NEDO's activities for industrial decarbonization toward carbon neutrality

November 20, 2023

New Energy and Industrial Technology Development Organization
Technology Strategy Center (TSC)
Environmental and Green Chemistry Unit
Director General

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Contents

- **Overview of NEDO**
- Overview of industrial decarbonization toward carbon neutrality
- NEDO's project for industrial decarbonization using hydrogen
- Negative emission technologies

About NEDO

■ **New Energy and Industrial Technology Development Organization (NEDO)**

Organization	National Research and Development Agency
Mission	1. Addressing energy and global environmental problems 2. Enhancing industrial technology
Established	1980
Budget	152.8 billion yen (FY2023, ca. $1.2B) + Additional “FUNDS”
Nbr of staff	1,412 (as of April 1, 2022)

*USD is approximate at ￥130/USD rate

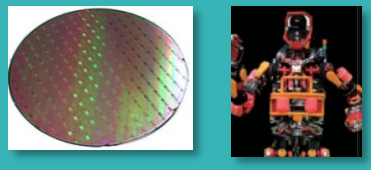
NEDO's Budget

1. Subsidy : total 152.8 Billion yen (FY 2023, ca. $1.2B)

Energy Systems
56.0 Billion yen

Energy Conservation and Environment
42.4 Billion yen

Industrial Technology
37.7 Billion yen



New Industry Creation & Discovery of Technology Seeds
9.1 Billion yen

2. Additional Fund : total about 6 trillion yen funds established until FY 2022

• **Moonshot Research and Development（2019.3～）**	25.6 billion yen
• R&D for Post 5G information and Communication system（2023.3～）	795 billion yen
• **Green Innovation Fund （2021.3～）**	2.75 trillion yen
• Program on Technologies for Economic Security（2022.3～）	250 billion yen
• Specified Semiconductor Funding Program (2022.3–)	1067 billion yen
• Deep Tech Startup Fund（new）	100 billion yen
• Fund for Promoting Bio-Manufacturing Revolution（new）	300 billion yen
• Project for Supporting a Secure Stable Supply (new)	829 billion yen

Contents

- Overview of NEDO
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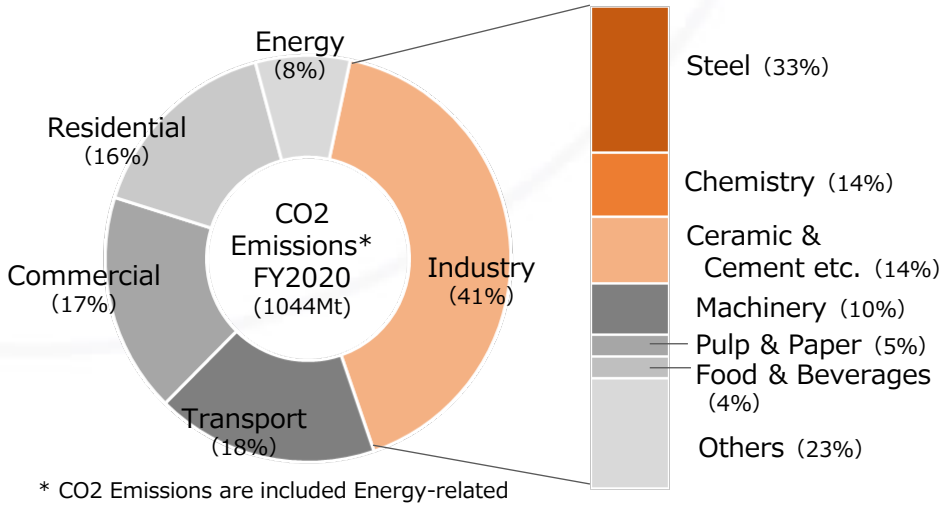
CO_2 emissions in the Industrial Sector

- Approximately 40% of the CO_2 emissions in Japan come from the industrial sector .
- The energy situation is different in each country, and the targets for 2050 are also different in each country. Realistic decarbonization efforts based on the circumstances of each country will lead to effective global climate change countermeasures.

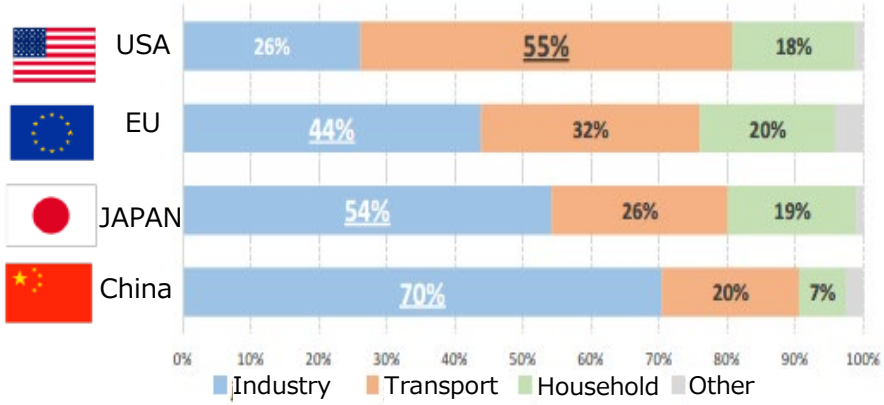
CO2 Emission in Japan(2020)



* CO2 Emissions are included Energy-related emission and non-Energy related emission.

Source: National Institute for Environment Studies Web-Site.

Ratio by sector for additional CO2 reductions necessary to achieve 2050 goal of each country (Non-power)

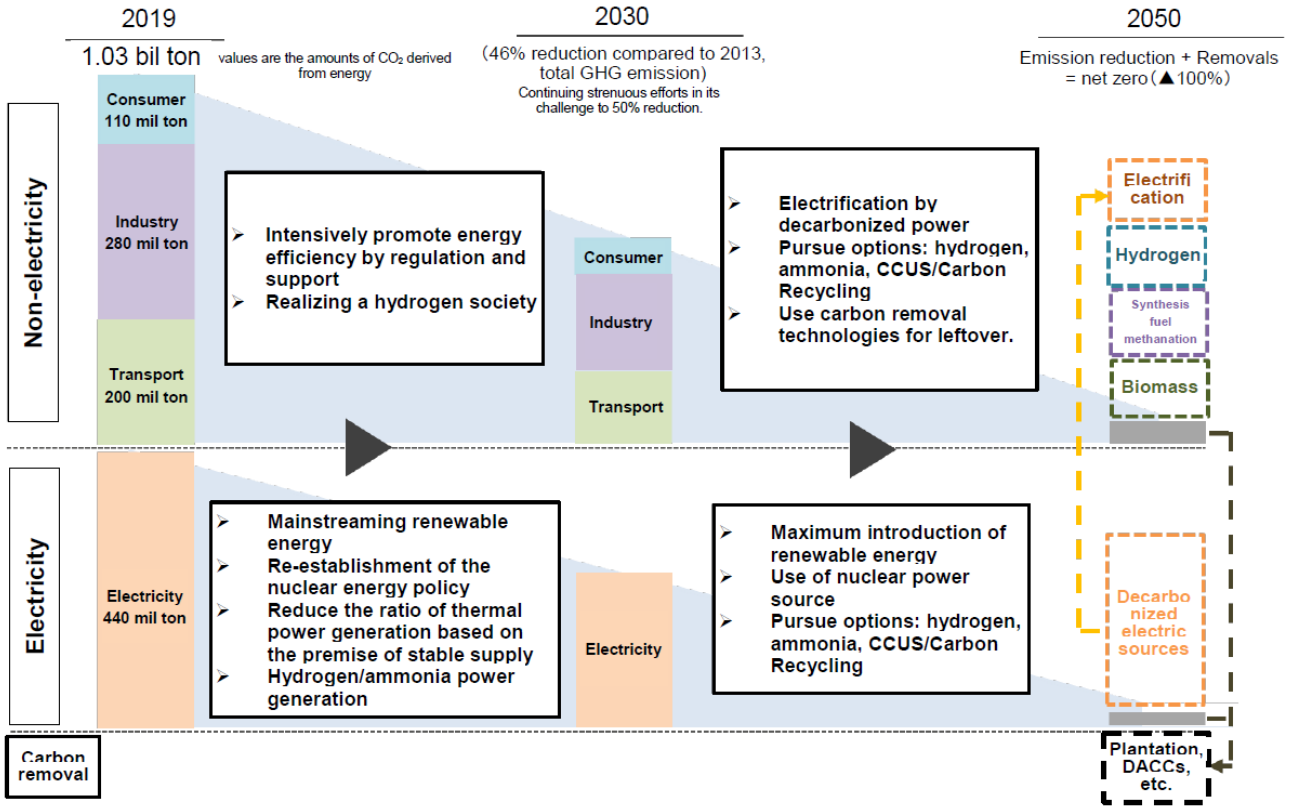


Source: Japan's Energy white Paper 2022 (METI)

Note: Calculated from differentials between Stated Policy Scenario(STEPS) , NDC and Announced Pledge Scenario(APS) in IEA World Energy Outlook 2021.

Achievement of Carbon Neutrality by 2050

- In October 2020, Japan declared Carbon-Neutrality by 2050.
- In April 2021, Japan announced aiming to reduce its GHG emission by 46% in 2030 from 2013 levels (with continued strenuous efforts towards 50% reduction).



Achievement of Carbon Neutrality by 2050

- To achieve Carbon Neutrality by 2050, the Japanese government developed the **"Green Growth Strategy"** which identifies goals, challenges, and actions of 14 priority sectors.
- In line with the strategy, **“Green Innovation Fund” of 2 trillion yen** was developed at NEDO. Currently, there are 19 projects being implemented. (Currently total fund is expanded to 2.75 trillion yen, ca. $21.2B)

14 Growth Sectors specified in Green Growth Strategy

Source: METI website

Characteristics of Green Innovation Fund

Feature 1

Continuous support over the long-term period with unprecedented huge scale fund

Feature 2

Aspirational and concrete **2030 target setting** in line with Green Growth Strategy

Feature 3

Requesting **commitment by management board** of project performer to realize the **social implementation**

Contents

- Overview of NEDO
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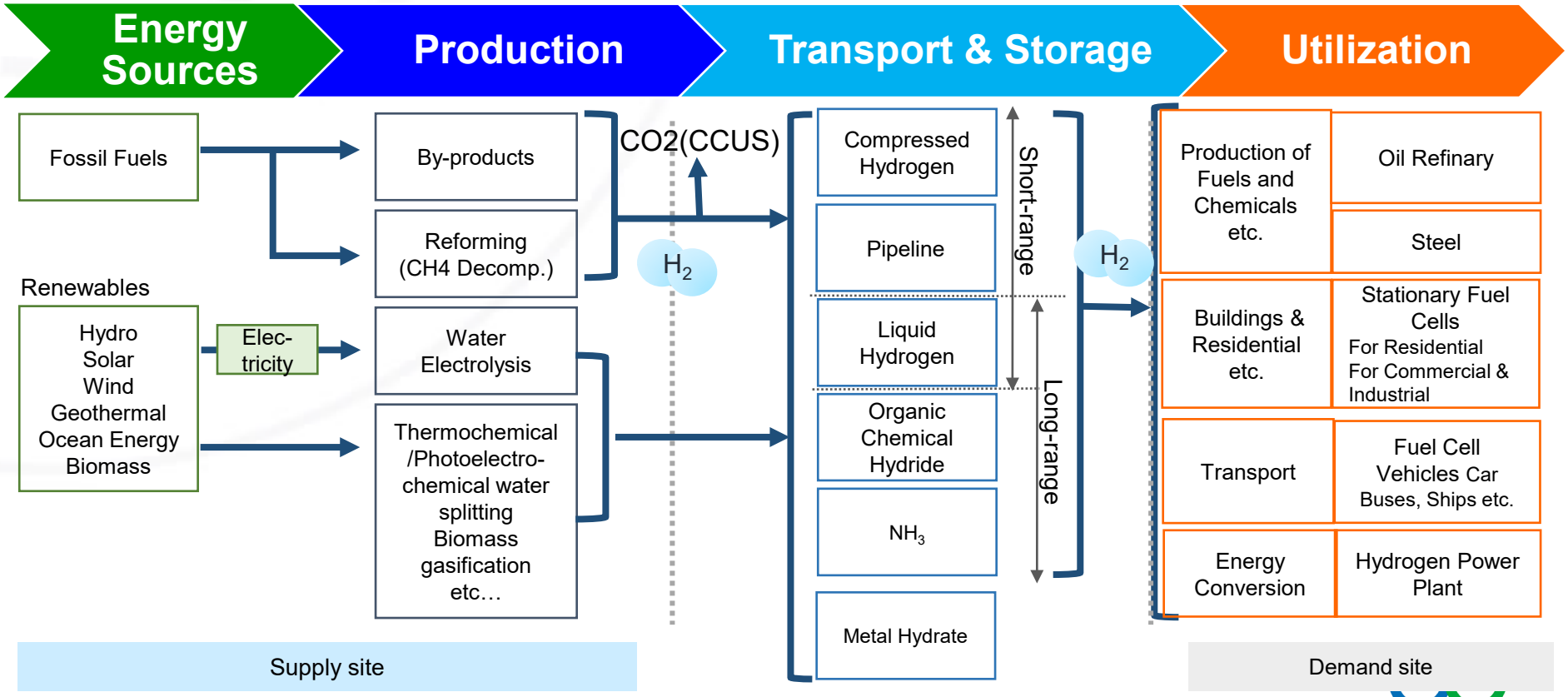
- **NEDO's project for industrial decarbonization using hydrogen**
- Negative emission technologies

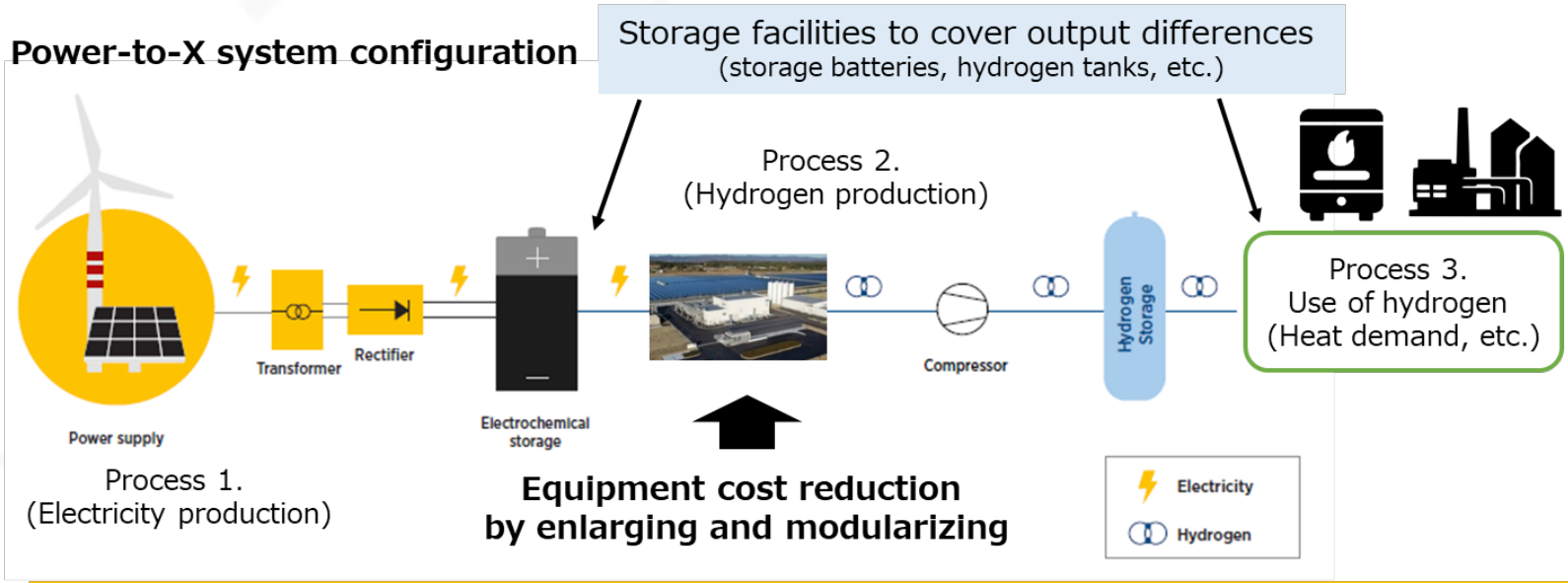
Overview of Hydrogen Technology

- Hydrogen provides various options in Japanese energy supply chain, and is one of the most important technologies for realizing carbon neutrality.
  - Flexibility in energy supply, Improvement in energy security
  - Decarbonization of various fields such as electricity, industry and transportation



Hydrogen Production through Water Electrolysis using Power from Renewable

- To establish domestic hydrogen production bases that utilize surplus renewables, etc. and to acquire the overseas market, this project **aims to further reduce the equipment cost (up to approximately 1/6 of the current cost)** by increasing the size and modularizing multiple types of water electrolyzers (alkaline and polymer electrolyte membrane types), implementing membranes, and demonstrating power-to-X systems.

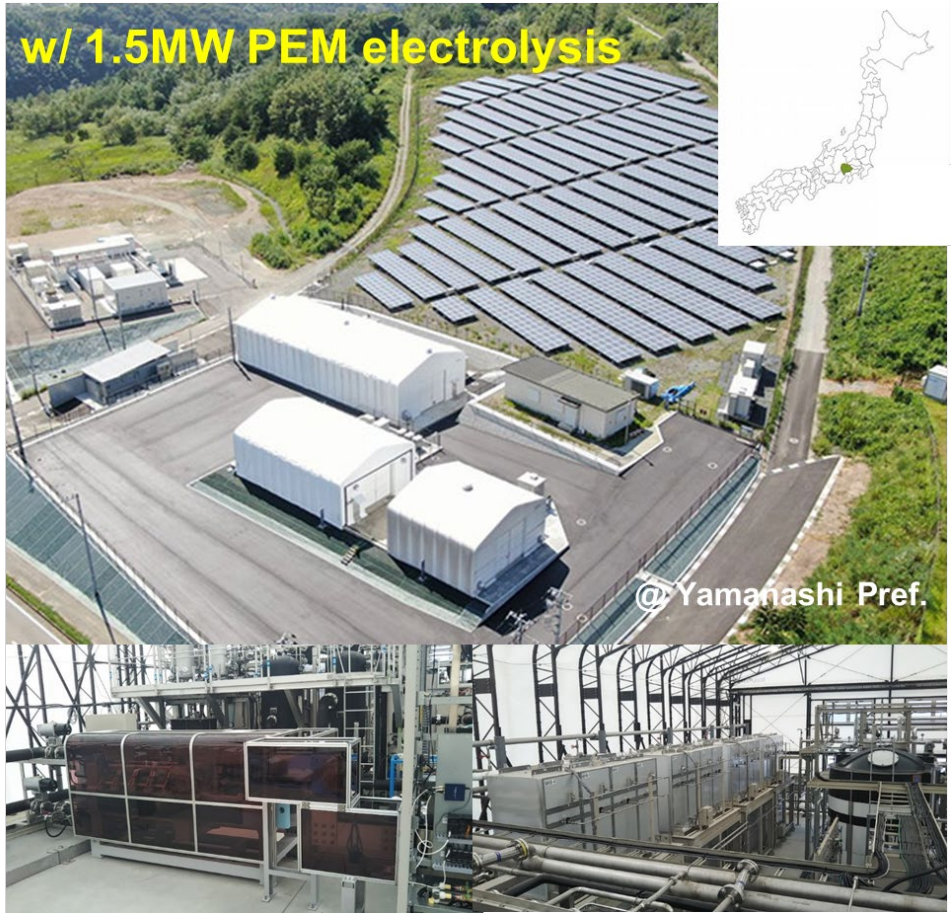


The project plans to conduct system demonstrations that contribute to the decarbonization of the non-power sector by using heat utilization equipment and chemical manufacturing processes, etc.

Image (Fukushima Hydrogen Energy Research Field)

Hot topic: MW scale Power-to-Gas

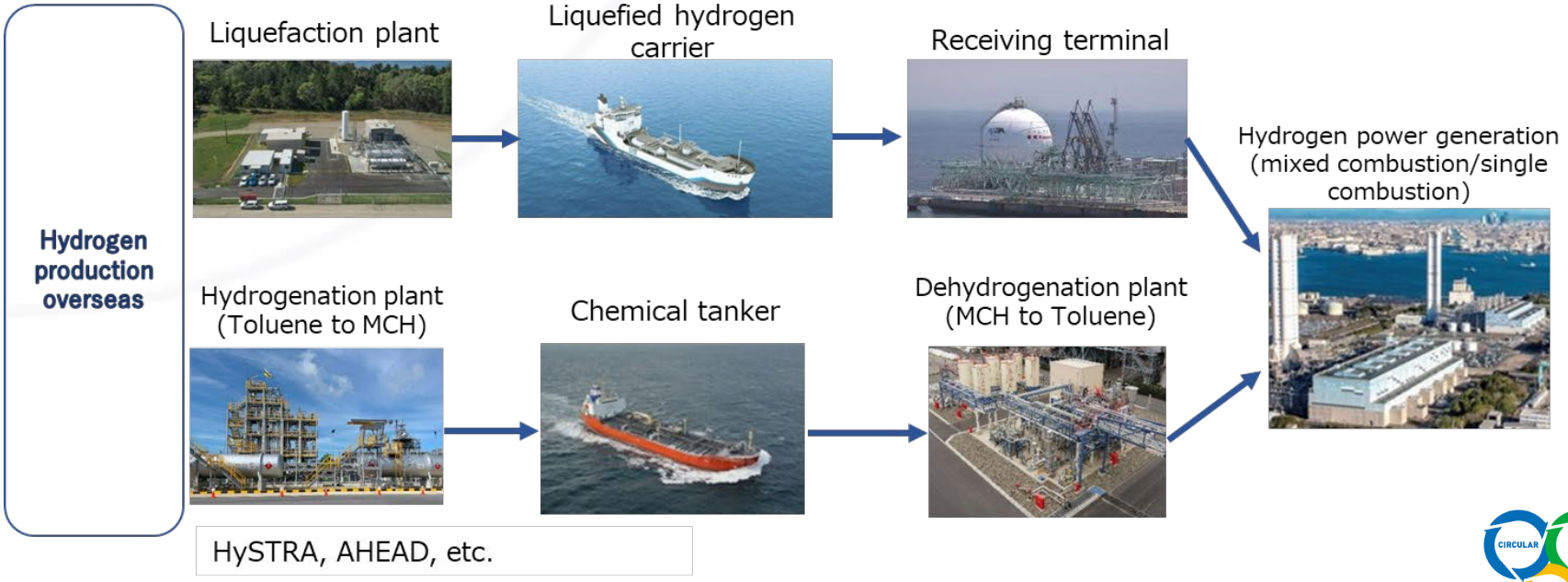
[Green Innovation Fund]



Large-scale Hydrogen Supply Chain Establishment

- Toward the realization of a hydrogen society, the project will promote **the construction of a large-scale hydrogen supply chain as well as demand creation.**
- Using multiple hydrogen carriers (liquefied hydrogen, methylcyclohexane (MCH)), the project aims to **reducing supply costs to 30 yen/Nm^3 in 2030 and 20 yen/Nm^3 or lesser in 2050** (equivalent to fossil fuels) through the by development and demonstration of large-scale transportation equipment and hydrogen combustion stability in actual hydrogen power generation equipment.

Large-scale hydrogen supply chain using a hydrogen carrier (image)



Hot topic: Large-scale Hydrogen Supply Chain

[Green Innovation Fund]

"Liquefied Hydrogen Supply Chain Commercialization Demonstration" project selects sites for shipping and receiving liquefied clean hydrogen

Hastings, Victoria, Australia

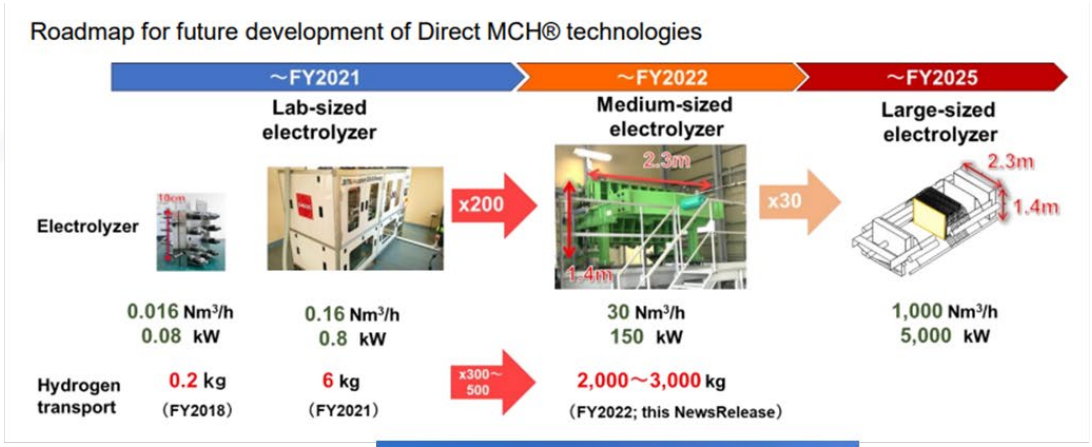
AZEC Public-Private Investment Forum

Hot topic: Large-scale Hydrogen Supply Chain

[Green Innovation Fund]

Demonstration Plant constructed in Brisbane, Queensland, Australia, to produce methylcyclohexane from toluene, using low-cost "electrochemical synthesis of organic hydride" method (Direct MCH)

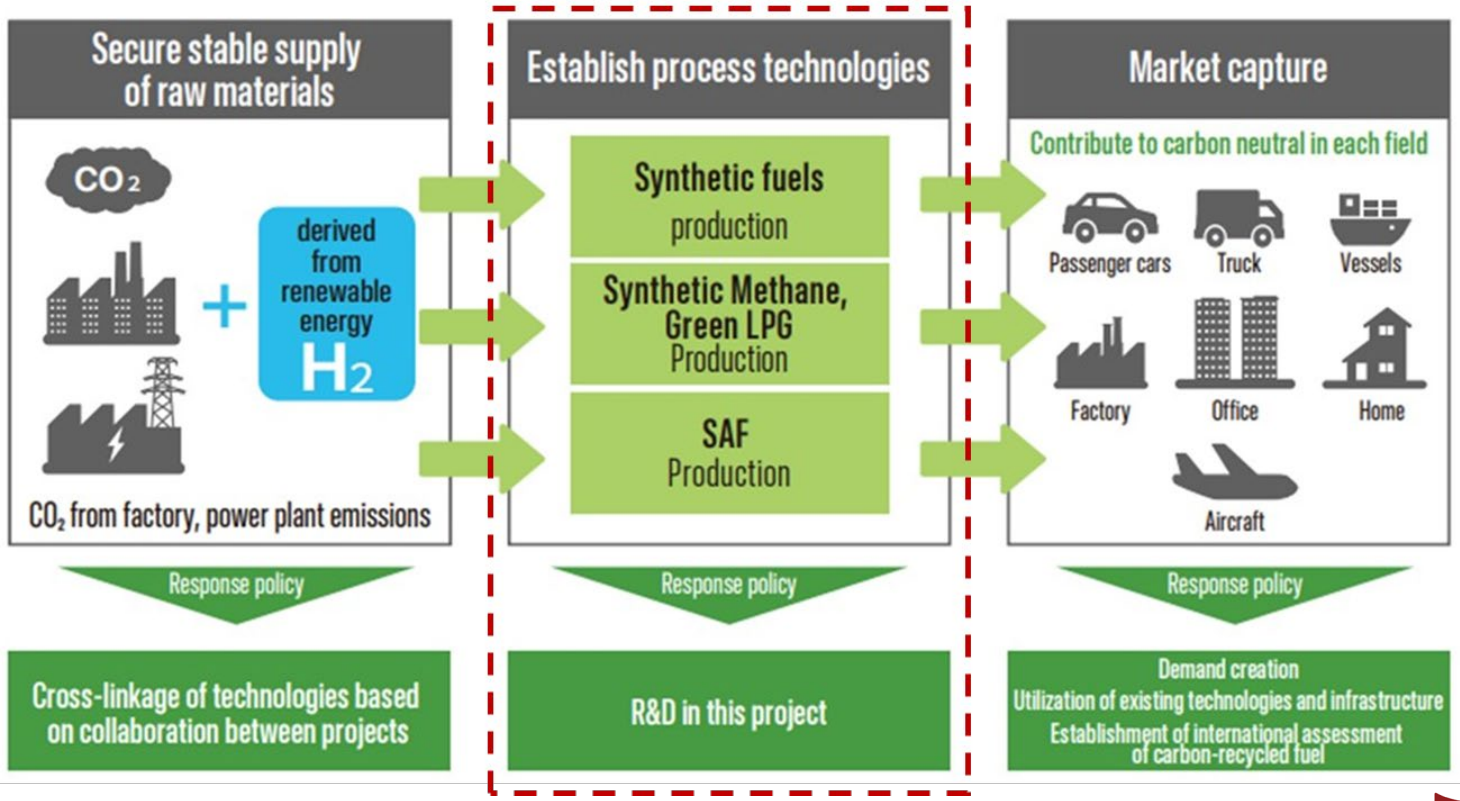
(From left to right)
Masuo Ono, Consul-General of Japan in Brisbane
Tomohide Miyata, Executive vice president, ENEOS Corporation
Honourable Dr. Steven Miles, Deputy Premier of Queensland, Queensland State Government
Honourable Mick de Brenni, Minister for Energy, Renewables and Hydrogen, Queensland State Government
Takanori Kugimiya, Project Manager, New Energy and Industrial Technology Development Organization



Source: ENEOS

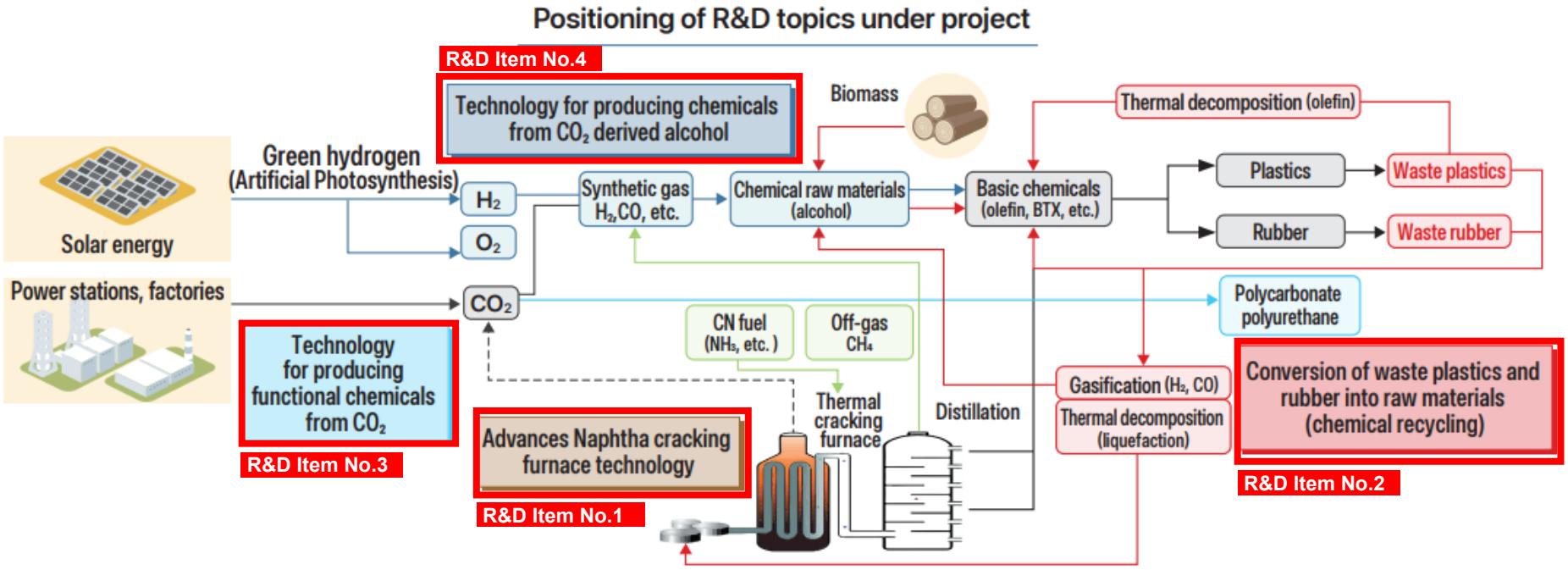
Development of Technology for Producing Fuel Using CO2, etc.

- It is necessary to promote the development of technology for carbon recycling Fuel as one of the various options for realizing a decarbonized society.
- This project will work toward the social implementation of two liquid Fuel and two gaseous Fuel.
  - Liquid Fuel ; (1) Synthetic Fuel (2) Sustainable aviation Fuel (SAF)
  - Gaseous Fuel ; (3) Synthetic methane (4) Green LPG



Development of Technology for Producing Raw Materials for Plastics Using CO_2 and other Source

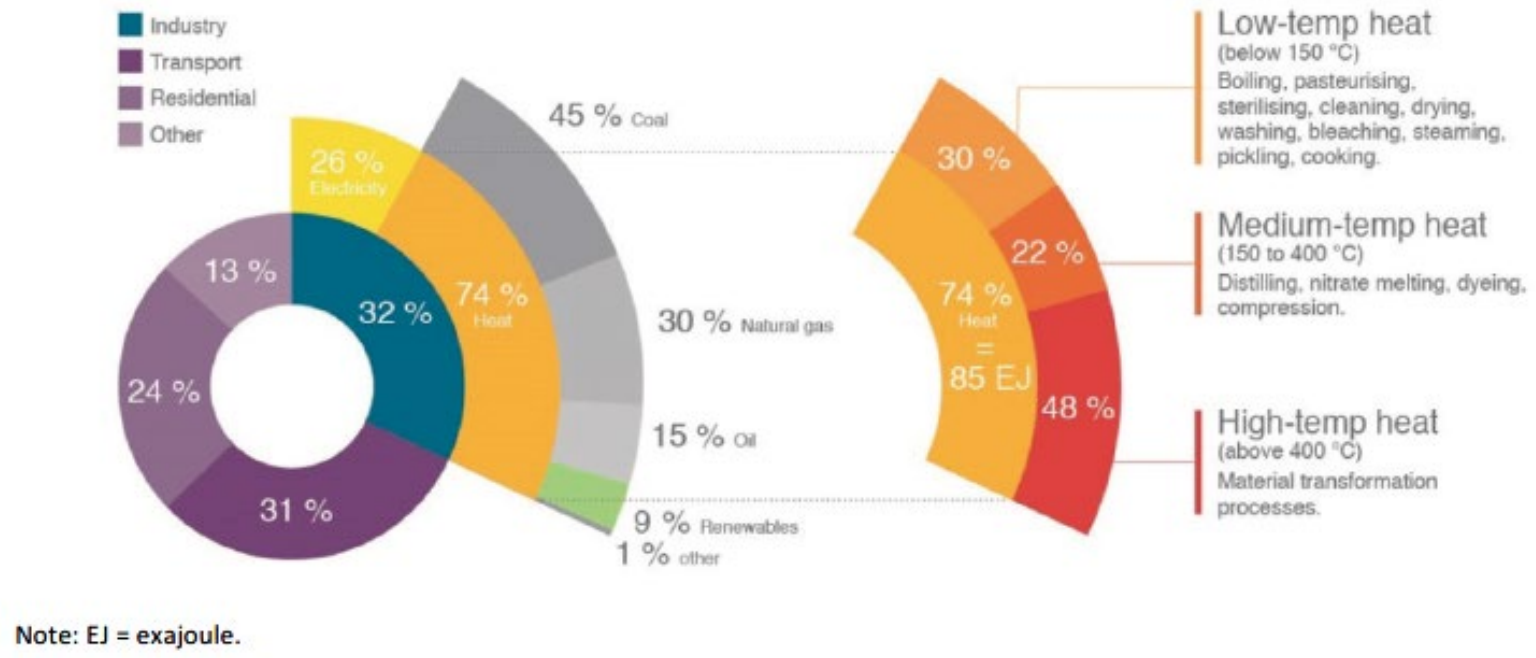
- About half of the CO_2 emitted by the chemical industry is emitted from naphtha cracking processes to produce basic chemicals such as ethylene and propylene.
- About 84% of waste plastics are recycled, but 57% of these are used as a heat source for waste-to-energy plants, etc. (thermal recycling), and are eventually discharged as CO_2.



Importance of Industrial Heating Process

- Industry uses 32% of total energy consumption worldwide.
- Heat Demand of Industrial Process is 74% of Industrial Usage.

Energy Consumption of World



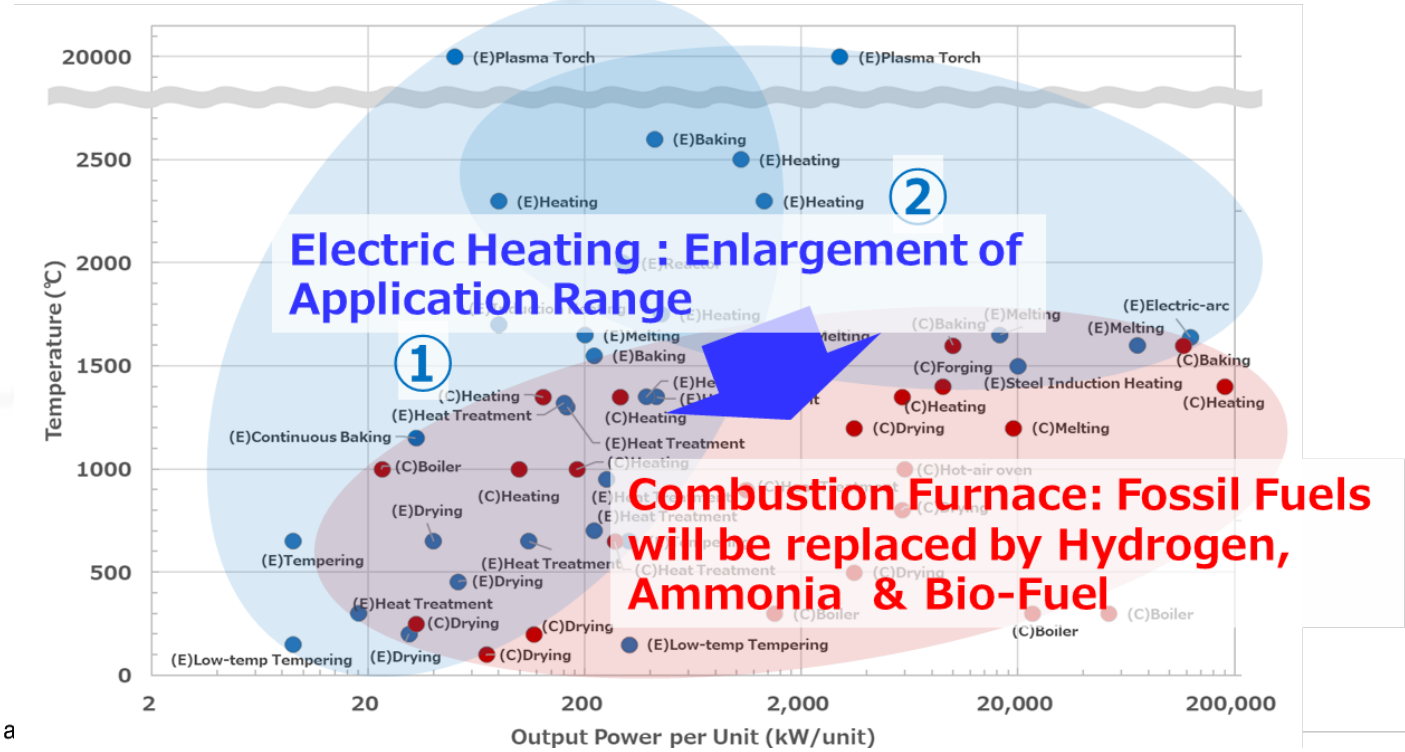
Note: EJ = exajoule.

Source: IEA Insight Series Renewable Energy for Industry

Current Status & Future Direction of Industrial Furnaces

- Industrial Furnaces have been systematically categorized according to the temperature and the output power.
- **Characteristics of Current Usage (Range of Output with Temp. Range):**
- **Combustion Furnace: Wide Range of Output(20kW~200MW) with Temp. below 1600℃**
- **Electric Furnace: ①Below 2MW (Relative Low Output Range) with Wide Range of Temp.**
  ②Wide Range of Output(50kW~100MW) with High Temp. above 1500 ℃

Systematic Categories of Industrial Furnaces



【Source】NEDO TSC

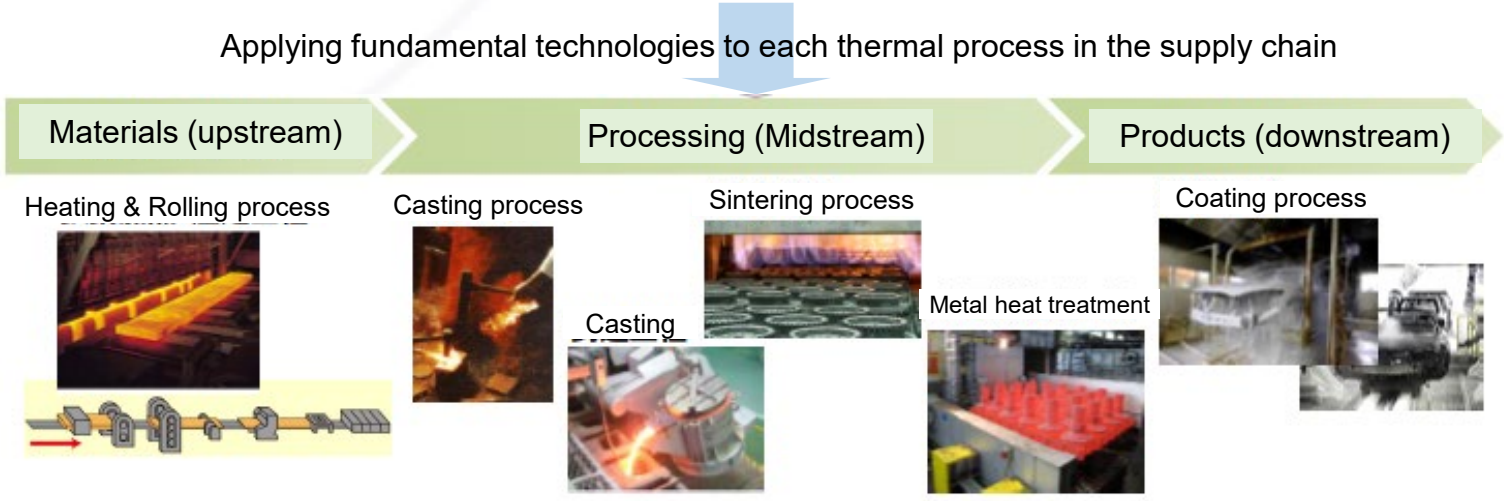
Decarbonization of Thermal Processes in Manufacturing

- The need to decarbonize manufacturing is glowing, as is the trend to decarbonize the entire supply chain in the automotive industry, for example
- Based on these trends, it is necessary to develop the technologies to decarbonize industrial furnaces by switching to zero-emission fuels, electrification, and energy conservation.

【Target Technologies】

- Fundamental technologies for effective combustion of zero-emission fuels(Hydrogen, Ammonia etc.)
- Fundamental technology for efficient electric heating that enables electrification of thermal processes

Applying fundamental technologies to each thermal process in the supply chain



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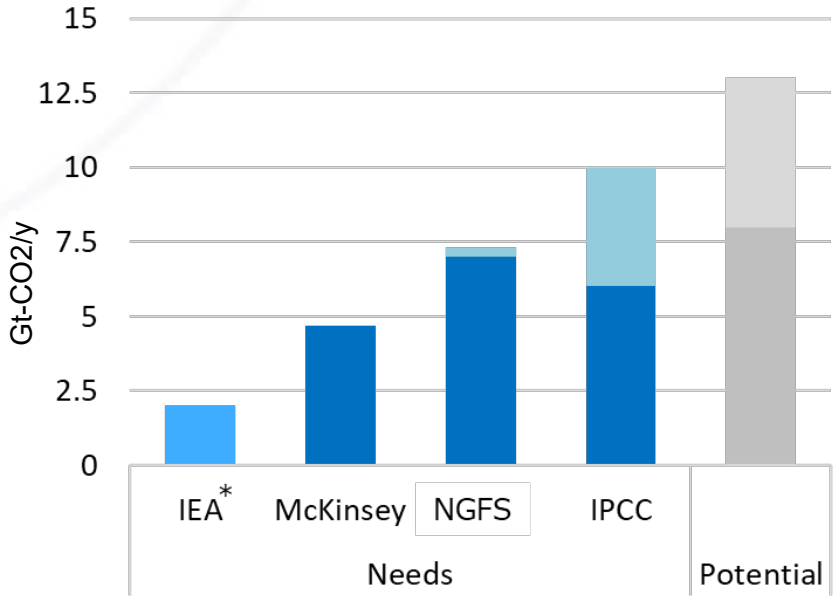
Negative Emission Technologies

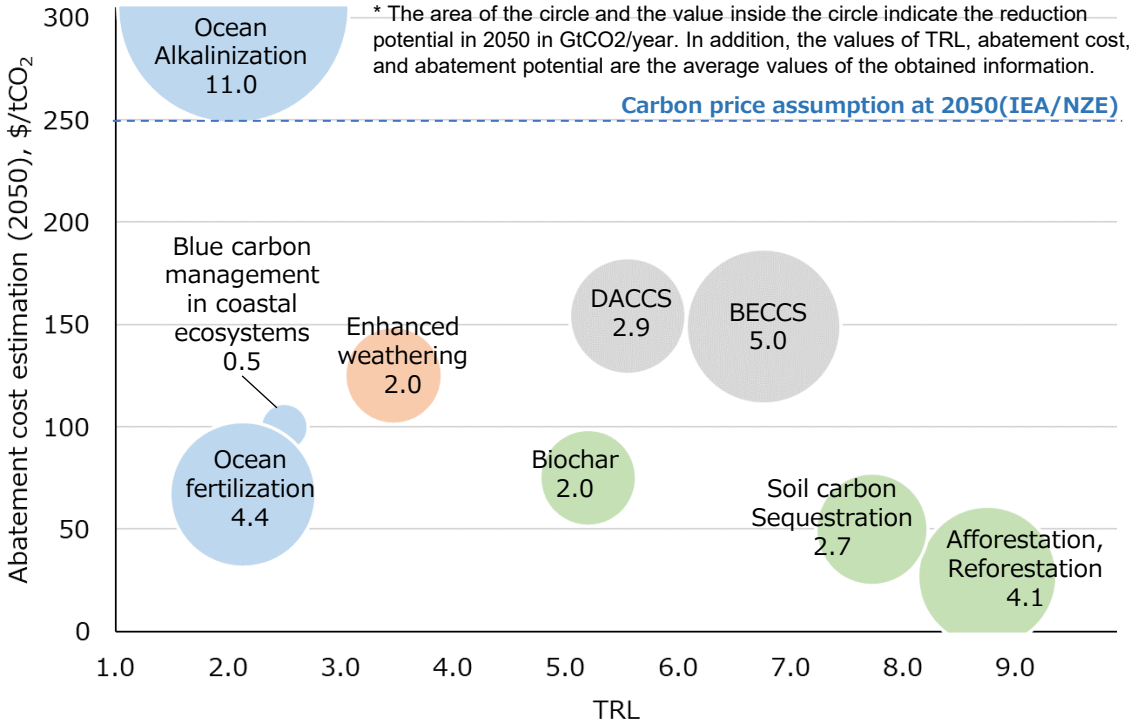
- Negative emission technologies(NETs) are necessary for counterbalancing residual emission from hard to abate sector such as industry, transportation.
- According to predictions by various organizations, the amount of CO2 removal required in 2050 will be in the range of 2 to 10 Gt per year.

Predictions of the CO2 removal in 2050



Negative emission technologies (Cost, Potential, TRL)

- Most of the NETs are expected to achieve abatement cost of less than \$200/tCO_2 in 2050, although some technologies, such as ocean-related, enhanced-weathering, DACCS, and biochar, are in development.
- DACCS and BECCS have definite CO_2 removal effect, but costs need to be reduced.
- NETs, which accelerates natural phenomena, has excellent features for low-cost CO2 removal, but they are need to evaluate scientifically the CO_2 removal effect and environmental impacts, co-benefits.

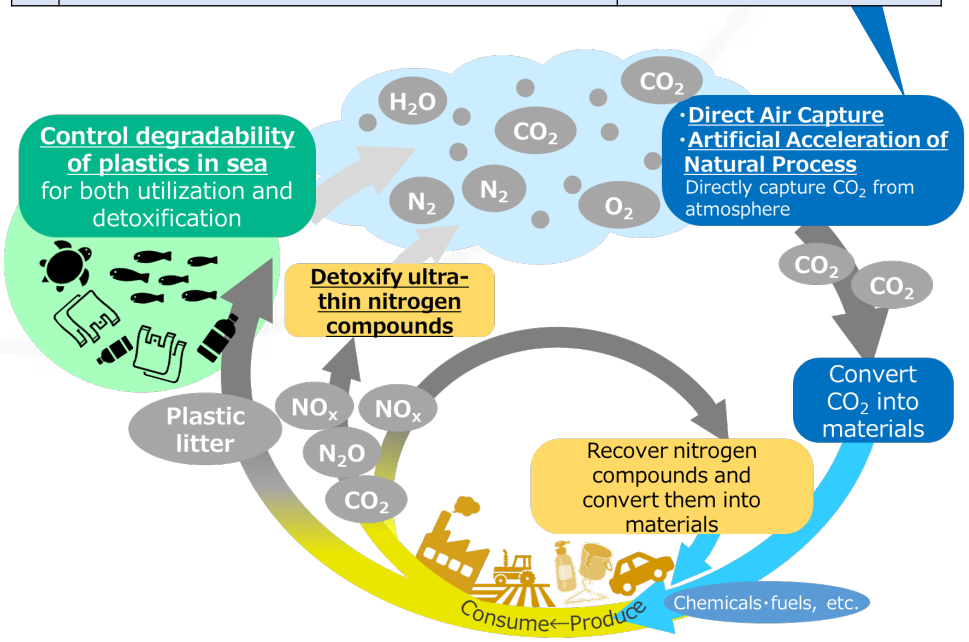


Moonshot Project (Goal No.4)

Cool Earth

Development of technologies to recover greenhouse gases (“GHGs”) and convert them into valuable materials

	R&D Projects	Project Managers
1	Development of a bioprocess that uses electrical energy to fix atmospheric CO2	Dr. KATO Souichiro, National Institute of Advanced Industrial Science and Technology (AIST)
2	Development of highly efficient direct air capture (DAC) and carbon recycling technologies	Dr. KODAMA Akio, Kanazawa University
3	Integrated Electrochemical Systems for Scalable CO2 Conversion to Chemical Feedstocks	Dr. SUGIYAMA Masakazu, The University of Tokyo
4	C4S Research and Development Project	Dr. NOGUCHI Takafumi, The University of Tokyo
5	Research and development toward saving energy for direct air capture with available cold energy	Dr. NORINAGA Koyo, Nagoya University
6	Development of Combined Carbon Capture and Conversion (quad-C) modules targeting low carbon dioxide concentration gases for balancing the global carbon budget	Dr. FUKUSHIMA Yasuhiro, Tohoku University
7	Development of Global CO2 Recycling Technology towards “Beyond-Zero” Emission	Dr. FUJIKAWA Shigenori, Kyushu University
8	Redesign of Macroalgae for Highly Efficient CO2 Fixation by Functional Modifications and Their Product Generation	Dr. UEDA Mitsuyoshi, Kyoto University
9	Development of Next-generation CO2 -fixing Plant Through the Gene Optimization, Distant Hybrid, and Microbial Symbiosis	Dr. MITSUDA Nobutaka, National Institute of Advanced Industrial Science and Technology (AIST)
10	Agrobiotechnological Direct Air Capture Towards Carbon Circulation Society	Dr. YANO Masahiro, National Agriculture and Food Research Organization (NARO)
11	Advanced Enhanced Rock Weathering (A-ERW) Technology Actively Combined With Site Characteristics	Dr. NAKAGAKI Takao, Waseda University
12	Feasibility Study of Enhanced Mineralization Based on LCA/TEA Platform	Dr. MORIMOTO Shinichirou, National Institute of Advanced Industrial Science and Technology (AIST)



NEDO aims to realize a carbon-neutral and sustainable society by promoting necessary technological development and creating innovation through the Green Innovation Fund Project, etc.

Thank you for your attention!