Fuel-in' Fashion?

The Japan startup turning old socks into hydrogen

The company looks at mountains of thrown-away clothes and sees a route to becoming a billion-dollar unicorn

Yuri Group
nearer by not keeping still

Japan's leaders have something of an obsession with local unicorns; that is, the type of business startup with a valuation of $1 billion and above. These are rare in Japan, but the government believes that spawning more such companies will keep the country on pace to compete globally.

Better still to be a budding unicorn that comprises high technology and greening of the energy grid – two other obsessions of the government.

Enter Tokyo-based Biotechworks-H2. The company claims that, based on tech developed by its California partners, they have a method for turning waste textiles into hydrogen for use as a clean energy source. (See below for a breakdown on how the technology works.)

On the face of it, the idea doesn't seem particularly exciting, considering the current global business infatuation with anything and everything related to artificial intelligence (AI). But the recycling potential in thrown away clothing is compelling when looking at the numbers. And use of hydrogen to reduce burning of fossil fuels is yet another preoccupation in Japan.

About 500,000 tons of clothing is ditched in Japan each year. Most of it (65%) is burned or buried. Worse, the manufacturing model in the global fashion industry gives the sector a surprisingly large carbon footprint – think large boot rather than svelte sandal.

Biotechworks-H2 believes it has a solution to all this waste and plans to have a pilot plant up and running in Osaka next year to coincide with the World Expo being held in the city. The premise is to showcase a means to capture the latent energy in the 2 billion clothing items discarded in Japan each year and establish a sustainable recycling model that can then be exported.

Given the massive waste in the fashion industry there is certainly an international problem out there looking for a solution. Biotechworks-H2 believes tackling this issue while producing hydrogen to help Japan and other nations wean themselves off fossil fuels is a two-way bet on a winning horse.

> According to the company's calculations, the future hydrogen market in Japan will be worth $212 billion by 2050. They argue that their method, employed nationally, could take 5% of that market. That's $42.4 billion based on their calculations.

But Biotechworks-H2 needs to walk before it can take a run at those dizzying projections. It aims for an IPO in 2028 and to have $70 million in revenue by 2030 as a national waste textiles processor. The company this month kicked off a new funding round, so will it find the capital and support to match its ambitions?

> This is a company that can change Japan and the world. We're aiming for an IPO, to grow the organization, and to make it a company that can benefit everyone. Unicorns are not often born in Japan, but we aim to be one of them.
>
> Biotechworks-H2 CEO, NISHIKAWA Akihide

Japan's Ministry of the Environment and the Ministry of Economy, Trade and Industry (METI) have launched initiatives to make better use of the almost half a million tons of clothing that ends up discarded as waste in the country each year.

Life Cycle of Garments in Japan (2022)

Going to Waste

Source: Ministry of the Environment

Fast and Furious

Alongside international brands like The Gap, H&M and Forever 21, Japanese giant Uniqlo (a subsidiary of Fast Retailing) is one of the main proponents of so-called "fast fashion."

The strategy is to make clothes cheap (usually in low income countries in south, central and southeast Asia), maintain rock bottom prices, then watch the items fly off the shelves in wealthier countries where fashions flip with the seasons and buyers discard items after limited use.

This model is a major contributor to the fashion industry's oversized carbon footprint. The fashion sector accounts for around 10% of the world's carbon emissions, be it via production or disposal. That's more than the emissions from the international airline industry and maritime shipping combined.

The surprising size of the carbon emissions from fashion don't tend to make the headlines as they do for, say, the airline industry, but environmentalists have in recent years started to highlight the CO2 footprint and the chemical usage in the fast fashion supply chain. This has so far done little to abate fast-fashion sales in places like Japan. However, the environmental consequences on the demand side are now gaining attention.

Japanese Fashion Industry's Environmental Load

CO_2 emissions About **90,000** kilotons

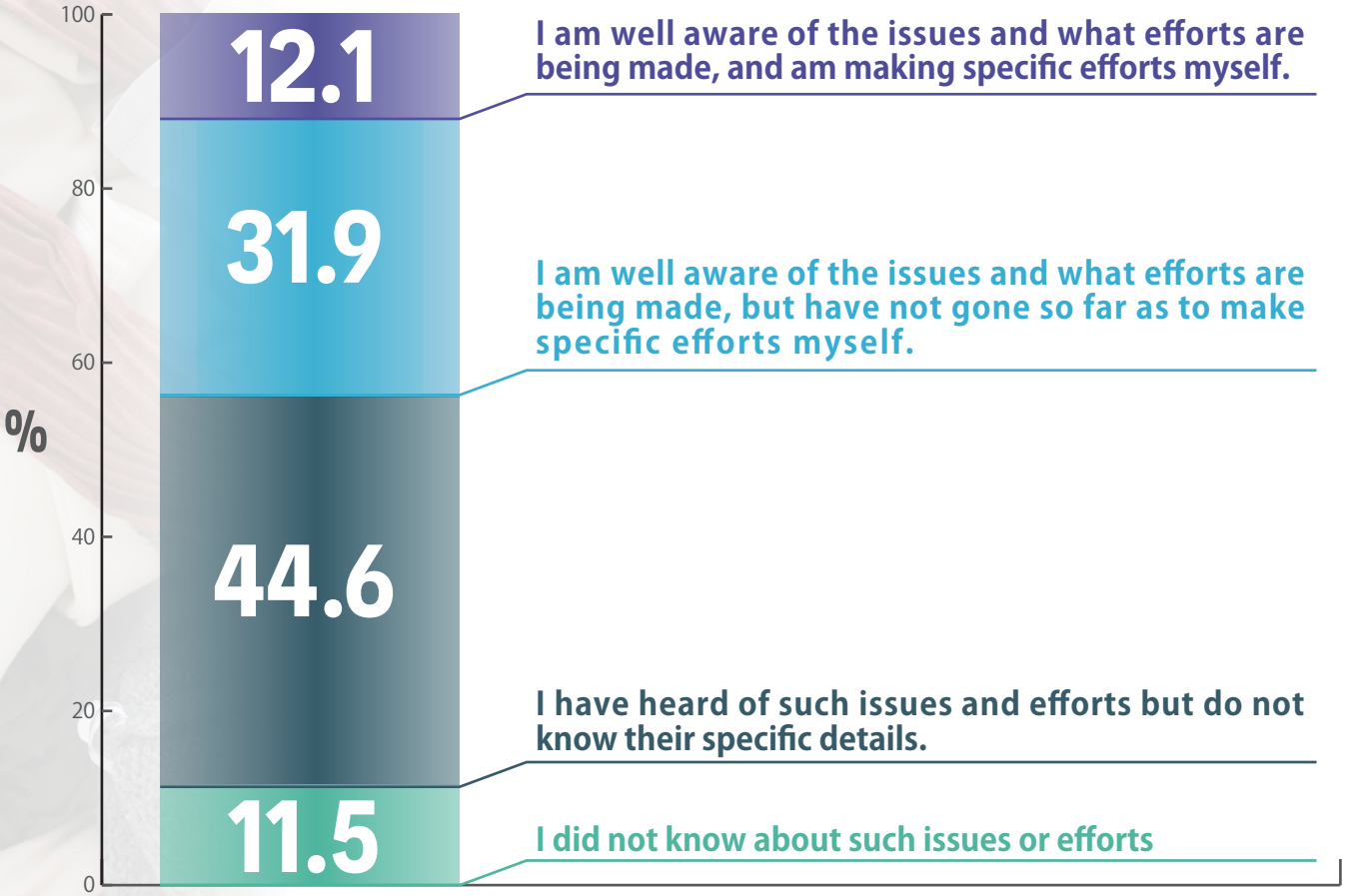
Water consumption About **8.3** billion cubic meters

Sense of Crisis

Since Japan committed to the United Nations Sustainable Development Goals (SDGs) in 2015, the government has pushed for greater accountability from manufacturing industries, including fashion. After setting up a SDGs Promotion headquarters in 2016, the Ministry of Foreign Affairs called on all parties involved to "share a sense of crisis across the country and make further efforts."

Perhaps fearing being squeezed out of sustainability focused markets overseas, a number of fashion brands in Japan, including Uniqlo, have set up clothing recycling bins in stores and added services like alteration and mending for customers who wish to wear older clothes.

But the most recent survey data in 2021 on sustainable fashion from the Consumer Affairs Agency suggests that a change in attitudes among Japanese consumers is needed.



Source: Consumer Affairs Agency, 'The Sustainable Fashion in Japan'

The data shows that the majority of Japanese consumers are aware of sustainable fashion efforts such as recycling, repairs, and use of environmentally friendly materials. However, the survey responses suggest these consumers regard the companies supplying the clothing as responsible for any sustainability initiatives. This mindset could benefit the Biotechworks-H2 business model.

Timely Development

> In the future, in order to achieve carbon neutrality in 2050, the challenge will be to promote green transformation (GX) even in sectors where decarbonization is difficult, and to simultaneously achieve stable energy supply, decarbonization, and economic growth. As the key energy and raw material for advancing GX in these sectors, it is essential to promote the use of low-carbon hydrogen, etc. while ensuring safety.
>
> METI, Hydrogen Society Promotion Bill, February 2024

In 2021, METI ratified the Basic Energy Plan based on Japan's commitments to the UN to drastically reduce the nation's reliance on fossil fuels. Later this year, the ministry is expected to update its decarbonization pledge by committing to a 66% reduction in carbon emissions by 2035.

Central to these decarbonization goals is the promotion of hydrogen as a clean energy carrier.

In February, the previous administration of Prime Minister Kishida Fumio passed the Hydrogen Society Promotion Bill, which positions the gas as the building block around which Japan will continue its "green transformation" – the transition from fossil fuels to new, clean sources of energy. To that end, the government estimates that the country as a whole will need to invest $107 billion a year over the next 15 years into a decarbonization program that includes boosting Japan's use of hydrogen.

Today, Japan consumes about 2 million tons of the clean-burning fuel, but most of it is created with fossil fuels and has an emissions footprint. By 2030, the government wants usage to rise to 3 million tons annually and the supply chain to switch to 'low carbon' hydrogen. By 2040, consumption is forecast to rise to 12 million tons.

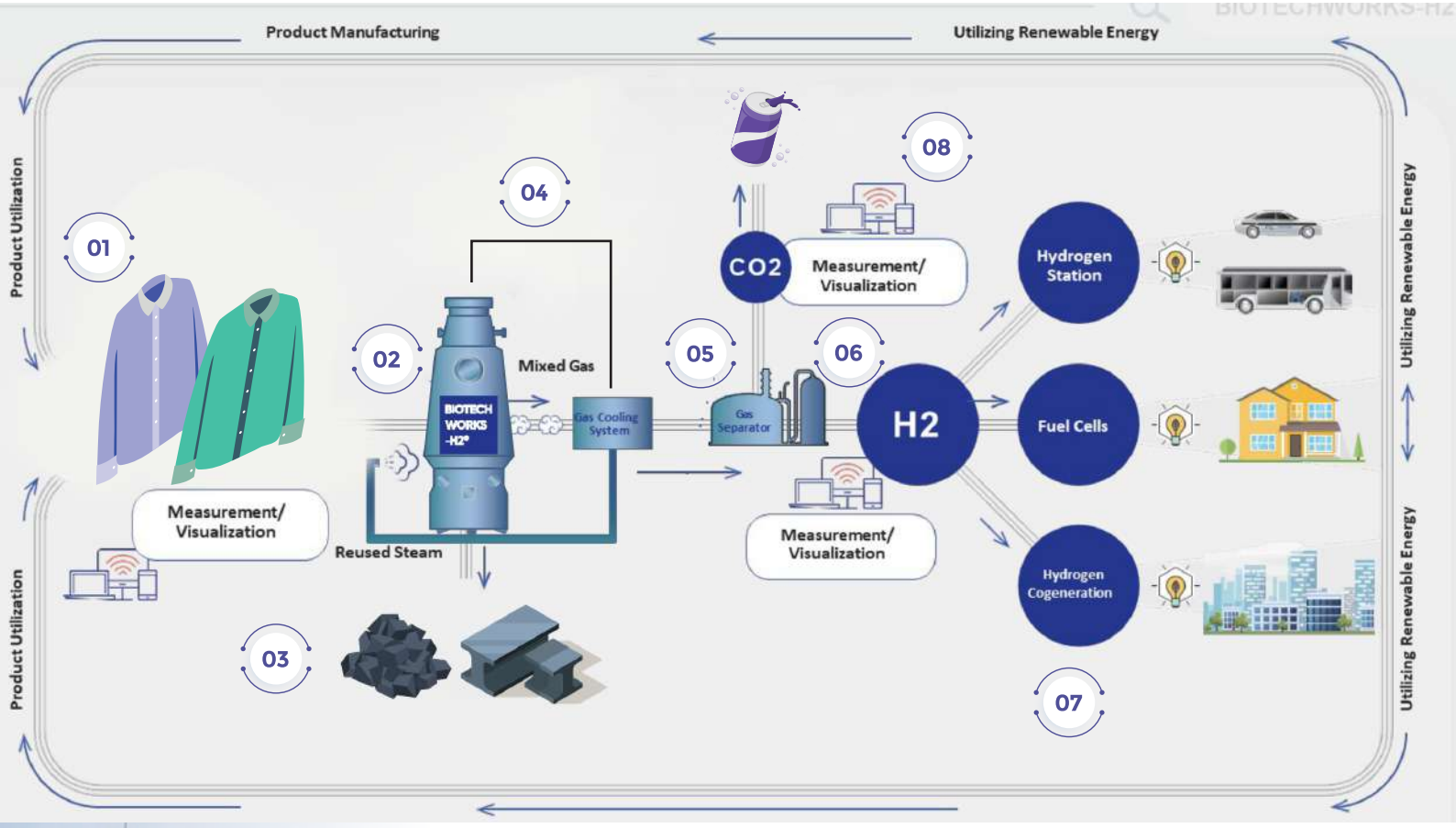
Proponents of hydrogen view this as a chance for resource poor Japan to lead the global energy industry toward a new form of energy production. Detractors see it as an expensive way to spend public funds that could otherwise go toward other renewable clean energy technology, such as solar and wind.

Hydrogen is a so-called clean energy carrier.

- It is clean burning, meaning it directly emits little to no CO2
- It can be stored as fuel in a cell, giving it potential as a storable and transportable source of energy
- When oxygen passes through the cell, it produces heat and energy
- It produces only water vapor as a byproduct
- It can be moved and stored in liquid form also, but requires extreme cooling to −253° C (−423° F)

Circular Economy

Biotechworks-H2's Hydrogenation Process



01 **Waste materials entered into the system**

02 **Impurities such as tar are separated at high temperatures, resulting in clean gas (gasification)**

03 **Slag and metals are separated for use in building materials**

04 **Heat is recycled to produce steam, which is then pumped back into the chamber, aiding gasification**

05 **Purified syngas passes through cooling and gas separation unit**

- Separates carbon dioxide and hydrogen
- Carbon dioxide can be recycled into carbonated drinks

06 **High purity hydrogen is separated and extracted**

07 **Hydrogen used as clean energy**

08 **In-house digital tracking system traces and monitors carbon footprint throughout each step of the hydrogenation process**

Rags to Riches?

> Local governments spend huge amounts of money on processing waste materials. By employing our method, those costs will no longer be necessary. Not only that, we can make profit by processing waste into hydrogen for use in making electricity. It's a win-win project with great potential benefits, not least for local governments.
>
> Biotechworks-H2 CEO, NISHIKAWA Akihide

Biotechworks-H2 began life in 2020 as an in-house venture at parent company Yamagin Inc., a holding company specializing in textile development, production and export.

Yamagin CEO Nishikawa Akihide spun off Biotechworks-H2 as a company in July 2023. Its US partner – set to be announced in an upcoming press release – operates a pilot site capable of processing 30 tons of city waste per day, with five kilos generating around 0.45 kg of hydrogen. Biotechworks-H2 say that waste clothing processed at this site can produce between 8-10% of its weight in hydrogen. Potentially, that amounts to around 3 tons of hydrogen per day.

Biotechworks-H2 also say they plan to bring in third-party tech experts and a chief technical officer to oversee the adoption of the technology in Japan. Although Biotechworks-H2 says they have no patent for their process at this moment, they plan to apply for it in the U.S. and Japan.

In 2025 it will start a two-year project with the Malaysian government aimed at processing the 2,000 tons of waste clothing the country generates per day. CEO Nishikawa, a Kansai region native, says the Osaka municipal government is following the progress of the project. He foresees a scenario where every municipality in Japan will install a Biotechworks-H2 facility to process waste textiles and use the hydrogen as energy.

Hydrogen Market (based on company estimates and projections)

Global Hydrogen Demand

2030 **150** metric tons

2050 **500** metric tons

$1.5 trillion

Japan's potential hydrogen market **$212 billion**

Biotechworks-H2's projected market share **5–7%**

Implications

The Biotechworks-H2 proposal, while embryonic, is timely. The Japanese government, for better or worse, has hitched its wagon to the hydrogen train, aiming to make Japan a "Hydrogen Society" over the course of the next fifteen years.

Some of Japan's biggest corporations, from city gas giant Tokyo Gas to real estate conglomerate Mitsui Fudosan, are fully invested in the government's vision of hydrogen as a clean fuel that can revolutionize Japan's approach to energy supply.

But that is by no means a view shared across the board.

Japan's decarbonization goals have opened up the race to various forms of clean energy and different entities are backing different horses. Still, the government's belief in hydrogen (and its various cousins and derivatives, such as ammonia, methanol, e-fuels, synthetic fuels) means that this energy has an edge in becoming Japan's future fuel of choice.

Proponents of hydrogen consider it a clean fuel due to the lack of carbon emitted when burned. But hydrogen isn't usually found in its native state (although recent discoveries suggest that may change in the future) which means it needs to be manufactured and processed.

One of the ways to make hydrogen is with an electrolyzer, powered by electricity created from renewable energy. But hydrogen skeptics ask why siphon off renewable power to make hydrogen, instead of just directly delivering such electricity to the grid for use in industry and households?

Another way to make hydrogen is from applying heat to natural gas (or coal) in a process called steam methane reforming (SMR). Unless all of the emissions from this process are captured, however, this technology also leaves a carbon footprint. Detractors insist that the workarounds needed to keep hydrogen made from gas clean is not worth the money and the power resources. And it risks keeping the fossil fuel industry in place even longer.

There are some other ways to make hydrogen, however, and Biotechworks-H2's method is one of them. The startup says its approach will create a circular economy model for hydrogen production that reduces and reuses waste. It also claims the method cuts emissions of carbon and other harmful substances during the production process.

Further, Biotechworks-H2 says widespread adoption of their method could recycle the huge amounts of waste textiles in Japan into clean hydrogen that has near-zero CO2 output.

But, Biotechworks-H2 is still in the very early stages of development. It will only progress to the proof of concept stage at the facility in Japan when the Osaka Expo arrives next year.

The company's business plan is detailed and contains some impressive numbers. But they need that injection of cash to get the ball rolling. Like most startups, it offers risk and opportunity. As they shoot for an IPO in just four short years, they'll be hoping they will have done enough by then to convince investors the risks are worth the potential reward.

The GxxD reports series covers the megatrends, business models, and innovations at the crossover between digital and clean energy. With stories on areas as diverse as AI, the CO2 economy, robotics, and fusion, we share intelligence that anyone with an eye on Japan will want to explore further.

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