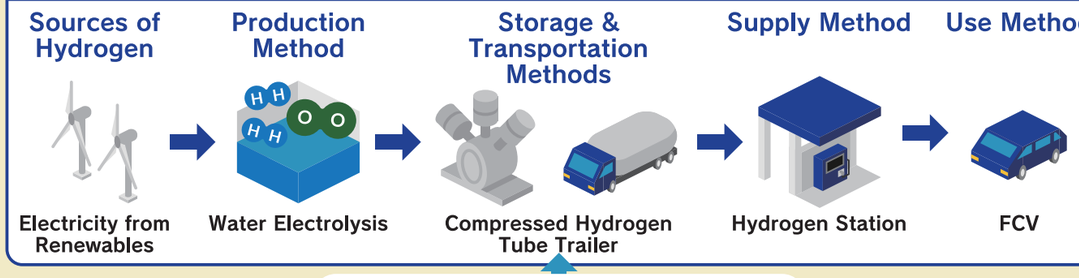
4 Tools for supporting operationalization

Ⅰ LCA Guidelines

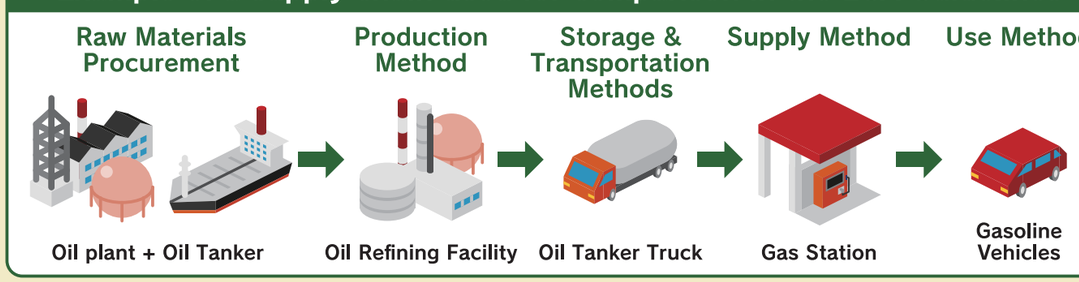
It is crucial to confirm that the use of hydrogen energy contributes to reducing greenhouse gas emissions in the whole supply chain, not only when hydrogen is used as fuel. LCA Guidelines help to calculate greenhouse gas reductions in the supply chain. These reductions are calculated by subtracting the greenhouse gases emitted by a conventional energy supply chain from those emitted by a hydrogen-based supply chain.

Example of a supply chain evaluated by the LCA Guidelines



Emission reductions

Example of a supply chain used for comparison in the LCA Guidelines



Method of calculating greenhouse gases

Volume of Activity × Emissions Per Unit = GHG Emission

■Volume relates to the scale of business
➤Each organization in the supply chain calculates their activity volume based on their expense sheet or design values
＜Example values＞
- Electricity consumption
- Fuel consumption for transportation
- Amount of waste products

■Greenhouse gas emissions per unit of activity
➤Use values in publicly available information
＜Example values＞
- Greenhouse gas emissions per 1kWh of electricity
- Greenhouse gas emissions per 1L of fuel
- Greenhouse gas emissions per 1t of garbage burned

Ⅱ Tool for calculating emission reductions

In order to support the guidelines above, Japan' s Ministry of the Environment (MOE) created a tool for calculating greenhouse gas emission reductions in hydrogen supply chains as a part of the Ministry' s 2016 project to evaluate and validate CO_2 reductions in hydrogen use. This tool automatically calculates hydrogen supply costs and CO_2 emission reductions in each stage of the hydrogen supply chain: production, transportation, supply, and use. The tool (an Excel file), its manual, and example calculations are available on the MOE website.

http://www.env.go.jp/earth/ondanka/lca/index.html

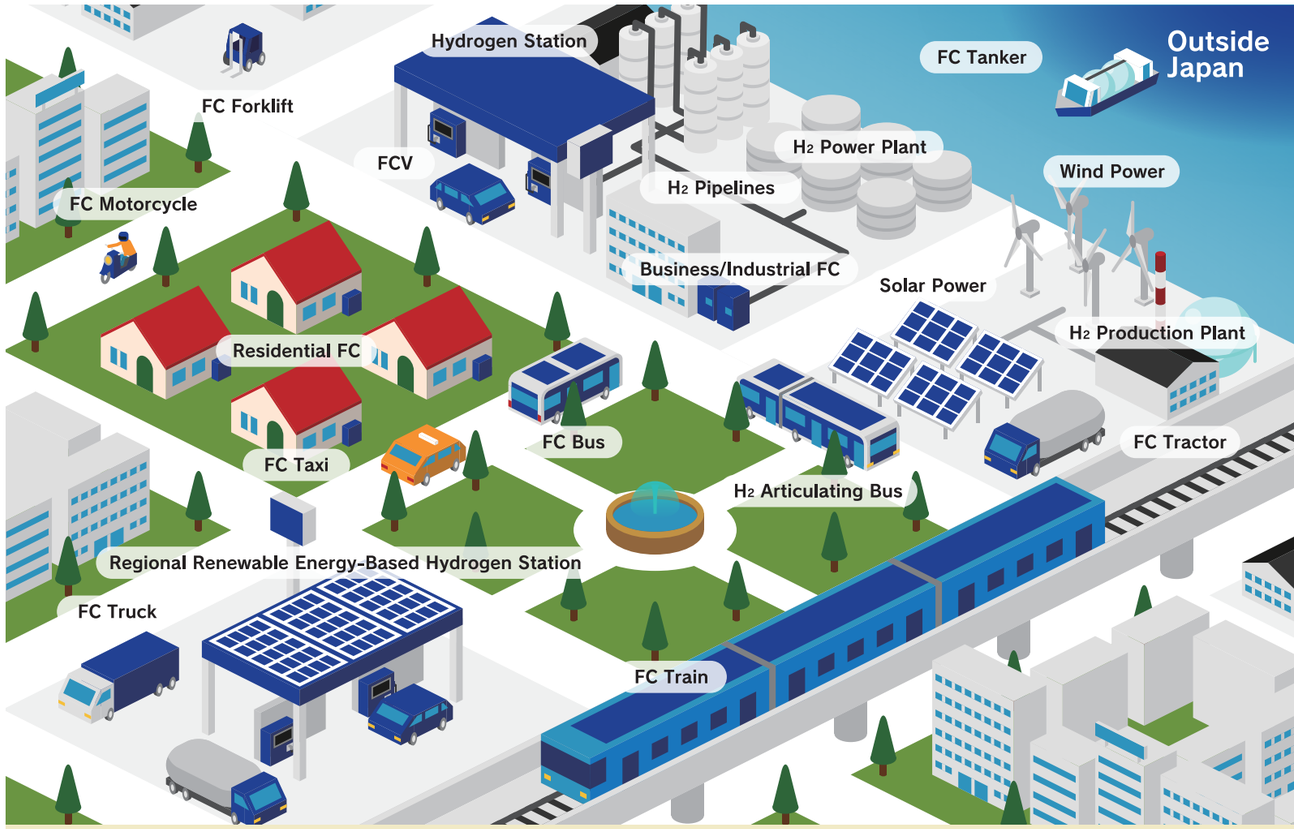
Contact Information : Climate Change Projects Office, Climate Change Policy Division,
Global Environment Bureau, Ministry of the Environment
TEL +81-3-5521-8339

環境省
Ministry of the Environment

Ministry of the Environment, Government of Japan

Projects for the Creation of Hydrogen Society

Hydrogen is one of the most important energy sources because it generates electricity and heat without CO_2 through the use of fuel cells. It could even be a lower-carbon energy source when it is produced from renewable energy. There are various projects to utilize hydrogen involving FCVs, FC forklifts, or hydrogen power generation both in and outside of Japan.



What is hydrogen?

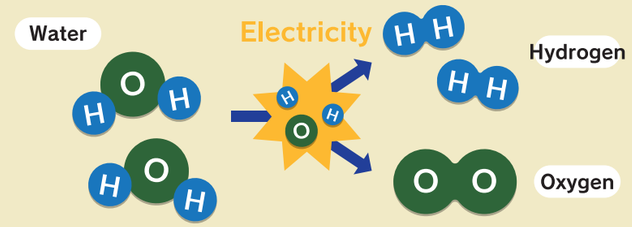
Hydrogen is the lightest gas on earth and is shown as H_2 in the world of chemistry. When a hydrogen atom, the most abundant chemical substance in the universe, bonds with another hydrogen atom, H_2 is produced. On earth, hydrogen atoms bond with many other elements and exist in the form of chemical compounds such as water or fossil fuels, which makes it possible to produce hydrogen atoms from various kinds of resources. The most common way to produce hydrogen is to electrolyze water (H_2O), thereby generating hydrogen (H_2) and oxygen (O_2).

Water electrolysis

By electrolyzing water

▼

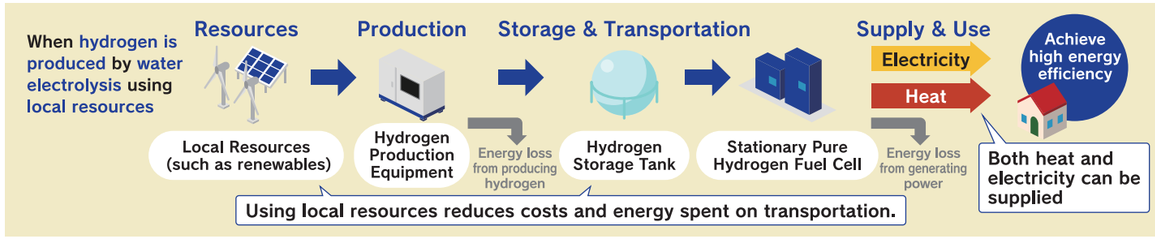
Hydrogen and oxygen are produced



Benefits of using hydrogen as energy

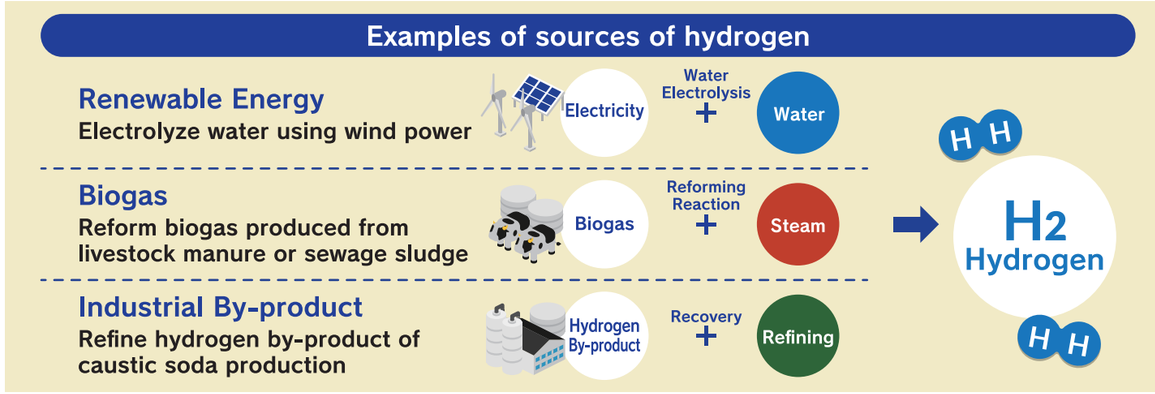
Ⅰ Reduce the amount of energy consumption

Fuel cells, which produce electricity by reacting hydrogen with oxygen, can achieve even greater energy efficiency when the reaction's by-product heat is also used, leading to a reduction in energy consumption.



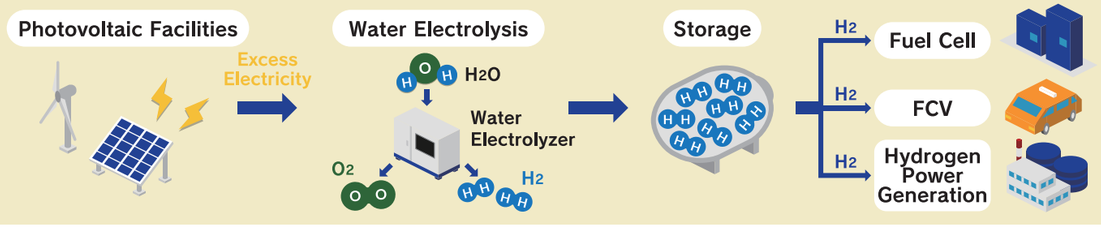
Ⅱ Decarbonize fuels

Although the amount of CO_2 emitted in hydrogen production varies depending on the sources of hydrogen, hydrogen can contribute to the decarbonization of fuels since no CO_2 is emitted when it is used.



Ⅲ Promote the use of renewable energy

Since renewables are unstable, mechanisms to store excess electricity or supply it when there is a shortage are needed. Hydrogen is one such mechanism because it can store energy for a long period of time.



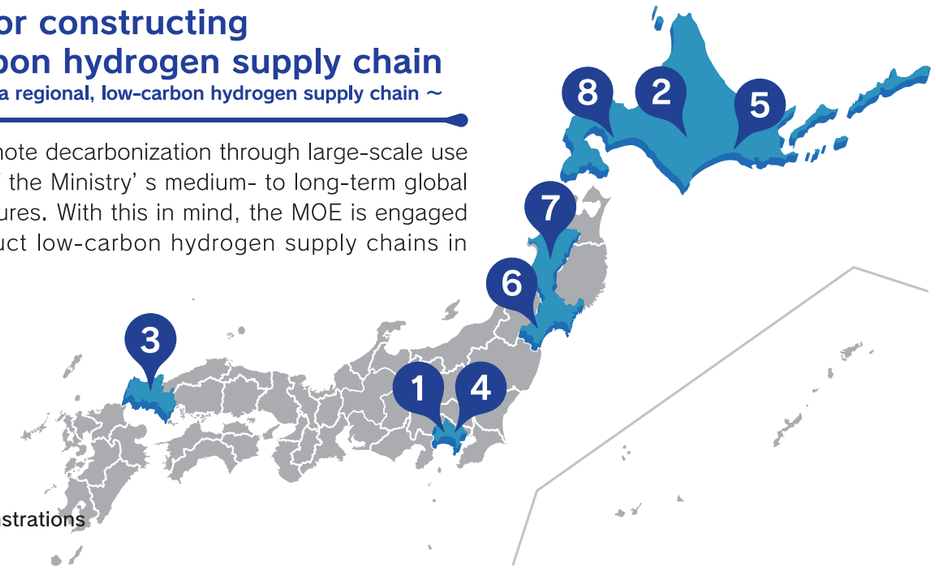
The MOE is engaged in projects to lead the efficient use of regional domestic energy to contribute to large-scale CO_2 reductions and local revitalization.

	Program (fiscal 2019)	Project
1	Projects for constructing a low-carbon hydrogen supply chain	■Promoting a hydrogen-based society through the use of renewable energy (Demonstrating a regional, low-carbon hydrogen supply chain)
2	Support for adoption of low-carbon hydrogen technologies	■Using renewable energy-based hydrogen to promote the decarbonization of community infrastructure ■Development of Self-sustained & Decentralized Hydrogen Energy System
3	Support for development of low-carbon hydrogen technologies	■Low-carbon Technology Research and Development Program ■Feasibility Study on FC Vessel Technology
4	Tools for supporting operationalization	■Promoting a hydrogen-based society through the use of renewable energy (Evaluation and validation of CO_2 emissions reduction in hydrogen use)

1 Projects for constructing a low-carbon hydrogen supply chain

～ Demonstrating a regional, low-carbon hydrogen supply chain ～

The MOE aims to promote decarbonization through large-scale use of hydrogen as part of the Ministry' s medium- to long-term global warming countermeasures. With this in mind, the MOE is engaged in projects to construct low-carbon hydrogen supply chains in various regions.



■ Prefectures of demonstrations (as of June 2019)

1 A hydrogen-station free direct supply of renewable hydrogen to fuel cell forklifts

■PJ Name/Introduction of fuel cell forklift at Keihin Coast Area and demonstration of clean hydrogen utilization model construction ■Demonstration:Keihin Coast Area ■Primary partner:Toyota Motor Corp. ■Municipalities:Kanagawa Prefecture, Yokohama City, and Kawasaki City

Production

Hydrogen is produced through water electrolysis using wind power, which is generated at a wind power plant called Hama Wing.

With a storage battery system, electricity can be supplied even when there is little or no wind.

Storage & Transportation

Stored in a tank and then compressed, the hydrogen is delivered by a simplified hydrogen fueling vehicle to sites where it will be used.

Supply & Use

From the simplified hydrogen fueling vehicle, the hydrogen is supplied to FC forklifts at a fruit/vegetable market, distribution warehouses, and refrigerated warehouses.

2 Beyond dairy products: hydrogen production from livestock manure

■PJ Name/The Hydrogen Energy Supply Chain Demonstration Project from Livestock Manure ■Demonstration:Shikaoi Town and Obihiro City, Hokkaido ■Primary partner:Air Water Inc. ■Strategic partners:Kajima Corp., Nippon Steel Pipeline & Engineering Co., Ltd., and Air Products Japan K.K. ■Municipalities:Hokkaido, Shikaoi Town, and Obihiro City

Production

Hydrogen is produced from biogas originating from livestock manure.

Storage & Transportation

After compression, the hydrogen is delivered by pipelines or in gas tanks to each site.

Supply & Use

The hydrogen is supplied to FCVs and FC forklifts from the hydrogen station on the project operation site.

Pure hydrogen fuel cells at a sturgeon farm and tourist sites use the hydrogen to generate electricity and heat, which are supplied to these facilities.

3 Making use of byproduct hydrogen with various transportation means

■PJ Name/Project to build a model of regional cooperation and local energy production/consumption using high purity waste hydrogen from caustic soda production ■Demonstration:Shunan City and Shimonoseki City, Yamaguchi Prefecture ■Primary partner:Tokuyama Corp. ■Strategic partners:Tosoh Corp., Yamaguchi Prefecture, Shunan City, and Shimonoseki City

Production

Hydrogen is effectively collected using buffer drums and pipelines that connect companies. The gas is then utilized in 4 different supply chains (SCs) using distinct hydrogen-delivery systems.

Storage & Transportation

SC1

The hydrogen is delivered to a nearby swimming club from a caustic soda plant through pipelines.

SC2

The hydrogen is compressed and delivered to a roadside station in tanks.

SC3

SC4

©Iwatani

The hydrogen gas is liquefied, and then transported to a hydrogen station in Shunan by tanker truck.

After being liquefied, the hydrogen is transported over a long distance and delivered to a refueling facility in Shimonoseki by tanker truck.

Supply & Use

The hydrogen is used to supply electricity and heat produced with a pure hydrogen fuel cell at the swimming club.

A pure hydrogen fuel cell at the roadside station supplies electricity and heat using the hydrogen for this facility.

The hydrogen is supplied to FCVs, FC forklifts, and a pure hydrogen fuel cell. The fuel cell supplies electricity and heat.

4 A hydrogen hotel running on used plastics

■PJ Name/Low-carbon hydrogen demonstration project of waste plastics regional circular model ■Demonstration:Kawasaki City, Kanagawa Prefecture ■Primary partner:Showa Denko K.K. ■Municipality:Kawasaki City

Production

Waste Plastics

RPF

Hydrogen is produced from plastic waste.

Storage & Transportation

The hydrogen produced at the Showa Denko Kawasaki Plant is transported to the sites where it will be used by pipeline or using a compressed hydrogen tube trailer.

Supply & Use

The hydrogen is used to generate electricity and heat with a pure hydrogen fuel cell at a hotel.

It is also supplied to FCVs at a hydrogen station.

5 Boosting regional renewable potential: hydrogen production from small-hydro power

■PJ Name/Expanding the use of hydrogen produced from a small hydropower plant and establishing a hydrogen utilization model suitable for the local characteristics of Hokkaido ■Demonstration:Shiranuka Town and Kushiro City, Hokkaido ■Primary partner:Toshiba Energy Systems & Solutions Corp. ■Strategic partner:Iwatani Corp. ■Municipalities:Hokkaido, Kushiro City, and Shiranuka Town

Production

Hydrogen is produced by electrolyzing water with electricity generated by a small-scale hydropower plant.

Storage & Transportation

Stored in a tank and then compressed, the hydrogen is delivered in high-pressure gas tanks to sites where it will be used.

Supply & Use

The gas is supplied to a pure hydrogen fuel cell installed at a heated indoor swimming pool, and then used as electricity and heat.

6 Safe delivery of renewable hydrogen to households using hydrogen-absorbing alloy cartridge

■PJ Name/Project to demonstrate a low-carbon hydrogen supply chain using fuel cells and the existing logistics network in Tomiya, Miyagi Prefecture ■Demonstration:Tomiya City, Miyagi Prefecture ■Primary partner:Hitachi, Ltd. ■Strategic partners:Marubeni Corp., Miyagi Coop., and Tomiya City

Production

Hydrogen is produced by solar power in Tomiya.

Storage & Transportation

The hydrogen is stored in hydrogen-absorbing alloys and transported to the sites. Taking advantage of the existing logistics network of Miyagi Coop., this delivery also involves the delivery of other goods.

Supply & Use

The hydrogen is supplied through hydrogen-absorbing alloy cartridges.

The hydrogen is used as electricity and heat produced with a pure hydrogen fuel cell installed at a store.

7 Making use of existing infrastructure: mixing renewable hydrogen with town gas

■PJ Name/Project to demonstrate the production of hydrogen from electrolysis using wind power, as well as the supply and use of hydrogen mixed with municipal natural gas ■Demonstration:Noshiro City, Akita Prefecture ■Primary partner:NTT Data Institute of Management Consulting, Inc. ■Strategic partner:Dainichi Machine and Engineering Co., Ltd. ■Municipality:Noshiro City

Production

Hydrogen is produced using electricity generated by a wind power plant in Noshiro, Akita.

Storage & Transportation

After being mixed with a gas similar to town gas, the hydrogen is temporarily stored in gas holders or tanks. The hydrogen-mixed gas is then supplied through gas pipelines to the sites where it will be used.

Supply & Use

The gas mixture is used in stoves and other commercially available gas devices in model homes to demonstrate the devices' compatibility with the gas.

8 Renewable hydrogen delivery with hydrogen-absorbing alloy tank and effective heat utilization

■PJ Name/Project to demonstrate a low-pressure hydrogen delivery system to promote hydrogen use in buildings and city infrastructure ■Demonstration:Muroran City, Hokkaido ■Primary partner:Taisei Corp. ■Strategic partners:Muroran City, Kyushu University, Muroran Institute of Technology, Tomoe Shokai Co., Ltd., The Japan Steel Works Ltd., and Kita Koudensha Corp.

Production

©The Muroran Minpo Co. Ltd.

This project uses electricity generated by wind power facilities in Muroran, Hokkaido, to produce hydrogen.

Storage & Transportation

The hydrogen is stored in a portable hydrogen-absorbing alloy tank and then transported by delivery vehicle. At the sites where it is used, the hydrogen is stored in a stationary hydrogen-absorbing alloy.

Supply & Use

A pure hydrogen fuel cell at a hot spring facility generates electricity and heat from the hydrogen. Exhaust heat at the facility is utilized to extract the hydrogen from the alloy.

＊These images are for illustration purposes only.

2 Support for adoption of low-carbon hydrogen technologies

The MOE renewable-energy-based hydrogen infrastructure, as well as hydrogen mobility, to promote low-carbon hydrogen.

Support for Hydrogen Mobility

The MOE supports the introduction of FC buses and FC forklifts, the popularization of which is expected to contribute a reduction in the mobility sector. Both of them are equipped with an emergency power supply function.

FC Forklift / FC Bus

R&D End User

- Supported R&D of a FC forklift for its potential to reduce costs and its improvement of energy efficiency and durability, leading to its commercialization in 2016.
- Supports the introduction of forklifts, which boast both environmental friendliness and convenience (about 3 min. of refilling time).
- Supported R&D of a FC bus for the improvement of its power performance, reliability and durability, leading to its commercialization in 2017.
- Supports the introduction of the FC buses, which boast both environmental friendliness and comfort.

Courtesy of Toyota Industries Corp.

Courtesy of Toyota Motor Corp.

Column

Example of Fuel Cell Bus Utilization

When Chiba Prefecture, Japan was struck by the typhoon in 2019, fuel cell bus successfully supplied electricity as an emergency power source.

Fuel Cell Bus

Courtesy of Toyota Motor Corp.

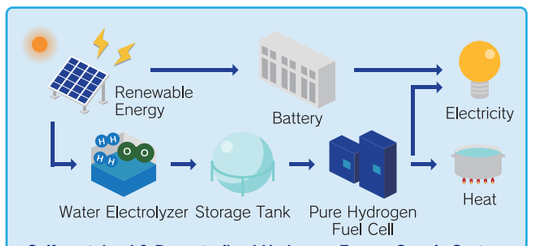
Support for Hydrogen Infrastructure

The MOE subsidizes hydrogen stations that supply hydrogen to FCVs, and decentralized hydrogen energy systems that supply power and heat. These systems allow self-sustained energy supply in times of disaster, and reduce the loss of energy in transmission and distribution.

Self-sustained & Decentralized Hydrogen Energy Supply System

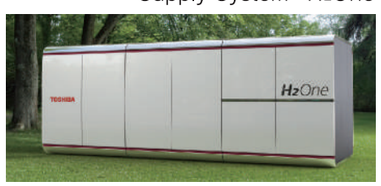
End User

- Supports the introduction of hydrogen energy supply systems, which consist of a battery, a water electrolyzer, or hydrogen storage tank.
- Aims to develop renewable energy storage and use models with hydrogen, which can accommodate different regional circumstances.



Self-sustained & Decentralized Hydrogen Energy Supply System

e.g.
Hydrogen-based Autonomous Energy Supply System "H_2One"



Courtesy of Toshiba Energy Systems & Solutions Corp.

Column

Example of Stationary Fuel Cell Utilization

When Hokkaido Eastern Iburi earthquake occurred in 2018, the self-sustain function of stationary fuel cell worked successfully. It also supplied electricity to the facilities with using fuel cell vehicles and fuel cell forklifts.

Sturgeon breeding facility

Courtesy of Environmental Conservation Center of Shikaoi Town

3 Support for development of low-carbon hydrogen technologies

The MOE supports the development of low-carbon hydrogen technologies for a large scale CO_2 reduction.

Development of Hydrogen Storage Technologies

The MOE supports the development of safe and cost-efficient hydrogen storage technologies.

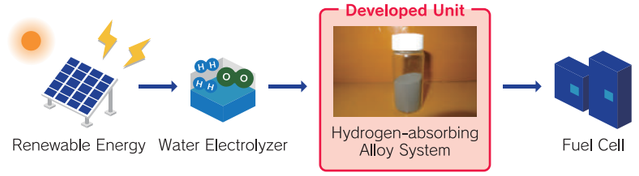
Hydrogen-absorbing Alloy

R&D

Developed a hydrogen-absorbing alloy, which allows for low-pressure, high-density hydrogen storage, for a cost reduction, and improved its absorption and emission efficiency.

■Primary partner: Nasu Denki-Tekko Co., LTD

■Implementation from fiscal 2017



Column

Benefits of Hydrogen-absorbing Alloys

A hydrogen-absorbing alloy can store hydrogen and allow for its handy carrying.

Loading of hydrogen-absorbing alloy cartridges

Courtesy of Hitachi, Ltd.

Development of Hydrogen Usage Technologies

The MOE supports the development of hydrogen mobility for decarbonizing transportation.

Stationary FC

R&D

Developed a control system for connected multiple 100kW units, for the downsizing of the stationary FC, and improvements of its durability and power output.

■Primary partner: Toshiba Energy Systems & Solutions Corporation

■Implementation from fiscal 2018

Courtesy of Toshiba Energy Systems & Solutions Corp.

FC Vessel

R&D

Developed a water- and salt-proof FC unit for vessels, and demonstrated at sea.

■Primary partner: Toda Corporation

■Implementation from fiscal 2014 to fiscal 2015

Courtesy of Toda Corp.

FC Truck

R&D

Tested a FC truck' s basic performances and practicality, and demonstrated on public roads for its mass production.

■Primary partner: Tokyo R&D Co., Ltd.

■Implementation from fiscal 2016

Courtesy of Tokyo R&D Co., Ltd.

FC Garbage Truck

R&D

Developed an FC garbage truck, tested its basic performances, and identified optimal uses in actual garbage collection.

■Primary partner: Flat Field Co., Ltd.

■Implementation from fiscal 2015 to 2017

Courtesy of Flat Field Co., Ltd.