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MOE

CCUS and Hydrogen in Japan
— Overview of Policies and Project —

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Policies in Japan

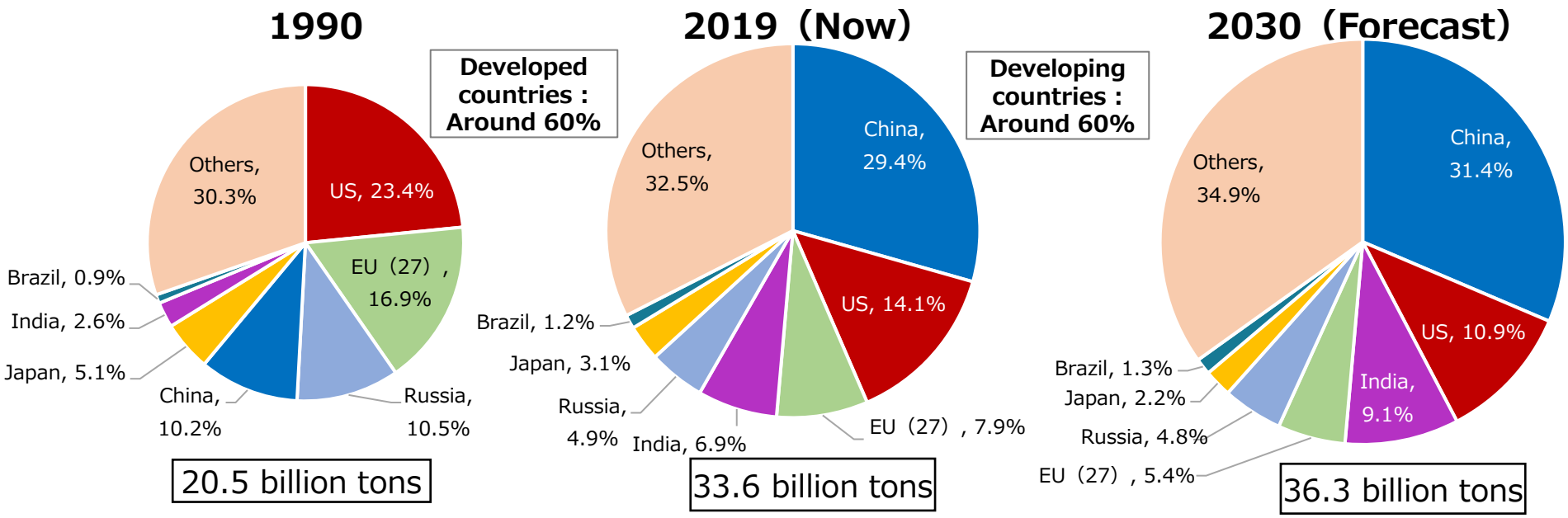
Paris Agreement and global trends in CO_2 emissions from energy consumption

- **The Paris agreement was adopted at COP 21 in 2015.** Unlike the previous Kyoto Protocol, **all parties that adopted Paris Agreement (193 countries and regions),** regardless of whether they are developed or developing countries, **are required to establish greenhouse gas reduction targets.**
- Japan actively pursues efforts to limit the global average temperature increase to 1.5℃ (**1.5℃ active target**), while keeping it less than **2℃** above pre-industrial levels (**2℃ target**) .
- To do so, Japan aims to **achieve global decarbonization (carbon neutrality)** ※ **in the second half of this century**.

※Resulting in annual emissions and absorption of greenhouse gases such as CO_2 are equal.

→In the IPCC Special Report on Global Warming of 1.5°C (October 2018), global net anthropogenic CO_2 emissions need to reach net zero around 2050 in order not to go much higher than 1.5 °C.

Comparison of each country's CO_2 emissions from energy consumption



MOE created these figures based on IEA「Greenhouse Gas Emissions from Energy (2021)」「World Energy Outlook (2021)」 etc

Reduction targets in major countries

Comparison of countries

	Mid-term goals	Long-term goals
Japan	**In FY 2030, ↓46%** **(From FY 2013 level)** Continuing efforts to meet ↓50%	**In 2050, net zero emissions** ※26th Oct 2020, former Prime Minister Suga expressed in his policy speech during the extraordinary Diet session
US	**In 2030, ↓50-52%** **(From 2005 level)** ※From 2013 level ↓45-47%	**In 2050, net zero emissions**
UK	**In 2030, at least ↓68%** **(From 1990 level)** ※From 2013 level ↓55% Until 2035, ↓78% (From 1990 level) ※From 2013 level ↓69%	**In 2050, at least ↓100%** (From 1990 level) ※Presenting 3 scenarios with certain assumptions
EU **(FR･IT)**	**In 2030, at least ↓55%** **(From 1990 level)** ※Agreement at the European Council (10-11 Dec 2020) ※From 2013 level ↓44%	**In 2050, net zero emissions** ※Analyzing 8 scenarios with several assumptions
Germany	**In 2030, ↓65%** **(From 1990 level)** ※From 2013 level ↓54% In 2040, ↓88% (From 1990 level) ※From 2013 level ↓84%	**In 2045, net zero emissions**
Canada	**By 2030, ↓40-45%** **(From 2005 level)** ※From 2013 level ↓39-44%	**In 2050, net zero emissions** ※Submission of related bills to the Diet in Nov 2020
China	**By 2030, making emissions turn to reductions.** **CO_2 emissions per GDP more than ↓65%** (From 2005 level) ※President Xi expressed at Climate Ambition Summit 2020	**In 2060, net zero CO_2 emissions** ※President Xi expressed at Global Assembly in Sep 2020

2050 Carbon Neutrality Declaration・Announcement of target for FY 2030 in Japan

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■ On October 26, 2020, at the 203rd extraordinary session, former Prime Minister Suga declared the **"2050 Carbon Neutrality"** and **"Aim to realize a decarbonized society "**

【203rd Diet session: Policy speech of former Prime Minister Suga】(Oct. 26, 2020) <Excerpt>

➢ **With the virtuous cycle between the economy and the environment** as a pillar of our growth strategy, we will focus our utmost efforts on **realizing a green society**. **We hereby declare our aim to reduce the overall greenhouse gas emissions to zero by 2050, namely, to achieve carbon neutrality and a decarbonized society by 2050.** Dealing with global warming is no longer a constraint on economic growth. It is necessary to shift to a viewpoint that proactive measures to combat global warming will lead to significant growth by transforming the industrial structure and the economic society.

■ At the Global Warming Prevention Headquarters and Leaders' Summit on Climate, on Apr. 22, 2021, former Prime Minister Suga mentioned that **Japan aims to reduce greenhouse gas emissions by 46% in FY 2030 from its FY 2013 levels, and continue efforts to meet the high goal of cutting its emissions by 50%.**

【Former Prime Minister Suga's speech at Leaders' Summit on Climate】(Apr. 22, 2021)

<Excerpt>

➢ Japan will also take a major step toward solving global challenges. **Japan aims to reduce its greenhouse gas emissions by 46% in FY 2030 from its FY 2013 levels, setting an ambitious target which is aligned with the long-term goal of net zero by 2050. Furthermore, Japan will continue strenuous efforts in its challenge to meet the high goal of cutting its emissions by 50%.**

Long-term target

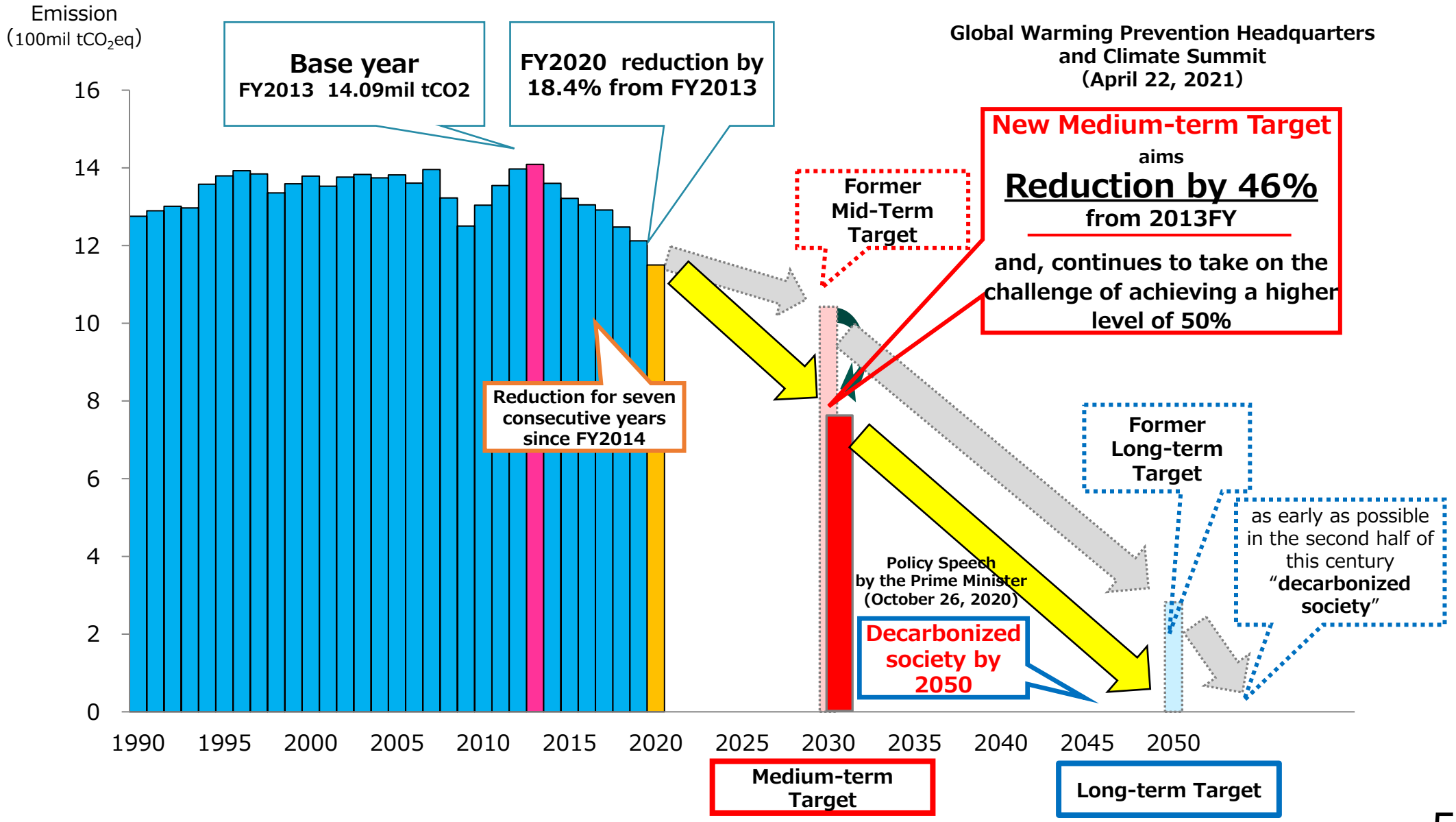
In 2050, net zero greenhouse gas emissions

Mid-term target

Reducing greenhouse gas emissions by 46% in FY 2030 (versus the FY 2013 level)

Continuing efforts to achieve cutting its emissions by 50%

GHG emissions and reductions target in Japan



Revised “Global Warming Countermeasures Plan”

Approved by the Diet on Oct. 22, 2021

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■ Government’s comprehensive plan based on the Act on Promotion of Global Warming Countermeasures

The plan was revised, mainly to realize the **2050 Carbon Neutrality Declaration and the goal to reduce greenhouse gas (GHG) emissions 46% in FY 2030***.

*As a mid-term goal, Japan aims to reduce GHG emissions by 46% versus levels in FY 2013. Furthermore, it will continue its challenge to achieve its high goal of 50%.

GHG emissions/absorption volume (Unit: 100 million t-CO_2)		2013 emissions actual	2030 emissions	Reduction rate	Prior goals
		14.08	7.60	-46%	-26%
CO_2 from energy sources		12.35	6.77	-45%	-25%
By department	Industry	4.63	2.89	-38%	-7%
	Business operations, etc.	2.38	1.16	-51%	-40%
	Household	2.08	0.70	-66%	-39%
	Transport	2.24	1.46	-35%	-27%
	Energy shift	1.06	0.56	-47%	-27%
CO_2 from non-energy sources methane, N_2O		1.34	1.15	-14%	-8%
Four gases including HFC (fluorocarbons)		0.39	0.22	-44%	-25%
CO2 sink		-	-0.48	-	(-0.37 100 million t-CO_2)
Bilateral offset credit mechanism (JCM)		Japan aims to internationally reduce/absorb about 100 million t-CO2, cumulatively, by FY 2030 through private-public sector partnerships. Japan will adequately count the credits it secures towards the achievement of its NDC.			-

Revision of Japan's "Long-term Strategy under the Paris Agreement"

Approved by the Diet on Oct. 22, 2021

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- Established based on the provisions of the Paris Agreement
- Mainly outlines the basic concept and vision for achieving the **"2050 Carbon Neutrality"**

<Basic concept>

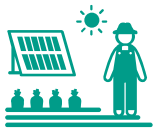
The global warming countermeasures **will not constrain economic growth** but rather serve as the key for largely transforming the economic society, promoting investment, improving productivity, making a revolutionary change to the structure of industry, and **bringing about resilient growth**.

<Visions in each field and the direction of measures/policies>

Energy:
- Top-priority principles for renewable energy
- Full-fledged energy-saving
- Decarbonization of power sources/electrification of whatever is possible
- Pursue various options, including hydrogen, ammonia and nuclear power

Industry:
- Full-fledged energy-saving
- Decarbonization of heat and manufacturing processes

Transport:
- All passenger cars in 2035 to be fully electric vehicles
- Link and integrate electric vehicles and social systems



Local community/Lifestyle:
- Solve local issues/resilient and energetic society
- Produce and consume decarbonized household energy for decarbonization of the local community

Sink measures
- Use of forest sink measures and DACCS (Direct Air Capture with Carbon Storage)

MOE's Initiatives

Greenhouse gas reduction measures by the MOE

■ **To achieve carbon neutrality in 2050, Japan plans to reduce greenhouse gas emissions in FY 2030 by 46% versus FY 2013 levels, and will further aim to cut emissions by a high 50%. To achieve this goal, we promote these three "transitions:" a decarbonized society, a circular economy and a decentralized society.**

Role of the MOE	**Through collaborations with ministries and agencies, the MOE will promote changes in the economic society to create demand for carbon neutrality, including creating new regions and transformation of the lifestyles of citizens, and contribute to global reductions.**

Domestic deployment

The First Pillar

Creating resilient and comfortable communities and lives through decarbonization

- Based on the Regional Decarbonization Roadmap, the MOE will promote local development through decarbonization and the nationwide implementation of priority measures that will serve as the foundation for decarbonization, as well as provide proactive support for the establishment of regional implementation systems.
- By promoting decarbonization initiatives in areas including logistics/transportation, and housing/buildings, we will support the realization of resilient and comfortable lifestyles and businesses through decarbonization.

The Second Pillar

Accelerating the social implementation of decarbonization technologies

- Promote the development and demonstration of technologies, including renewable energy-derived hydrogen and CCUS, and accelerate the social implementation of decarbonization technologies to realize a decarbonized society early on.

The Third Pillar

Promoting ESG finance and corporate decarbonization management

- Encourage the transformation to a decarbonized socioeconomic system, by promoting Green Finance (which enhances private decarbonization investments, including ESG finance) and corporate decarbonization management practices.

Overseas deployment

The Fourth Pillar

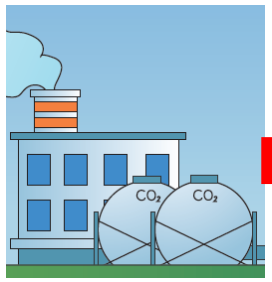
Business-led international expansion and global contribution, including by JCM

- Japan will play a leading role in reducing global emissions by supporting developing countries in their transition to decarbonization through the Joint Crediting Mechanism (JCM) and emissions verification by the Greenhouse Gases Observing Satellite (GOSAT series), both of which are included in Article 6 of the Paris Agreement.

Interconnection between CCUS and Hydrogen

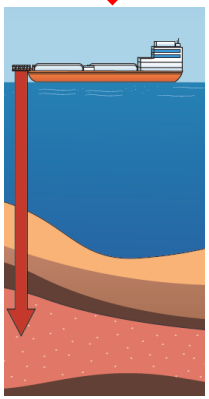
CCUS

Capture



CO2

CO2

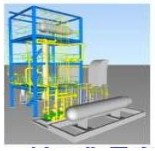


Storage

Utilization

CO2

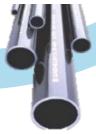
Chemical reaction



Incineration plant

Substitute materials derived from fossil fuels

Waste



Chemical products

Hydrogen

Renewable energy and other resources

Using Renewable Energy

Reforming biogas

H2

Transportation

Pipelines

Hydrogen-absorbing alloy carried by delivery trucks

Applications

Fuel Cell

FC[1] Forklifts

FC[1] Buses

Fish breeding facilities

Hotels / Buildings

Significant Reduction of CO2 × **Carbon Circulation** × **Production and Utilization of Low-Carbon Hydrogen**

[1] Fuel Cell

Prospects of CCUS

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Establishment of technology

- **Verified operability, environmental impact, etc.** of CO2 capture facilities at a commercial-scale thermal power plant.
- Studied **CO2 transportation and storage technology**
- Started **CCU technology demonstrations**
- Investigation of potential CO2 storage sites with METI

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Practical development

- Aiming to establish first commercial scale CCU technology by 2023
- **Establishment of an integrated verification base and supply chain**
- **Feasibility study of CO2 transportation and storage, including overseas, international cooperation, etc.**

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Implementation

- In addition to the realization of the integrated CCUS demonstration, **full-scale social implementation will be pursued** based on the results of operation and evaluation and the study of environmental improvements.

Image of social implementation

Project on environmentally conscious CCUS integrated experimental site and supply chain construction (from FY2021)

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①Separation and recovery

■ Conducting CCUS integrated experimental site, environmental impact assessment (EIA) according to operating pattern, and EIA of energy-saving CO_2 separation and recovery technology using amine absorbent

Long-term operation and EIA of CO_2 separation and recovery facility using liquid absorbent material, and establishing the site

- An existing site in Omuta-city is utilized to build supply chain model for mass transportation and effective use of recovered CO_2.
- Improvement measures such as enhancing recovery performance (recovery amount and recovery rate) and improving operability are considered through the experimental operation, and the applicability to further large-scale facilities is evaluated.
- The results of the experiment will proactively be disseminated both in Japan and abroad.

CO_2 recovery experimental plant (Operation started in Oct 2020)

Experiment of energy-saving CO_2 separation and recovery technology using solid absorbent material

- US-Japan cooperation project being implemented in Wyoming, USA, which has a globally noteworthy experimental research institute and a thermal power plant capable of demonstrating technology.
- The EIA of separation and recovery using solid absorbent material, which saves more energy than the method using liquid absorbent material, is the world's first trial.
- The technology would be widely available through the world as an established technology and contribute to global CO_2 reduction, after confirming that its operation has no negative environmental impact.

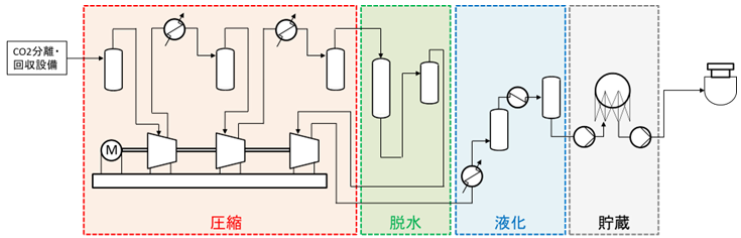
Image of the plant to be built

②Transportation and storage

■ Building a consistent supply chain in order to ship compressed and liquefied CO_2 to Japan and then to inject it on the ocean

- Implement the design and examination of CO2 compression and liquefaction facilities, and shipment and port facilities, and furthermore, mainly of transport systems, for the transportation of separated and captured CO2.
- Implementation plans and risk management plans are established to build a consensus for smooth implementation.
- Through the above initiatives, conducted a feasibility test for CO2 transportation and storage

Image of Offshore storage site



Flow diagram of CO_2 compression and liquefaction facility

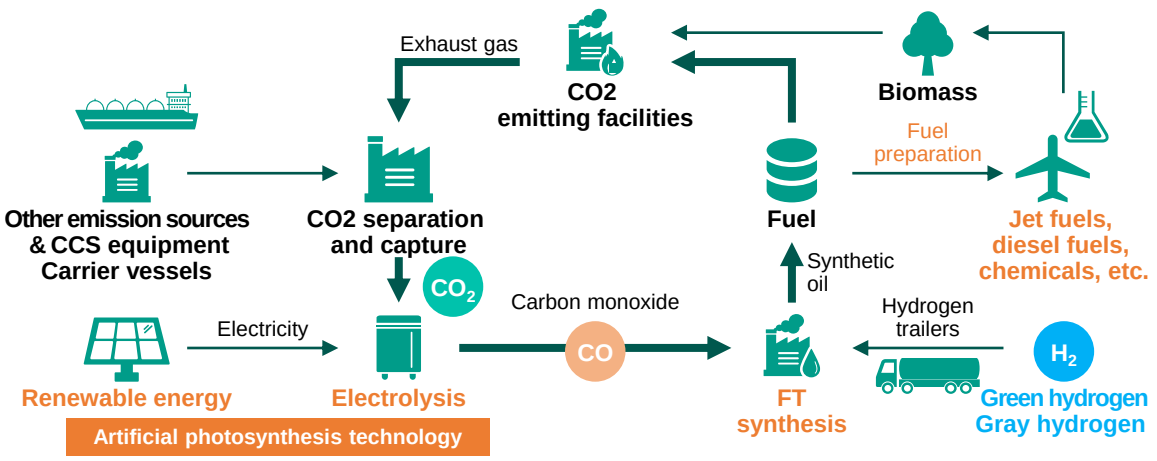
Demonstration project on converting CO2 into a resource through artificial photosynthesis (from FY2018)

Representative: **Toshiba Energy Systems & Solutions Corporation** | Period: FY2021 to FY2024

Regional CO2 Resource Utilization Study Business through Electrolysis Utilizing Artificial Photosynthesis Technology

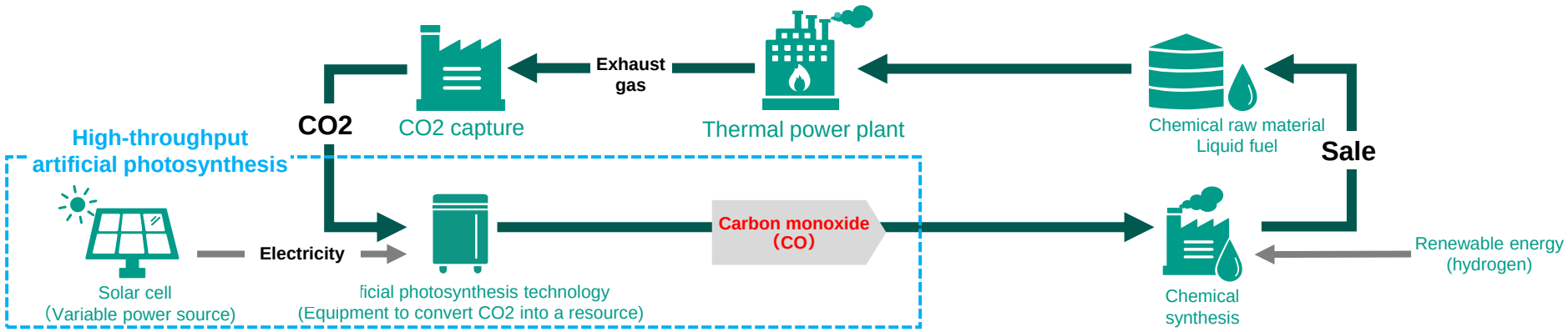
This initiative is designed for practical use in society of the technology to electrolyze CO2 to convert it into CO. Also, in the initiative, examinations are made for the establishment of a supply chain in which CO2 separated and captured from emission sources will be electrolyzed into CO by the use of artificial synthesis technology and then converted into sustainable aviation fuel (SAF) for jet planes and into liquid fuel that can be used locally.

Illustrative image of a process to convert CO2 into a resource



Representative: **Toshiba Corporation** | Period: FY2018 to FY2022

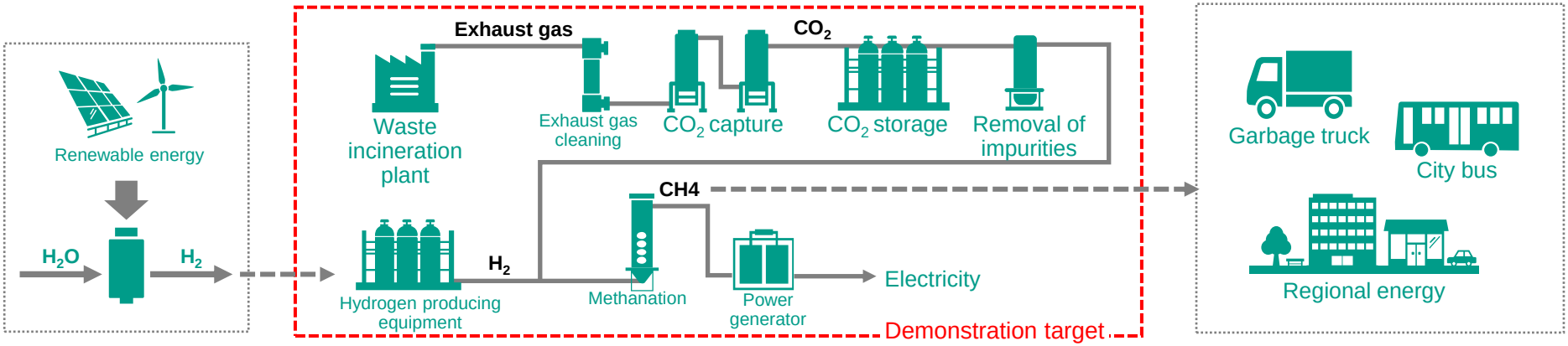
Capture CO2 from exhaust gas and generate a large amount of CO from the captured CO2 at the world's highest conversion speed.



Demonstration project on converting CO2 into a resource through methanation (from FY2018)

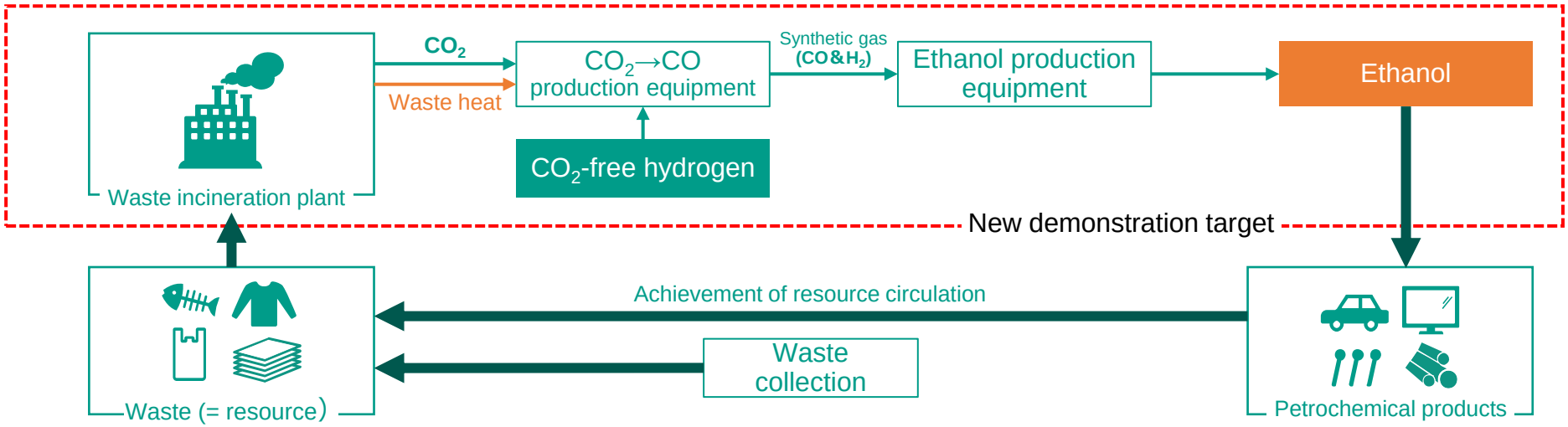
Representative: **Hitachi Zosen Corporation** | Period: FY2018 to FY2022

Separate and capture CO2 contained in exhaust gas from waste incineration facilities to use it as a material to manufacture methane through the reaction of CO2 with hydrogen.



Representative: **Sekisui Chemical Co., Ltd.** | Period: FY2018 to FY2022

Separate and capture CO2 contained in exhaust gas emitted from waste incineration facilities to use it as a material to manufacture ethanol through the reaction of CO2 with hydrogen, which is to be made by using waste heat and catalyst.

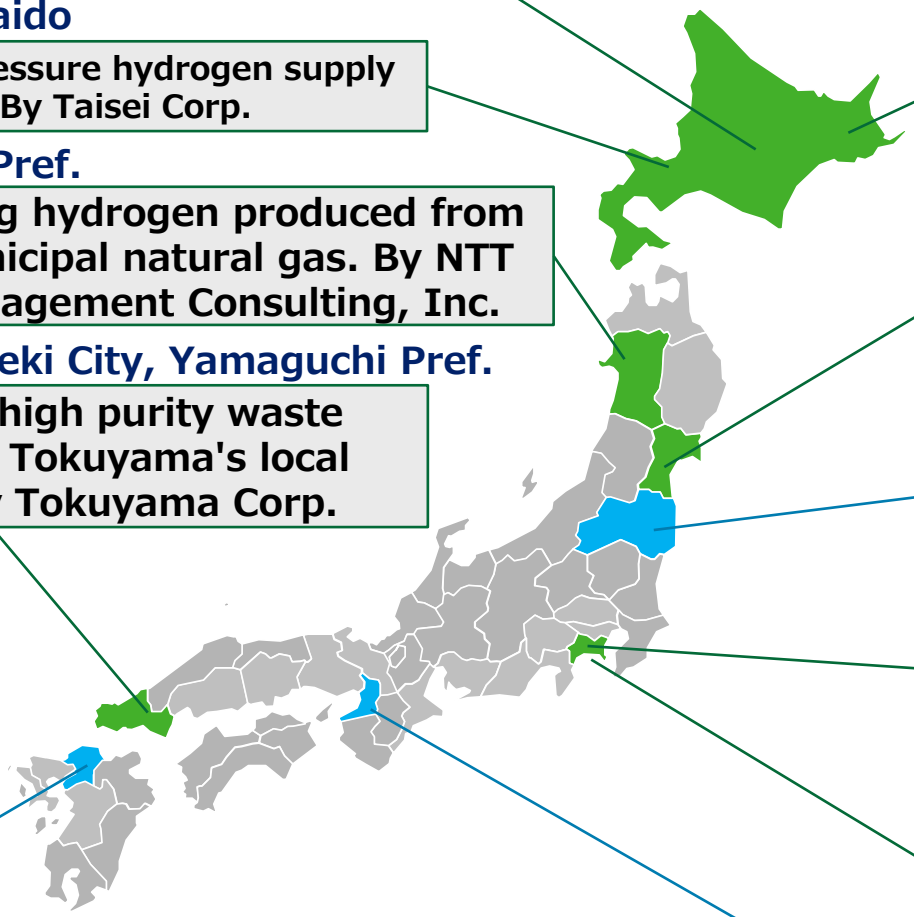


Hydrogen Supply Chain Projects

Conducting supply chain demonstrations that produce, carry and use hydrogen by utilizing local resources for a construction of self-sustaining decentralized societies. (Gray boxes were finished.)

: Prefectures demonstrating a regional, low carbon hydrogen supply chain

: Prefectures creating and demonstrating low-cost hydrogen models using existing facilities and infrastructures (As of March 2022)



②Shikakoi Town, Hokkaido

Demonstration using clean hydrogen (biogas from livestock excreta). By Air Water INC

⑧Muroran City, Hokkaido

Demonstration of low pressure hydrogen supply chain using wind power. By Taisei Corp.

⑦Noshiro City, Akita Pref.

Demonstration mixing hydrogen produced from wind power with municipal natural gas. By NTT Data Institute of Management Consulting, Inc.

③Shunan & Shimonoseki City, Yamaguchi Pref.

Demonstration using high purity waste hydrogen supplied by Tokuyama's local caustic soda plant. By Tokuyama Corp.

⑨Kitakyushu City, Fukuoka Pref.

Demonstration using green hydrogen from waste-to-energy and local renewable energy. By Kitakyushu Power Co., Ltd.

⑤Shiranuka Town, Hokkaido

Demonstration using clean hydrogen (small hydraulic power). By Toshiba Corp.

⑥Tomiya City, Miyagi Pref.

Demonstration of low carbon supply chain utilizing existing distribution network and pure hydrogen fuel cell. By Hitachi Ltd.

⑩Namie Town, Fukushima Pref.

Demonstration constructing a low-cost renewable hydrogen supply chain. By Obayashi Corp.

④Kawasaki City, Kanagawa Pref.

Demonstration using waste plastics for hydrogen.
By Showa Denko K.K

①Kawasaki & Yokohama City, Kanagawa Pref.

Demonstration using clean hydrogen (wind power).
By Toyota Motor Corp.

⑪Osaka City, Osaka Pref.

Demonstration of supply chain using methanation of clean hydrogen (renewable power) and biogas from compostable waste in cityside. By Osaka Gas.

Hydrogen Supply Chain Depends On Local Conditions - 11 demonstration projects in Japan-

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Production

Water Electrolysis

Renewable Energy

By-product

By-product of Caustic soda production, etc.

Transformation

Gasification of used plastics

Reformation of biogas

Storage & Transportation

Compressed hydrogen fuel trailer

Compressed hydrogen tube trailer

Hydrogen-absorbing alloys carried by delivery trucks

Hydrogen fueling truck

Pipelines

Use

Fuel Cell

Swimming Pool

Children's Clubhouse

Fish Breeding facilities

Hotels / Buildings

FCV[2]s

FC[1] Buses

FC[1] Forklifts

CO2 Free Energy Sources / Sources of H2

Transportation of H2

Applications

[1] Fuel Cell
[2] Fuel Cell Vehicle

Development of Hydrogen Usage Technologies

FC Forklift

Courtesy of Toyota Industries Corp.

- R&D 2014-2016
- Released from 2016

FC Bus

Courtesy of Toyota Motor Corp.

- R&D 2013-2015
- Released from 2017

FC Power Supply Vehicle (2019-2021)

Courtesy of Denyo Co., Ltd.

FC Truck (2016-2019)

Courtesy of Tokyo R&D Co., Ltd.

FC Vessel (2014-2015)

Courtesy of Toda Corp.

FC Garbage Truck (2015-2017)

Courtesy of Flat Field Co ., Ltd.

[1] **F**uel **C**ell

Model Cases to Generate a Domino Effect

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- Hydrogen from Renewable Power
- CCUS
- Floating wind turbine
- Local renewable energy, disaster prevention and mitigation

Saga City

Business development using CO2 from a waste-to-energy facility （Cosmetics, agricultural products)

Ishikari City

Zero-emission data center with 100% renewable energy

Yokohama City

Wide-area cooperation through purchase of renewable electricity from 12 municipalities in Tohoku

Kuji City

Ethanol production from CO2 in a waste treatment facility

Kawasaki City

Hydrogen from used plastic to be used in nearby hotels

Goto City

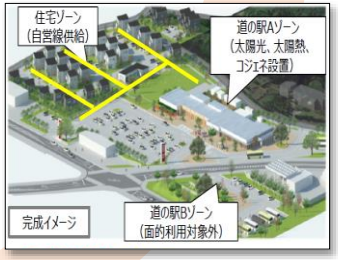
・Japan's First Commercial-Scale Floating Wind Turbine
・Regional development through fish reef effects

Namie Town

Utilization of hydrogen from Renewable Power, encouraging the realization of zero-carbon cities.

Mutsuzawa Town

Self-contained disaster prevention base area that operated even during typhoon power outages



Odawara City

・Car sharing using local renewable energy (EVs as mobile storage batteries)
・Methane production from CO2 in a waste treatment facility.

Omuta City

Japan's first commercial-scale CO2 capture technology demonstration, and the world's first BECCS* to be realized. (*)Bio-energy with CCS

Akashi City

DAC (Direct Air Capture) demonstration Project*

(*) Negative emission technology

Challenges in introducing CCUS and future hydrogen initiatives

- To achieve carbon neutrality in 2050, the current decade up to 2030 will be critical. It is important that we stand on the concept that all available technologies must be used without ruling out any possibilities.
- We must accelerate the spread of renewable energies and implement the early establishment of CCUS and hydrogen technologies to create a carbon-neutral society.
- CCU and hydrogen are closely related and will contribute both to solving the plastics issue, and the achievement of a decarbonized and circular economic society.
- CCS is expected to be a practical and fast solution to achieving carbon neutrality in 2050, on top realizing other significant CO_2 reductions.
- The early social implementation and introduction into local communities, not only the development of technologies, is important. Our goal is to create a leading model case incorporating CCUS and hydrogen technologies that will likely contribute to triggering a paradigm effect that will topple the so-called “decarbonization dominos.”

Thank you