, joining Indonesia, Malaysia, Vietnam, Thailand, Philippines and Singapore.
- Two Japanese electrolyzer manufacturers (Asahi Kasei and Tokuyama Corp) announced plans to commercialize alkaline water electrolysis (AWE) systems.
- A group led by TEPCO and Toray Industries began building a 16 MW power to gas (P2G) system that uses Proton Exchange Membrane (PEM) electrolyzers at Suntory's Hakushu whiskey distillery in Yamanashi Prefecture. When completed in 2025, it could be Japan's largest green hydrogen production plant.
- Kawasaki Heavy Industries said it will build a mid-sized ship for domestic shipping of liquefied hydrogen (80,000 m3 storage capacity, or four 20,000 m3 tanks). This adds to the goal to complete an oceangoing H2 carrier with a 160,000 m3 tank storage in about 2030. The vessels will transport cryogenic liquefied hydrogen, cooled to –253°C and reduced to one eight-hundredth its initial volume.
- IHI has developed prototypes of a 70-KW turbo blower and other components made of aluminum alloys to feed hydrogen to fuel cells for high-speed hydrogen-powered engines on aircraft.
- Honda embarked on trials of hydrogen fuel cells as backup power systems for data centers in North America. The initial trial is near the Los Angeles International Airport.

Old World Hydrogen Scenario

The hydrogen strategy unveiled in 2017 described "green hydrogen" as a European concept of "premium-grade hydrogen" that's renewables-driven, and went on to say that fossil-fuel derived "gray hydrogen" could possibly be classified as "premium-grade" if carbon credits were used to offset emissions.

Japan's annual "gray hydrogen" production is 1.9 million tons, derived as byproducts from processes at oil refineries, chemical and steel plants. According to the Japan Hydrogen Association, only a meager 1.4 tons were sold in the market. The rest was consumed on-site mainly for industrial power generation.

Some believe the "gray hydrogen" market could grow because demand is there. According to Mizuho Research & Technologies, 30 caustic soda plants have the capacity to market 50,000 tons of 99.99%-purity gray premium grade hydrogen. Steel plant coke ovens produce hydrogen with 50-55% purity, which complicates its handling. But the supply is there.

Commercial supply of green hydrogen, meanwhile, is tiny. There are two domestic producers, in Yamanashi and Oita prefectures, and the supply is expected to increase to only 200 tons when the state-run facility, the Fukushima Hydrogen Energy Research Field (FH2R), begins commercial sales possibly in 2026.

The government's base scenario is 3 million tons / year of hydrogen becoming available by 2030. However, Japan NRG believes local gray hydrogen production will decline to less than 1.7 million tons due to plant closures and decreases in oil products demand. This METI model is a simplified picture with numbers rounded off.

Local gray hydrogen	**2 million tons**
Local green hydrogen	**marginal**
Imports	**1 million tons**
Total	**3 million tons**

Emphasis On Hydrogen's Carbon Intensity

The updated strategy also points out that hydrogen's carbon intensity is an important feature, and since the shift to cleaner hydrogen is an international trend Japan must also be a part of this process.

Japan's approach in line with the IEA, which wants to cap intensity at 7 kg CO2-eq/kg H2 Japan views "low carbon" H2 as 3.4 kg CO2-eq/kg H2

While METI has not changed its "3 million tons in 2030" scenario, its new hydrogen strategy is causing base assumptions to change. For example, there's now a 15 GW electrolyzer capacity goal for 2030 in order to increase green hydrogen supply.

One official at Yamaguchi Prefecture told Japan NRG that this was a paradigm shift, suggesting that the 1.9 million tons of gray supply will no longer be something buyers in Japan can depend on being available. Introducing regulatory constraints on export of products that used gray hydrogen in any manner were also possible, he said Yamaguchi Prefecture is Japan's largest producer of gray hydrogen, with a 10% share of the total. But rather than leveraging its gray hydrogen and ammonia supplies, the locality is pushing manufacturers to cut their carbon intensity.

"The area will not survive if plants lose markets and are closed. We're pinning hopes on ammonia," said the Yamaguchi official.

Key businesses in Yamaguchi are Idemitsu Kosan, Tokuyama, Tosoh, and Zeon Corp. They plan to build a 1 million ton / year ammonia supply chain. Idemitsu will import and store ammonia in LPG tanks, transport the fuel via existing pipelines to Tokuyama and Tosoh, which may then conduct ammonia-coal co-firing at their power plants, possibly from 2025.

The chemical industry is exploring other ways to use ammonia for emission cuts. This year, Mitsui Chemicals started the "chemical recycling demo" in Osaka, which is replacing methane – fuel for the 480,000 tons / year naphtha cracking operation – with ammonia. Mitsubishi Ube Cement is developing ammonia-fueled cement kilns.

Ammonia-coal co-firing is spreading faster in the power sector that runs larger coal power plants. In 2023, JERA and Kyushu Electric conducted co-firing demos, and three other regional utilities said they plan either ammonia or hydrogen co-firing. On October 26, 2023, Kobe Steel said that its two 700 MW coal power plants will start 20% ammonia co-firing by 2030, and two other 650 MW plants will follow.

2030 Ammonia Demand In Different Transition Scenarios

(million tons / year)

Japan NRG slow transition scenario		Ammonia Assn scenario	Japan NRG fast transition scenario	
Power	**Chemical**	**Power**	**Power**	**Chemical**
20% co-firing (JERA, Kyushu Electric, Kobe Steel)	20% co-firing (Tosoh, Tokuyama)	20% co-firing at plants where it is technicall possible	20% co-firing (JERA, Kyushu Electric, Tohoku Electric, Chugoku Electric, Shiko-ku Electric, Kobe Steel)	20% co-firing (Tosoh, Tokuyama), naphtha cracking, ammonia-fueled ships, small ammonia turbines, etc.
1.7	0.7	3	3.15 (assuming 20% co-firing at the biggest coal plant of each EPCO)	1.8 (co-firing 0.7, naphtha cracking 1, others 0.1)
2.4 (0.4 hydrogen equivalent)		3 (0.5 hydrogen equivalent)	4.95 (0.825 hydrogen equivalent)	

Base assumptions: 500,000 tons of ammonia required for 20% co-firing at 1 GW coal power plant; 2.23 million tons of ammonia for 1 million ton / year naphtha cracker. One ton of ammonia is equivalent to 0.16 tons of hydrogen.

JERA, Tohoku Electric, Chugoku Electric, and Kyushu Electric each own 1 GW coal power plants, while the biggest coal plant operated by Shikoku Electric is 700 MW.

The Japan Clean Ammonia Fuel Association forecasts ammonia demand of 3 million tons by 2030, from just 20% co-firing alone (500,000 tons / year hydrogen-equivalent). This falls in the middle of Japan NRG's slow and fast transition scenarios.

Hydrogen As Carbon Recycling Raw Material

The updated government strategy has redefined hydrogen as a fuel and a raw material for synthetic methane (e-methane), synthetic fuel and other forms of carbon recycling. Expanding hydrogen's scope to carbon neutral material has spurred diverse industries to explore carbon recycling possibilities. Examples include making synthetic textiles and plastics.

Opening up hydrogen to non-fuel usage also means wider use of hydrogen of various grades. Hydrogen for fuel-cell vehicles (FCV) is strictly limited to premium-grade hydrogen with 99.97% purity. Suppliers aim for this since FCV is the only commercial hydrogen market today.

But if industries start using hydrogen from the 50% to 99.999% grades, then hydrogen production will not be limited to electrolysis. It could be produced from chemical recycling and city waste. According to Iwatani Corp, a producer of hydrogen and other gases, residential FC systems can run on 75%-grade hydrogen.

The main users of hydrogen as carbon-neutral material feedstock are synthetic methane (e-methane) and synthetic fuel producers. Japanese gas utilities have a 2030 goal to make e-methane account for 1% of total city gas supplies from zero today. Based on the 2020 figures, this translates as 360 million cubic meters of e-methane.

To supply e-methane of this volume, 130,000 tons of hydrogen are required, according to METI. E-fuel is called 'carbon neutral gasoline' since it is a liquid fuel primarily for vehicles. E-fuel and e-methane have similar chemical compositions except that the former is liquid and the latter a gas. A 17,000 kiloliter / year e-fuel demo plant, to be built by ENEOS, is expected to come online in 2028.

The plant will require 8,170 tons of hydrogen. ENEOS and JFE Steel began studies on using the methanation process for steelmaking.

2030 Hydrogen Demand (Tons)

H2 Application	Type	H2 Demand
Direct use as fuel	Power sector's ammonia co-firing	280,000-530,000
	Chemical transition using ammonia	120,000-300,000
	FCV	~80,000
TCN raw material	E-methane	~130,000
	E-fuel	~8,170
	Methanation-treated iron	~100,000
Total		**~1,140,000?**

Note: The figures are based on currently available transition plans, and are subject to change as markets develop.

Conclusion

The 2030 demand outlook put together by Japan NRG, based on individual sector demand assessments, falls short of the 3-million-ton hydrogen market that the government describes in its Hydrogen Strategy. Still, we believe that a further regulatory push could well drive hydrogen demand to hit national targets, assuming there are adequate demand-side subsidies.

For example, if petrochemical plants started to use ammonia instead of electricity for ethylene production, then 22-29 million tons / year of ammonia (3.66-4.83 million tons / year hydrogen equivalent) demand would be created, according to the Japan Chemical Industry Association.

Indeed, the Japan Hydrogen Association says the government is underestimating demand. The Association told a hydrogen safety panel in October 2023 that while the government currently forecasts 20 million tons of H2 demand in 2050, in reality, the number could reach 70 million tons by that time.

Japan's hydrogen strategy will next face a review in 2027. It will likely be longer and more detailed than the recent 43-page report because many projects currently in the study phase will have come to fruition. By then, there will be more clarity on what the new technologies can do, as well as their limitations.

Japan Energy Summit & Exhibition

Japan Energy Summit & Exhibition is a platform that connects the global energy community to Japan's energy value chain driving the nation's energy transition forward. Returning for the 6th edition in Tokyo from 3 - 5 June 2024 at Tokyo Big Sight, the event will focus on Japan's current and future energy mix from LNG and gas to hydrogen, ammonia, and renewables.

The Summit & Exhibition provides an unrivalled platform for sourcing products and services, showcasing innovative concepts and technologies and a meeting point for senior decision makers, innovators and solution providers to foster international collaboration in achieving energy security.

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Strategic Conference

The Strategic Conference provides a platform for global though leaders, ministers, and industry experts to debate, analyse and explore the latest trends impacting Japan's energy markets.

Technical Conference

The Technical Conference provides industry professionals across the energy value chain with an opportunity to share innovations and inspiring visions to expedite Japan's energy transition.

Climatetech Theatre

The Climatetech Theatre is an opportunity for students, young professionals, entrepreneurs, and industry executives to explore cuttingedge ideas and innovations that can expedite net-zero ambitions.

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