# FH2R

FUKUSHIMA HYDROGEN ENERGY RESEARCH FIELD

福島水素エネルギー研究フィールド

Fukushima Hydrogen Energy Research Field

English Edition

# Welcome to FH2R!

## FUKUSHIMA HYDROGEN ENERGY RESEARCH FIELD

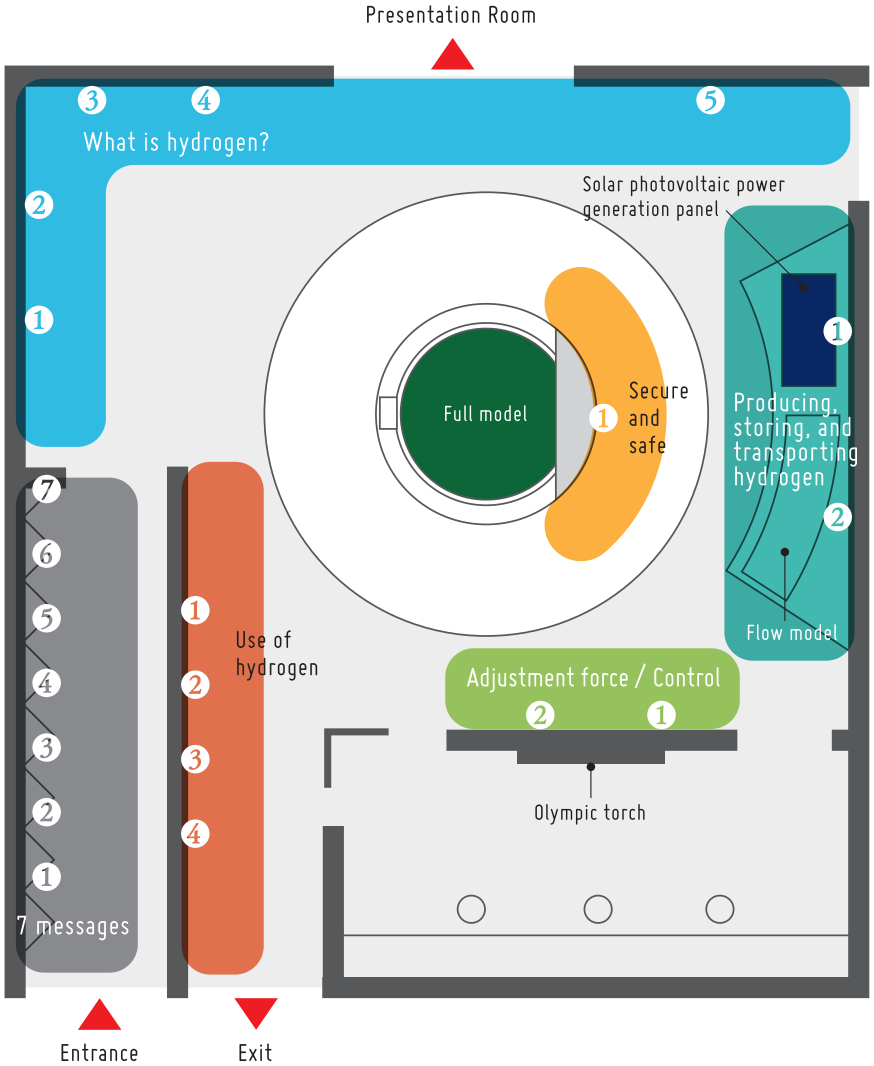
In addition to playing a part in Fukushima's revitalization, hydrogen is performing an active role as an essential energy infrastructure.
The flagship for realizing these expectations for the near future is here,
FH2R — Fukushima Hydrogen Energy Research Field.
At FH2R, specialists work together to verify and operate the control systems.
Their aim is to achieve a "Power-to-Gas system" containing an even greater accumulation of knowledge and even more advanced subsequent control systems.

# R&D CENTER

This facility was constracted as a place for disseminating information and sharing opinions about hydrogen within a facility where hydrogen is actually being produced, in addition to being a place where researchers can carry out their research.



## FLOOR MAP



# 7 messages

## that create an awareness of the connection among us, energy, and hydrogen

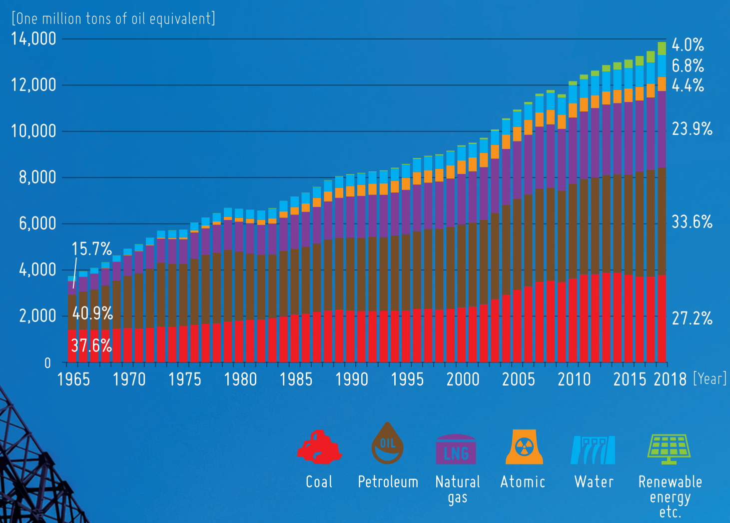
On the earth where we live, there are various problems.
What kind of problems are there,
and are there any solutions for them?
Let's think together.



# Our lives that have become affluent together with energy

Energy is inescapably tied to the affluence of our lives.
Can you image our lives without energy?

**The changes in the world's energy consumption**
(by energy source, primary energy)




※There are cases where the total does not become 100% due to rounding.

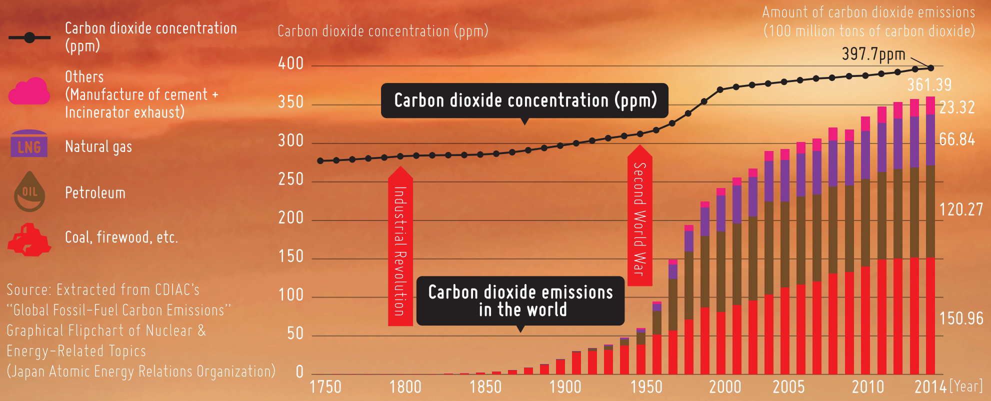
Source: Prepared based on BP's "Statistical review of world energy 2019"
The Agency for Natural Resources and Energy, the Ministry of Economy, Trade and Industry

# What is happening behind our affluent lives

The consumption of fossil fuels in various fields (power generation, transportation, heat, materials, etc.) is leading to an increase in carbon dioxide ($CO_2$) emissions. This is one of the causes accelerating climate change.

## Changes in the amount of carbon dioxide emissions from fossil fuels, etc. and the carbon dioxide concentration in the atmosphere

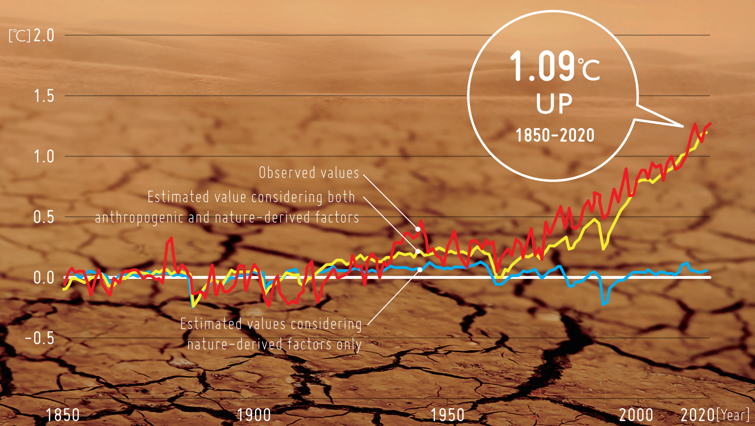
※There are cases where the total does not match due to rounding.




Source: Extracted from CDIAC's "Global Fossil-Fuel Carbon Emissions" Graphical Flipchart of Nuclear & Energy-Related Topics (Japan Atomic Energy Relations Organization)

## How much has the world's average temperature increased?

Changes in the world's average temperature (annual average)




※The estimated value considering the observed values and both anthropogenic and nature-derived factors as well as the estimated value considering nature-derived factors only (Both are for 1850 – 2020)

Source: IPCC's sixth assessment report and JCCCA (Japan Center for Climate Change Actions)

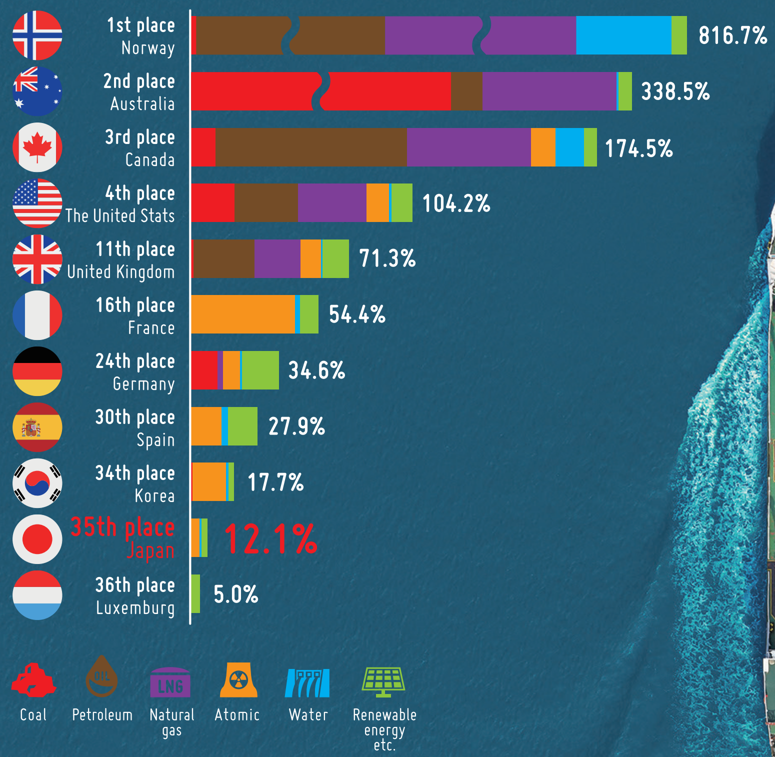
**The global temperature has increased as if it is synchronized with an increase in carbon dioxide. It has increased by approximately 1.09°C in the past 170 years.**



# "Decarbonization" and "Self-sufficiency in energy" are our tasks.

Such as massive natural disasters and loss of biodiversity, various global-scale tasks related to climate change are almost upon us. In addition, it is also necessary that domestic resources can be used for energy as much as possible.

## Comparison of the primary energy self-sufficiency rate among major countries (2019)




Source: The estimated value of the FY 2019 from the IEA's "World Energy Balances (2020 edition)"
※Only for Japan, the estimated value of the FY 2019 from "Comprehensive Energy Statistics"

# Let's reduce the utilization of fossil resources.

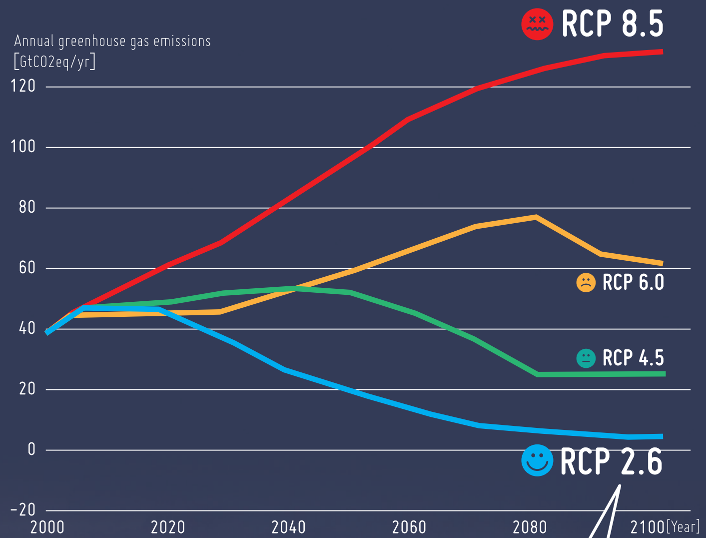
It is necessary to reduce the amount of fossil resources used in various fields (such as power generation, transportation, heat, and materials) and the emissions of greenhouse gases represented by carbon dioxide.

## How much do emissions need to be reduced in the future?

Greenhouse gas emission pathway based on various scenarios

※RCP...The representative concentration pathway scenario
(Represr tative Concentration Pathways)

Source: IPCC's fifth assessment report and JCCCA
(Japan Center for Climate Change Actions)




In order to reduce the temperature increase in the future to below 2°C, greenhouse gas emissions need to be reduced to **zero or below zero** by 2100.

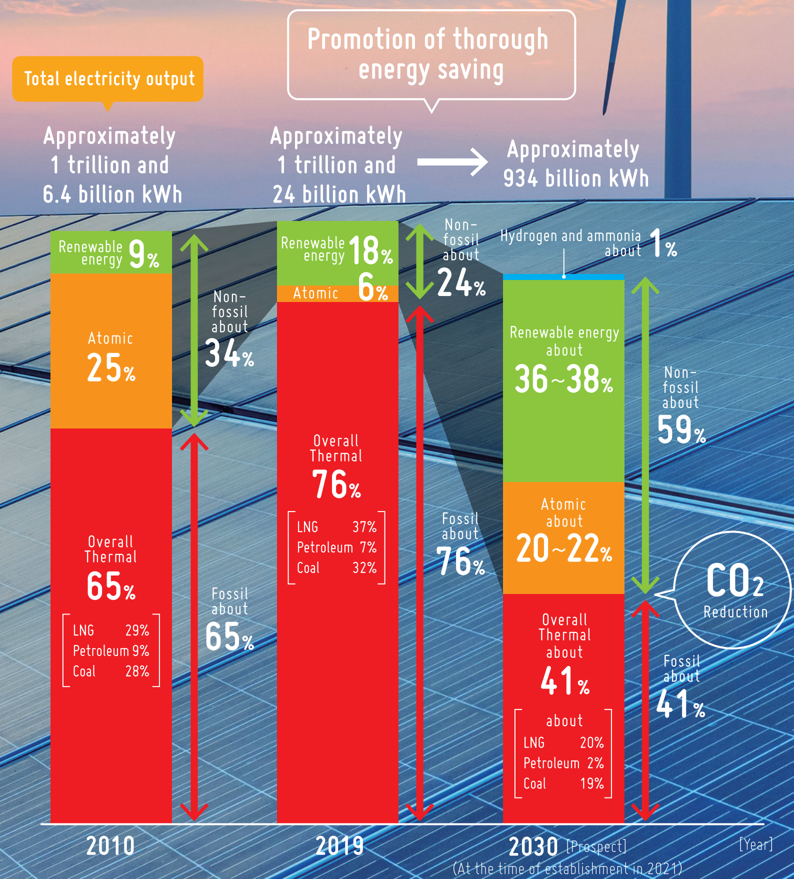
| | | |
|---|---|---|
| RCP 8.5 | **High-level referential scenario** (The radiative forcing at the end of century is 8.5 w/㎡) | Scenario equivalent to the maximum greenhouse gas emissions in 2100 |
| RCP 6.0 | **Mid-level stabilization scenario** (The radiative forcing at the end of century is 6.0w/㎡) | |
| RCP 4.5 | (The radiative forcing at the end of century is 4.5w/㎡) | |
| RCP 2.6 | **Low-level stabilization scenario** (The radiative forcing at the end of century is 2.6w/㎡) | The lowest emissions scenario developed based on the goal of reducing the temperature increase in the future to 2°C or lower |



# Let's produce earth-friendly electricity.

In the field of electric power among energies, the introduction and expansion of "renewable energy" characterized by converting natural energy such as sunlight and waterpower into electric energy without emitting carbon dioxide is being promoted. As for thermal power generation, it is also required to reduce carbon dioxide emissions.

## Electric power demand and power supply configuration



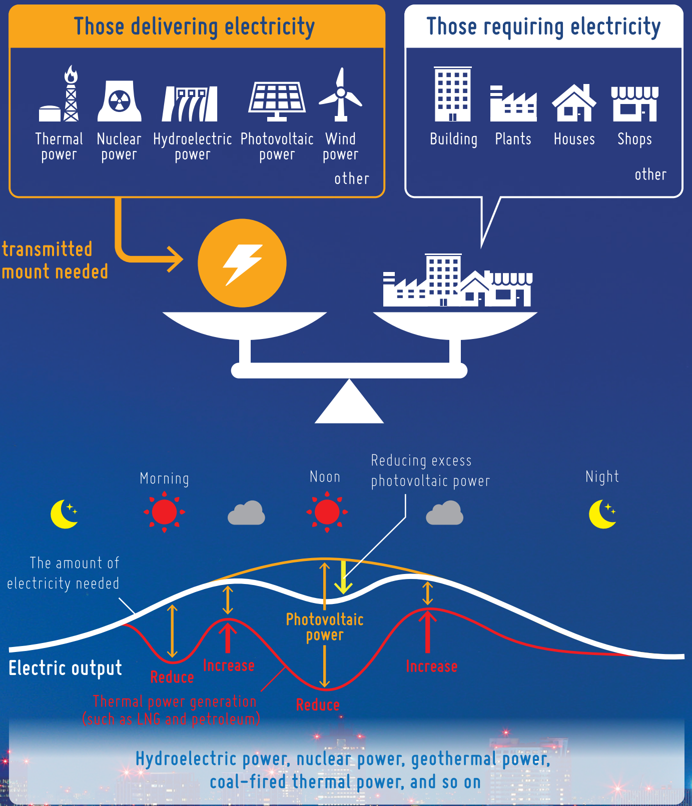

↓$CO_2$

Source: Prospect of energy demand in the FY 2030
The Agency for Natural Resources and Energy

# Electricity demand — supply Importance of balance

In order to use electricity in a stable manner, the balance between supply and demand always needs to be maintained.
However, associated with an increase in renewable energy with a variable electric-generating capacity depending on solar irradiation, wind conditions, etc., it becomes difficult to adjust the demand balance.

Source: The Agency for Natural Resources and Energy, the Ministry of Economy, Trade and Industry



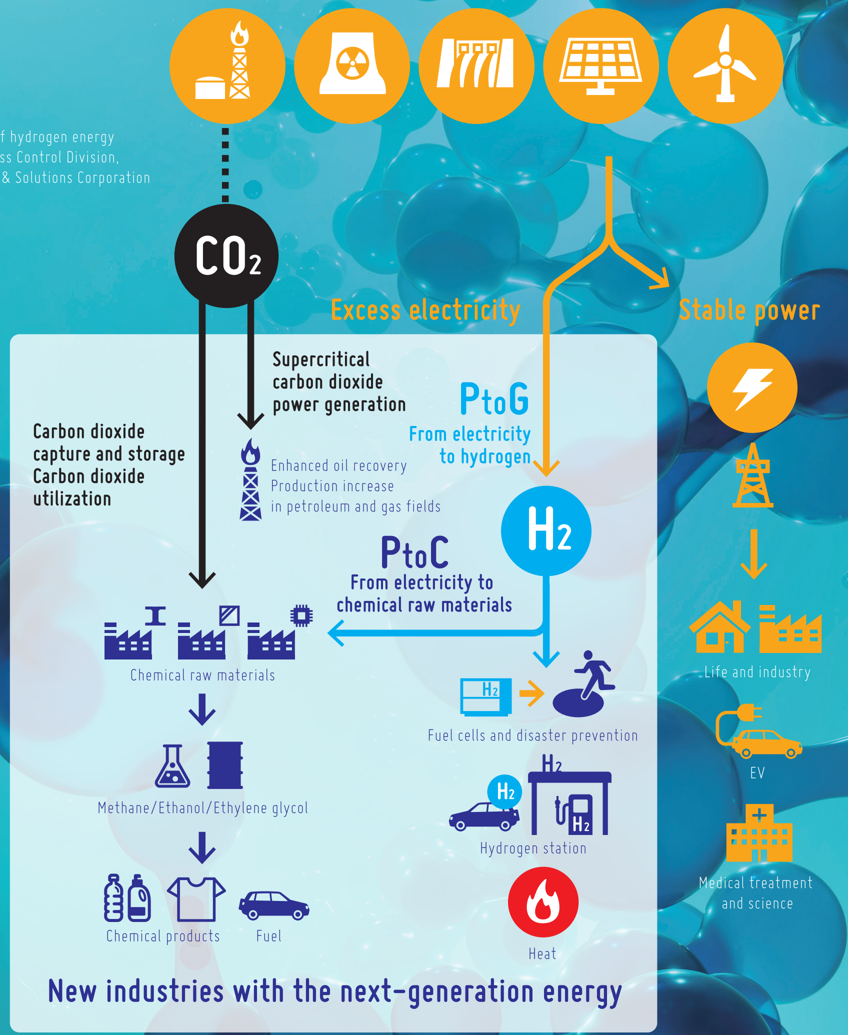



# Expectations are centered on "hydrogen" now.

At present, "hydrogen" is expected to be a solution for this issue.
In this facility, the abundant potential of "hydrogen" is introduced.

**With a central focus on hydrogen, excess renewable energy and carbon dioxide are converted into high-value substances and new services to create new industries = Hydrogen society**

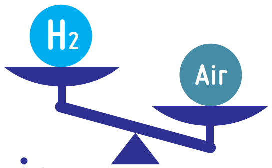
Source: Understanding of hydrogen energy Hydrogen Energy Business Control Division, Toshiba Energy Systems & Solutions Corporation



# Q

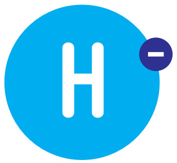
# What is hydrogen?

# A

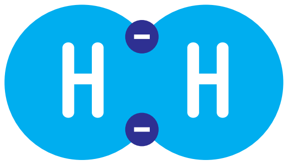



## It is the element that is the lightest and highest in number.

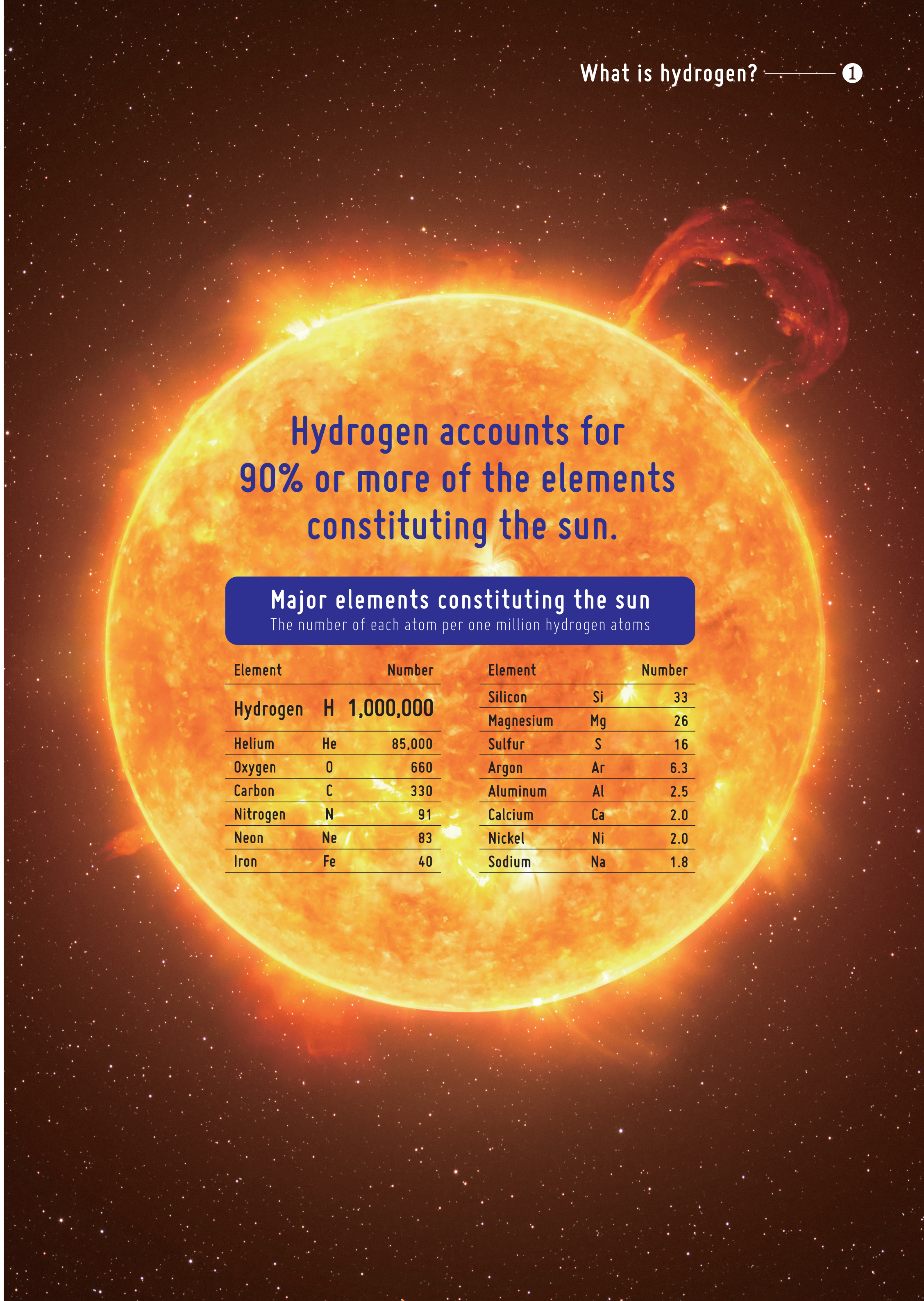
Hydrogen is the lightest and most abundant substance in space.
Its weight is approximately one-fourteenth of that of air.
It is the lightest of elements, it alone normally exists in a gaseous state.




Hydrogen atom




Hydrogen molecule



## Hydrogen accounts for 90% or more of the elements constituting the sun.

**Major elements constituting the sun**
The number of each atom per one million hydrogen atoms

| Element | | Number | Element | | Number |
|---|---|---|---|---|---|
| Hydrogen | H | 1,000,000 | Silicon | Si | 33 |
| | | | Magnesium | Mg | 26 |
| Helium | He | 85,000 | Sulfur | S | 16 |
| Oxygen | O | 660 | Argon | Ar | 6.3 |
| Carbon | C | 330 | Aluminum | Al | 2.5 |
| Nitrogen | N | 91 | Calcium | Ca | 2.0 |
| Neon | Ne | 83 | Nickel | Ni | 2.0 |
| Iron | Fe | 40 | Sodium | Na | 1.8 |

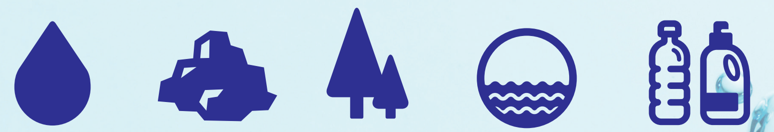
# Q

# How is hydrogen produced?

# A

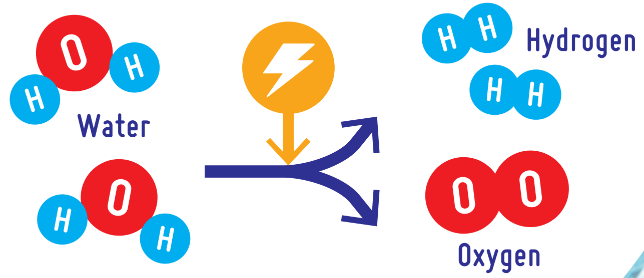
## It can be extracted from resources around us, such as water.

Hydrogen can be extracted from water using electricity.In addition, it can be produced from all kinds of resources, such as fossil fuels including petroleum and natural gases, biomass, sewage sludge, and waste plastics.




## The principle of electrolysis of hydrogen

Applying electricity to water generates hydrogen and oxygen.



# Q
# What is hydrogen used for?

# A
## It can be utilized as heat and electricity.

Hydrogen can generate power by combining it with oxygen and can be utilized as thermal energy by burning it.
In addition, since hydrogen is high in energy efficiency, it is also utilized as fuel for rockets that require a great deal of energy.


# Q
# Can hydrogen be stored?

# A
## Hydrogen can be transported and stored.

Electricity can be generated as long as fuel cells and hydrogen are available, even in places with no electricity.

# Q What is hydrogen useful for?

## A It is already useful in various places such as chemical plants and ironworks.

### Petroleum refining

It is used as an additive for desulfurization to remove sulfur contained in crude oil as well as for producing petrochemical products.

### Ironworks and plastic plants

Hydrogen is added to bright annealing agents that make steel product surfaces such as stainless steel shiny.Hydrogen is also used as a reducing agent for metallurgy that alters the properties of metals with heat treat furnaces and for production of resins such as plastics.

### Glass plants

In the field of glass such as optical fibers and quartz glass, mixed combustion with oxygen enables the firing of unclouded and clear glasses.

### Semiconductor plants

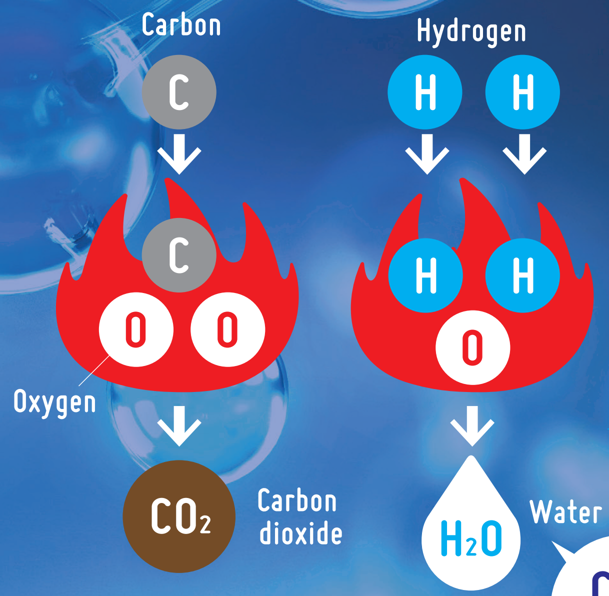
Ultrapure hydrogen gas is used as a material when manufacturing semiconductors used in cell phones and computers.

### Food plants

For oils and fats such as margarine, hydrogen is added to raw materials to alter the chemical properties.

# Q Tell me the amazing thing about hydrogen

## A It is that hydrogen does not generate carbon dioxide even when combusted.




Fossil fuels such as coal, petroleum, and natural gas generate carbon dioxide ($CO_2$) when they are combusted. However, hydrogen does not generate carbon dioxide at all even if combusted. This “zero generation of carbon dioxide” is the remarkable feature of hydrogen.

“Combustion” means that substances connect with oxygen while emitting light and heat.

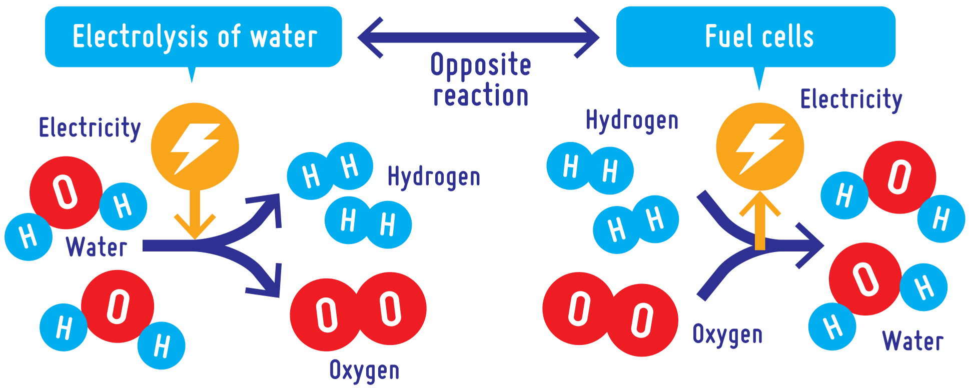
# Q
# What are fuel cells?

# A

Fuel cells

## They are devices that generate electricity from hydrogen and oxygen.

Fuel cells produce a chemical reaction by delivering hydrogen to one electrode and oxygen to the other electrode to generate water and electricity.
Since they have various uses, they support our lives in a wide variety of applications, including not only household uses but also automobiles, buses, ships, etc.




# Produce hydrogen from renewable energies to reduce carbon dioxide emissions

One of the essentials for producing hydrogen is "electricity".
In FH2R, hydrogen is produced by using "electricity" produced from natural energy, as much as possible, that emits less carbon dioxide.
The photovoltaic panels installed in the spacious 180,000㎡ premises can generate electricity of up to 20 MW.

# $H_2$ Produce hydrogen


In FH2R, **the hydrogen producing system** of 10 MW is used to electrolyze water and produce hydrogen. Up to approximately 2,000 Nm³ of hydrogen can be produced per hour.
The produced hydrogen gas is delivered to the hydrogen gas holder through pipes after excess moisture content and impurities are eliminated.

## A daily hydrogen production volume enables electricity to be supplied to approximately 150 households (for a month) or hydrogen to be filled into 560 FCVs.

### Hydrogen production volume

Approximately **1200** Nm³ ※1 per hour

※1 Nm³ : The amount of 1 m3 of gas converted to the standard state (0°C, one atmosphere)

### Power consumption of general households

Approximately **150** households ※2

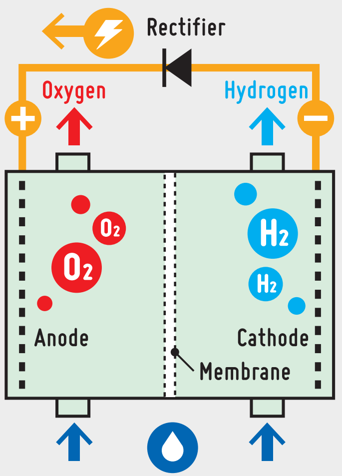
※2 Per household, calculated from the power consumption for one month

### Fuel for fuel cell vehicles (FCVs)

Approximately **560** FCVs ※3

※3 Cases where FCVs are filled

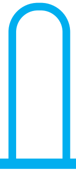
## The principle of alkaline water electrolysis

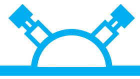



Water electrolysis system

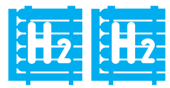
**Water electrolysis unit** The alkaline electrolyte is electrolyzed to produce hydrogen gas and oxygen gas.

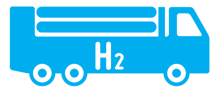
# Storing


Hydrogen gas holders


Compressor

# Transporting


Hydrogen gas cylinder packs

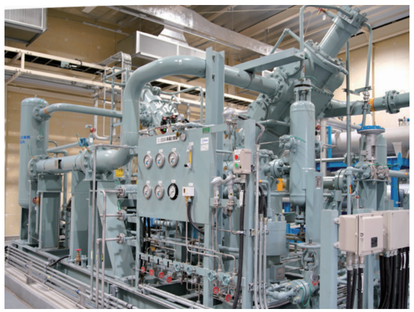

Hydrogen gas tube trailers

The hydrogen supplied through pipes is stored in eight **hydrogen gas holders** with 150$m^3$ internal capacity. Since the compressor to which the hydrogen is supplied can compress only a fixed amount of oxygen for a certain period of time, the hydrogen is stored here temporarily to adjust the amount of hydrogen. The hydrogen passes through **the purifier** before it is filled into trailers or cylinder packs to eliminate impurities such as moisture content and oxygen. To make it possible to store and transport a larger amount of hydrogen, the hydrogen gas is **compressed** to approximately 20 MPa, whose volumetric capacity is one two-hundredth of that of atmospheric pressure.

### Hydrogen gas holders

### Purifier

### Compressor



The compressed hydrogen is stored in containers with superior pressure resistance and is then transported to the areas of demand.

## Hydrogen gas trailers (12 trailers)

Up to 240kg and 3,000$m^3$ of hydrogen that is compressed to approximately 20 MPa, whose volumetric capacity is 1/200 of that of atmospheric pressure, which is 200 times as high as that of atmospheric pressure, can be filled.They are connected to towing cars to deliver hydrogen to areas of demand.

## Hydrogen gas cylinder packs (300$m^3$ x 15 and 150$m^3$ x 4)

Assembled containers made by fixing small containers collectively. In cylinder packs that enable the filling of 300$m^3$ of hydrogen, 24kg of hydrogen that is compressed to approximately 20 MPa can be filled. In addition, cylinder packs in which 150$m^3$ of hydrogen can be filled are also available, and they can be loaded onto trucks, etc. and delivered to areas of demand.

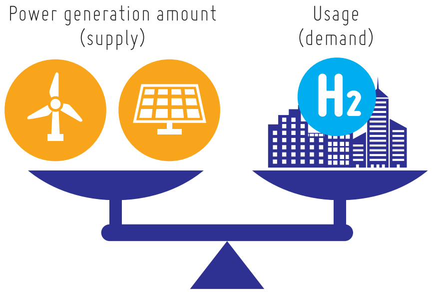
### Hydrogen gas cylinder packs

### Hydrogen gas tube trailers

# Stable electricity for everyone to deliver

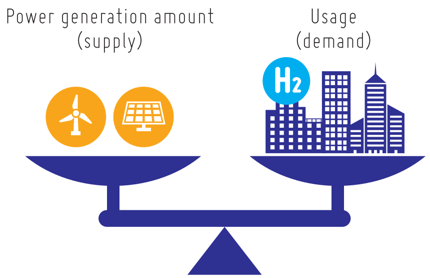
In our lives, the demand for electricity constantly varies depending on people's activities. However, in the case of renewable energies that do not emit carbon dioxide such as photovoltaic power and wind power, the supply also varies depending on the weather. In order to deliver stable electricity, it is necessary to match the supply and demand constantly and maintain balance.

## Maintaining balance through the utilization of hydrogen as an "adjustment force" (concept)




【 Renewable energy power generation amount > Electricity demand 】

Electricity demand is increased to maintain balance by operating or increasing the output of FH2R.

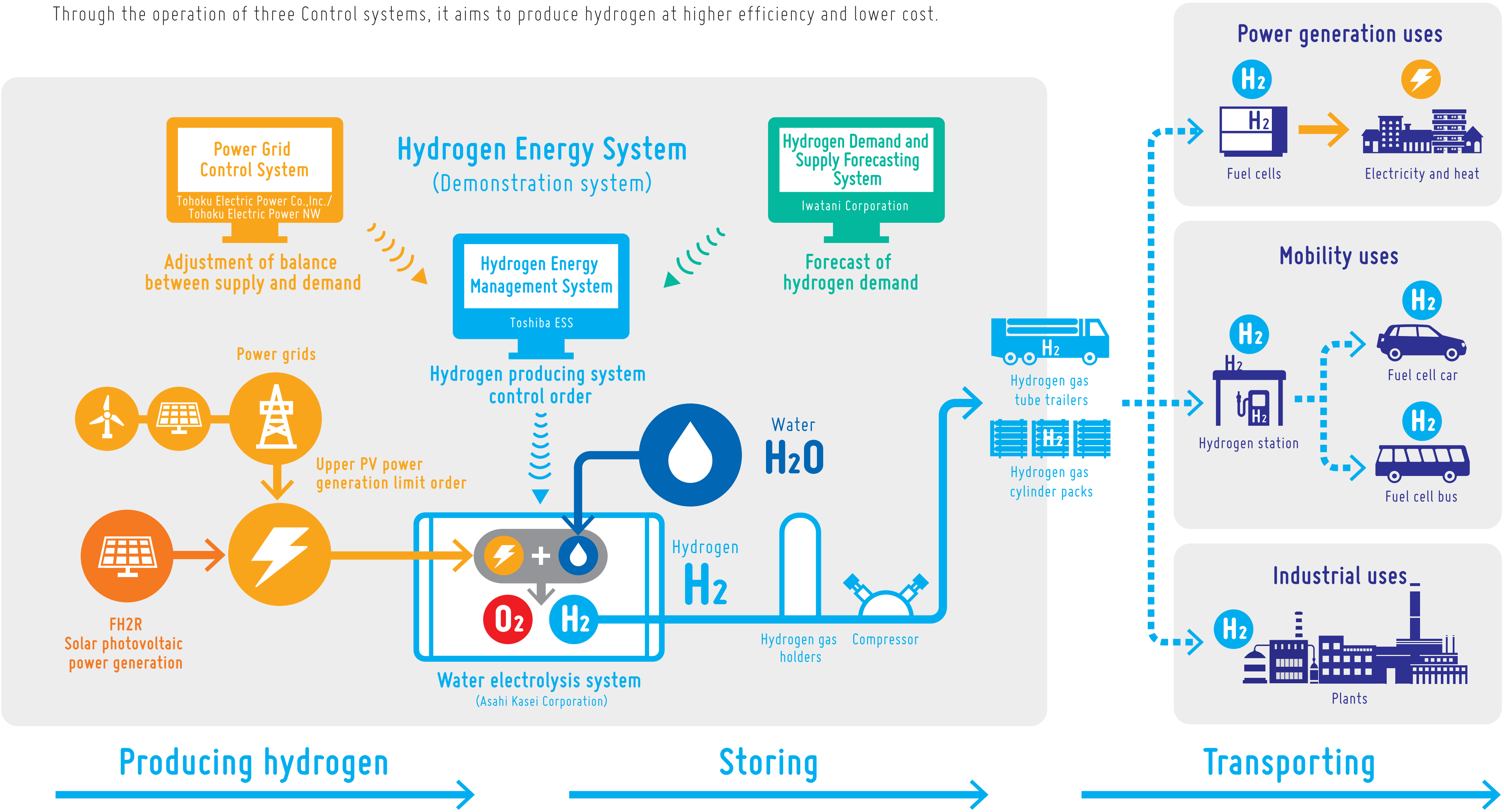



【 Renewable energy power generation amount < Electricity demand 】

Electricity demand is decreased to maintain balance by stopping or reducing the FH2R output.

# Utilizing hydrogen as an "adjustment force"

To maintain this balance, hydrogen is utilized as an "adjustment force".
The purpose of FH2R is to verify this and aim to establish an economical hydrogen producing technology.
FH2R is conducting the demonstrative operation of the control systems under the cooperation of specialists.
Through the operation of three Control systems, it aims to produce hydrogen at higher efficiency and lower cost.



# The properties of hydrogen and safety measures

Hydrogen is a very light gas and is characterized by diffusing immediately when released in the air. In addition, it is also characterized by being colorless, odorless, easily ignitable, and having a wide combustible concentration range. Understanding such properties of hydrogen and managing it properly enables safe use. Basically, safety measures are taken based on the following four major principles:

| | Hydrogen $H_2$ | Methane $CH_4$※ | The properties of hydrogen | Risk comparison |
|---|---|---|---|---|
| External appearance and odor | Colorless and odorless | Colorless and odorless | Difficult to detect | Risk factor |
| Specific gravity of gas (Air = 1) | 0.07 | 0.55 | The lightest gas and easy to diffuse | Risk reduction |
| Diffusion coefficient [$cm^2$/s] (in the air) | 0.61 | 0.16 | | |
| Explosive range [vol.%] | 4-75 | 5-15 | Wide combustible concentration range | Risk factor |
| Minimum ignition energy [mJ] | 0.02 | 0.33 | Easily ignitable | Risk factor |

※ A major component of city gas, etc.

## Preventing leakage

Appropriate design and construction are strictly observed based on laws and regulations to prevent hydrogen leakage.
In addition, qualified people conduct security control.

The flange fastening section of containers and pipes

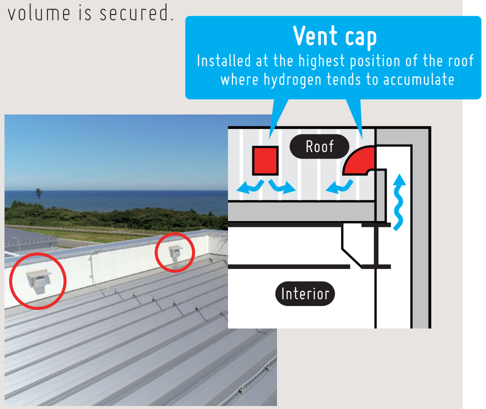
## Stopping upon detection

Detectors are installed so that safety shutdown can be performed immediately on both the system side and the entire plant side if hydrogen is detected.

Explosion-proof hydrogen gas detector

## Preventing accumulation even in the event of leakage

The areas where hydrogen facilities are placed are designed to prevent the accumulation of hydrogen, so that the required ventilating air volume is secured.




Vent cap

## Preventing ignition

Highly conductive materials are used for the floors, and they are properly grounded to prevent accumulation of static electricity that could cause ignition.


Floor materials of the water electrolysis system building

# The aseismic capacity of FH2R

To handle hydrogen safely, FH2R is designed to secure a higher aseismic capacity than general buildings.

※The table on the right was prepared based on "The Classification of Aseismic Safety Based on the Comprehensive Seismic Standards for Government Buildings".

## Category Ⅰ | Aseismic capacity : Very high

**The buildings where hydrogen is handled and with the highest aseismic capacity**

**1.5 times** higher than the seismic force assumed in the Building Standards Act

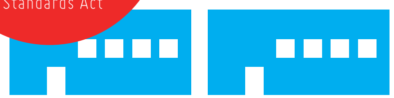
Water electrolysis system building, cylinder pack warehouse, power substation, and utility facilities building
Hydrogen storage/supply building


## Category Ⅱ | Aseismic capacity : High

**They have higher aseismic capacity than general buildings.**

**1.25 times** higher than the seismic force assumed in the Building Standards Act

Main control room, R&D center



## Category Ⅲ | Aseismic capacity : Standard

General buildings

**1.0 times** higher than the seismic force assumed in the Building Standards Act

Not applicable

| FH2R | Category Ⅰ | Category Ⅱ | Category Ⅲ |
|---|---|---|---|
| Target levels | Can be used continuously even after a large earthquake | Can be used after partial repair after a large earthquake | Damage tolerated after a large earthquake but does not result in collapse |
| Examples of relevant buildings | Government facilities that serve as hubs in the event of a disaster (such as government buildings and hospitals) | Schools, social welfare facilities, etc. | Standard buildings |

## In the event of an earthquake

FH2R stops automatically in a safe state even if a large earthquake occurs.
It is designed to discharge hydrogen to the outside of the building immediately to maintain a safe state, even in the event of breakage of hydrogen pipes due to an earthquake.
**Since hydrogen is light, easily diffusible, and harmless, it is safer to release hydrogen outdoors to diffuse it than to fill the building with it.**

# Expected utilization of hydrogen

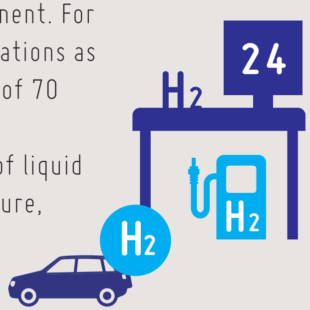
Energies utilizing hydrogen are now spreading steadily.
Currently expected uses of hydrogen include the following:

## Fuel cell vehicles (FCV)
## Fuel cell buses (FC bus)

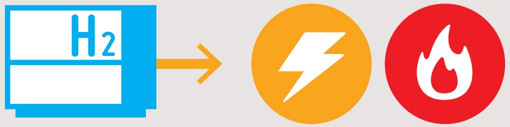
Electricity is generated with hydrogen using the installed "fuel cells" to use it to power automobiles, which enables low carbon passenger and cargo vehicles. In addition, hydrogen is also utilized in industrial vehicles such as forklifts.


### Hydrogen stations indispensable for the spread of fuel cell vehicles

For prompt promotion and expansion, comprehensive re-examination of regulations is conducted and easing of regulations are advanced by the national government. For example, hydrogen stations equipped with gas stations as well as hydrogen stations with a filling pressure of 70 MPa that were not allowed in the past have been constructed in urban areas, and the installation of liquid hydrogen storage tanksis also allowed. In the future, efforts on easing of regulations are expected to be advanced further.




## Fuel cells




Fuel cells are also used in sectors other than the transportation sector. A household fuel cell, "Ene Farm", that everyone is familiar with, is one example. It is designed to extract hydrogen from the gas, develop a chemical reaction with oxygen to generate electricity efficiently, and utilize the heat (exhaust heat) that is generated at that moment. Effective utilization of energy saves energy by 25% and reduces carbon dioxide emissions by 40% in general households.

### "Michi-no-eki Namie"Pure hydrogen fuel cell system

Fuel cells are also used in public facilities around us.They are also used in Michi-no-eki Namie and the electricity generated is utilized in some parts of this facility, such as for lights and air conditioners.The heat that is generated in the process of power generation is utilized effectively to warm water for washing hands.

# National efforts

Not only hydrogen does not emit carbon dioxide when being used but also has the potential of becoming a carbon-neutral energy that reduces greenhouse gas emissions to zero as a whole by combining it with renewable energy.
In addition, since hydrogen can be generated from various resources, it is expected to contribute to the diversification of energy suppliers and increase self-sufficiency.
In Japan, the "Basic Hydrogen Strategy" was formulated on December 26, 2017, as a policy related to hydrogen.

$H_2$

## About the Basic Hydrogen Strategy

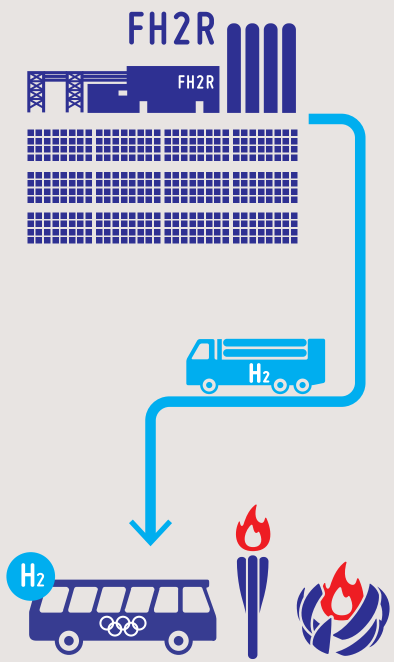
The Basic Hydrogen Strategy presents a vision for the future with a view to 2050 and integrates a group of policies ranging from the production to utilization of hydrogen such as regulatory reform, technical development, and infrastructure construction all under the same goal. The goal of this strategy is to show hydrogen as a new energy choice comparable to renewable energy and achieve hydrogen cost comparable with the costs of conventional energies such as gasoline and LNG, toward the realization of a hydrogen-based society. The determination to drive the world's carbon neutrality by expanding Japan's cutting-edge hydrogen technology to the world is shown.

## Producing hydrogen from renewable energy...FH2R

In such national efforts, the production of hydrogen using the excess electricity from renewable energy is also considered.This has the advantage that hydrogen enables carbon neutrality. And also, excessive renewable energy can be utilized effectively. As a pioneer, FH2R (Fukushima Hydrogen Energy Research Field), is conducting demonstrations where hydrogen is produced from renewable energy to establish economic hydrogen producing technology.

## Utilization in the Tokyo Olympic and Paralympic Games

The hydrogen generated in FH2R was also utilized in the Tokyo Olympic and Paralympic Games held in 2021.
Hydrogen that is an expected future energy was utilized as fuel for the Olympic cauldron for the opening/closing ceremonies and hydrogen torches, as well as in fuel cell vehicles used as vehicles related to the Olympic Games.




## Hydrogen torch

This torch that was used in the torch relay for the Tokyo Olympic and Paralympic Games held in 2021 was created in the style of cherry blossoms, a flower that represents Japan.As a symbol of the "Recovery Olympics" from the Great East Japan Earthquake, some aluminum building materials used in the temporary housing facilities for recovery were reused, and "hydrogen" produced here in Fukushima was used as a part of fuels.

# Expected hydrogen power generation

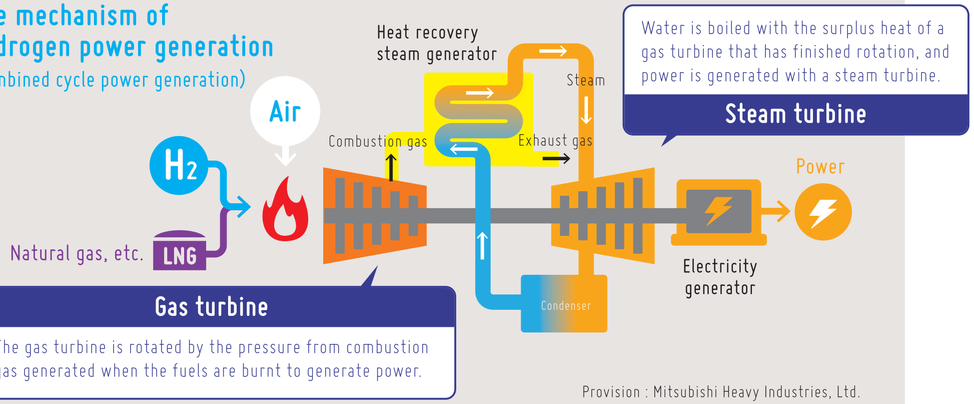
In the Basic Hydrogen Strategy, not only the produce, transportation, and utilization of hydrogen (such as fuel cells and fuel cell vehicles) but also utilization (hydrogen power generation) is one of the major goals.

## About hydrogen power generation

The methods for generating power by using hydrogen as fuel include one that uses fuel cells as well as one that burns hydrogen or hydrogen and other fuel in a gas turbine to obtain rotary power and then drives an electricity generator to generate power, called "gas turbine power generation".

In large-scale power generation, the "combined cycle power generation method" is used, in which, rather than just using a gas turbine alone, a gas turbine is combined with a steam turbine to use the generated thermal energy without any waste .

### The mechanism of hydrogen power generation (combined cycle power generation)




Provision : Mitsubishi Heavy Industries, Ltd.

## The significance of hydrogen power generation using gas turbines

Gas turbine power generation that does not emit carbon dioxide and uses hydrogen produce from a wide variety of energy sources has the potential to be a large-scale, stable, and environment-friendly power source, as is the case with conventional gas turbine power generation. For this, the supply of stable, inexpensive, and environment-friendly hydrogen is a prerequisite. In addition, this gas turbine does not have higher efficiency than existing thermal power generating facilities, the technology for high-efficiency hydrogen gas turbine needs to be developed.

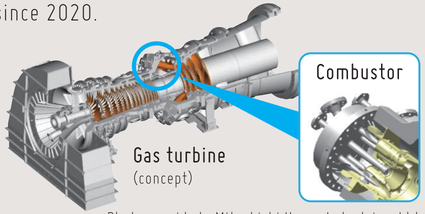
## The current state of hydrogen power generation

Japan, that is a pioneer with its technical capabilities, is contributing to world efforts toward the practical realization of hydrogen power generation.Two technical developments and demonstrations that are currently in process are introduced below.

### ① Technical development for large-scale thermal power generation (500 MW-class)

Technical development is conducted for hydrogen mixed combustion in existing large-scale thermal power generation plants. **A hydrogen mixed combustion rate of 20% was achieved in 2018.**

→ The technical development for **hydrogen-only combustion** technology has been ongoing since 2020.




Gas turbine (concept)

Photo provided : Mitsubishi Heavy Industries, Ltd.

### ② Technical development for cogeneration (1 MW-class) for regional supply of heat and power

Technology that enables combustion of natural gas with a mixture of hydrogen at a rate of 0 to 100% has been developed. **In 2018, the cogeneration for urban areas through hydrogen-only combustion was achieved for the first time in the world.**

→ Since 2019, the technical development for power generation through high-efficiency **hydrogen-only combustion** has been ongoing.

A hydrogen power generation facility established in Port Island, Kobe (Hydrogen CGS)

Photo provided : Kawasaki Heavy Industries, Ltd.

# Globally advanced hydrogen utilization

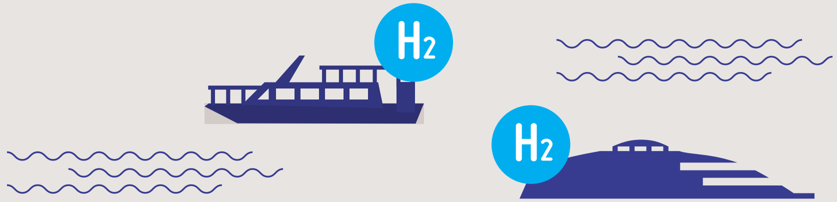
In Japan, the national government and various companies have been jointly advancing demonstration experiments to realize a "hydrogen society" ahead of other countries. The ways of using/utilizing hydrogen energy that are about to be realized or whose whole picture has been gradually revealed as of 2021 are introduced here.


## The world's first "liquid hydrogen carrying vessel"

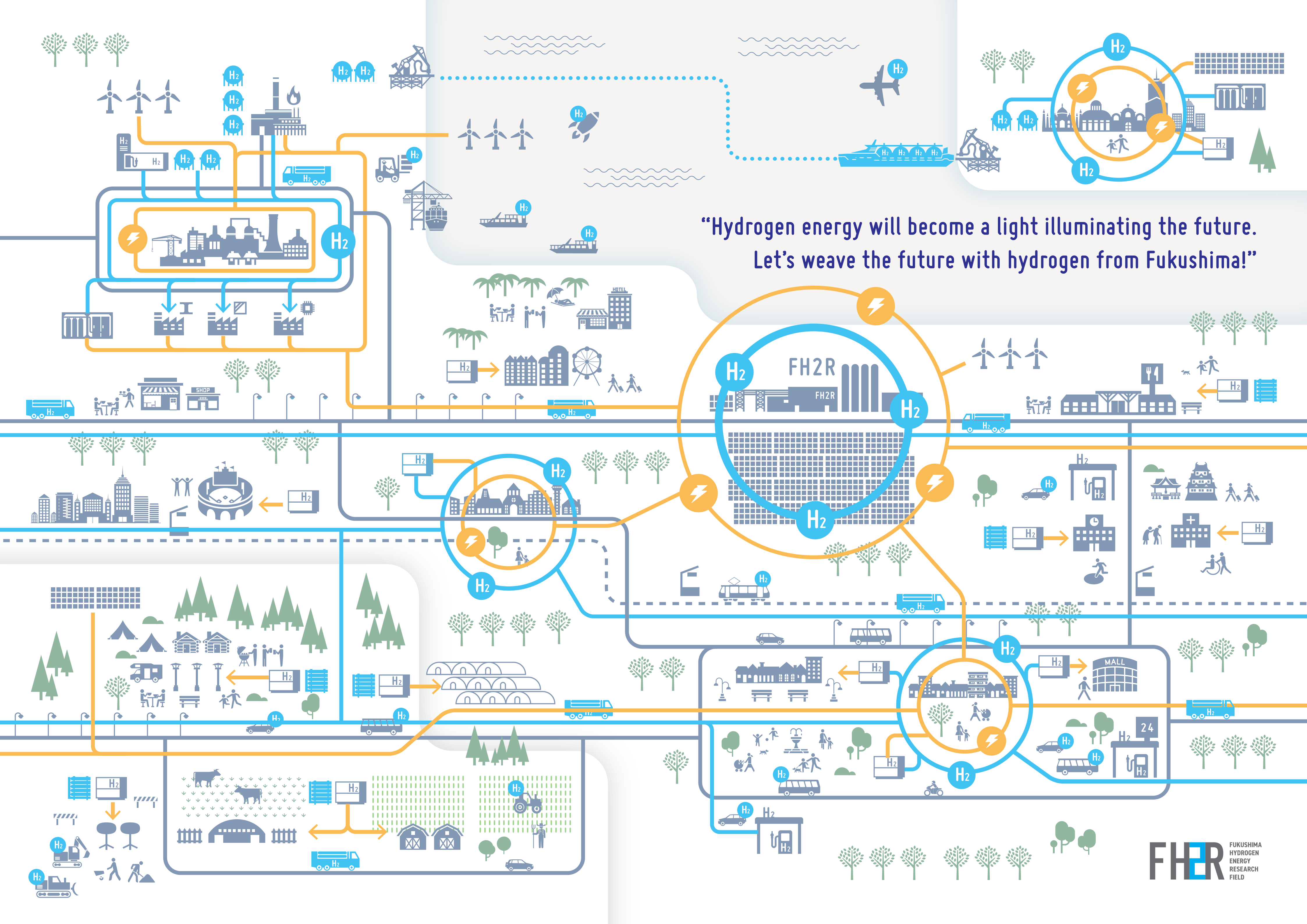
Hydrogen can be produced from a wide variety of resources.
For example, if a large amount of hydrogen can be produced from energy fuels that are buried unused due to being wastes, low quality, etc., the advantage of securing energy in a stable manner while reducing costs can be achieved.
At present, the "lignite hydrogen project" (A project for demonstrating the establishment of a supply chain for large-scale marine transportation of an unused lignite-derived hydrogen), which is aimed at producing hydrogen in Australia and transporting it to Japan by utilizing "lignite" that is low-quality coal whose use is limited due to difficulty in transportation, has been advanced.


## Utilization of hydrogen in the marine transportation field

The utilization of hydrogen toward achieving zero carbon has been advanced not only in cars but also in ships and vessels.
In Japan, a project for operating a hydrogen fuel cell vessel was launched for the Osaka/Kansai Expo 2025.
In addition, hydrogen-fueled ships and vessels are also being developed in various countries in the word, such as in the Netherlands.
In the field of ships and vessels, it is difficult to achieve carbon neutrality because they constantly receive water resistance and require a lot of energy for navigation. However, the International Maritime Organization (IMO) has set forth a goal of reducing the carbon dioxide emissions related to international maritime traffic by half by 2050 and to zero during the 21st century. Therefore, carbon neutrality is expected to be advanced in the marine transportation field, too.




**In not only Japan but also countries across the world, various utilization and research of hydrogen toward carbon neutrality are advanced.**


"Hydrogen energy will become a light illuminating the future.
Let's weave the future with hydrogen from Fukushima!"
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MALL
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