NEDO's R&D Activities in Hydrogen

Webinar on Promoting Research and Innovation in Hydrogen:
Opportunities for Cooperation between the EU and Japan

Wednesday, May 25, 2022

YABE Takahiro
Director, International Affairs Department
New Energy and Industrial Technology Development Organization

About NEDO

What's NEDO

- NEDO is a national research and development agency that creates innovation by promoting technological development necessary for realization of a sustainable society.
- NEDO acts as an innovation accelerator to contribute to the resolution of social issues by developing and demonstrating high-risk innovative technologies having practical application.

NEDO's Missions

- **Addressing energy and global environmental problems**
- **Enhancing industrial technology**

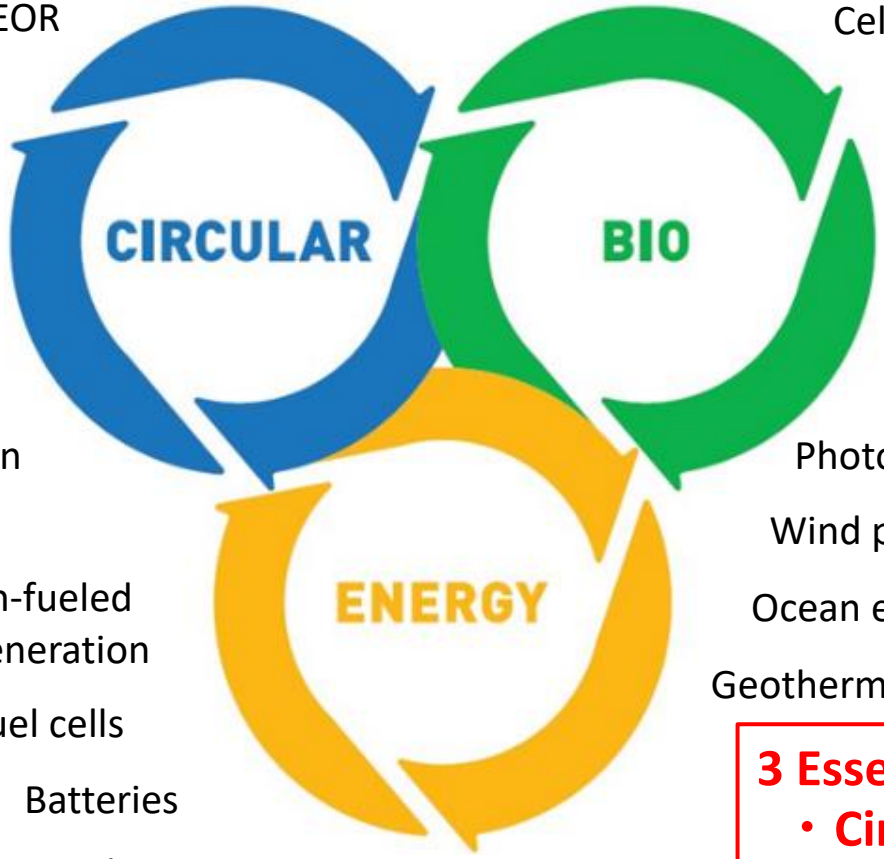
About NEDO

Positioning of NEDO

In order to contribute to the resolution of social issues, NEDO formulates technology strategies and project plans and, as part of its project management, establishes project implementation frameworks by combining the capabilities of industry, academia, and government. NEDO also promotes technology development by carrying out, evaluating, and allocating funding to promising projects to accelerate the practical application of project results.

Overview of NEDO's Technology Development to Promote a Sustainable Society

Recent technological advances, social environment changes	Technological advancement of energy systems, such as AI and blockchain	Contribution to SDGs, expansion of ESG investment
Progress of sharing economy	Prohibition of sale of ICE cars, mobility electrification	Ocean plastic pollution



CCU, CCS, EOR

Reduce

Reuse

Recycle

AI・IoT

Hydrogen reduction ironmaking

Hydrogen-fueled power generation

Fuel cells

Batteries

Power electronics

Energy management

Cellulose nanofibers

Cell-based material production

Bioplastics

Marine biodegradable plastics

Biofuels

Biomass power generation

Photovoltaic power generation

Wind power generation

Ocean energy

Geothermal power generation

3 Essential Social Systems

- **Circular economy**
- **Bioeconomy**
- **Sustainable energy**

NEDO's RD&D Activities on Hydrogen Technologies

NEDO has been carrying out various research and development projects for technologies related to hydrogen production, storage, transport, and utilization to address energy conservation and the environment.

H_2 resources in Overseas

- Brown coal
- By-product
- Associated gas

Convert to Hydrogen Carrier

Liquid H_2

Organic Chemical Hydride

Convert to Hydrogen

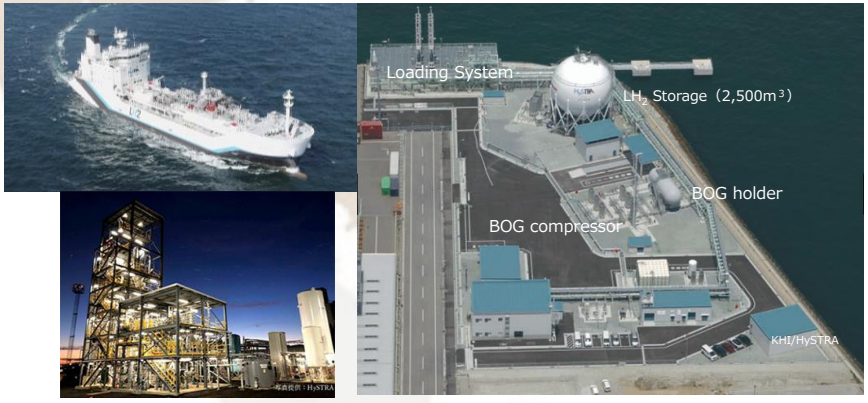
H_2 Utilization in Japan

- Large Scale Power Generation
- Small Scale GT / Heat and Power

Production

Fukushima Hydrogen Energy Field, Japan

Transport & Storage



Transport and storage of liquid hydrogen, Australia

Utilization

Hydrogen station, Japan

Promoting International R&D for Innovative Clean Energy Technologies

NEDO has started a program to develop and strengthen international joint research and development between Japan and other countries in order to create new and innovative clean energy technologies that will have practical use after 2040.

New Energy and Industrial Technology Development Organization (NEDO)

Funding

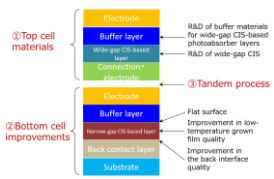
Research institutes/ universities/companies in Japan

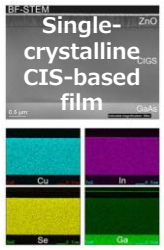
Joint R&D contract

Research institutes/ universities overseas

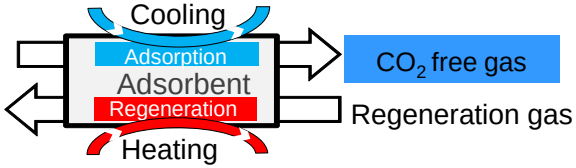
Creation of disruptive technology innovation by combining high-level expertise and advanced technologies from Japan and other countries

CIS-based tandem photovoltaic cell technologies (Germany: HZB)



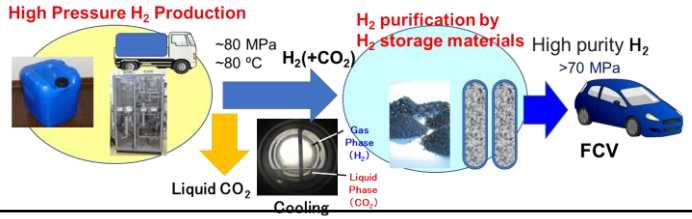


Low-cost CO_2 recovery technology using novel zeolite adsorbent (USA: UC Berkeley)



Utilize waste heat from combustion

Supply technology of hydrogen using formic acid. (France: Bordeaux University, CNRS, Netherlands: TU Delft, UK: QMUL, Saudi Arabia: KAUST, South Korea: KAIST)



R&D Themes for FY2020

Theme 1: Development of elemental photovoltaic cell technologies that simultaneously realize higher efficiency, lower costs, and higher durability more than ever before

Theme 2: Development of innovative geothermal power generation technologies utilizing overseas fields, including resource exploration/assessment and materials/measurement technologies

Theme 3: Development of innovative bioprocess technologies utilizing microorganisms and genome editing technology

Theme 4: Development of elemental technologies for innovative hydrogen production/use which contribute to substantial cost reduction for realization of a future hydrogen society

Theme 5: Development of innovative devices and evaluation technologies which utilize/control unused heat (hot and cold heat) generated from waste heat as well as renewable energy sources

Theme 6: Development of innovative devices and system control/evaluation technologies for making effective use of distributed power networks

Theme 7: Development of methodologies to ensure the reliability and quality of innovative heat resistant materials which contribute to improving aircraft engine fuel efficiency

R&D Themes for FY2021

Theme 1: Development of innovative technologies that can contribute to realizing the industrialization of carbon recycling, such as low-cost CO_2 separation and capture and production of useful materials

Theme 2: Development of innovative technologies that can contribute to the significant promotion and expansion of hydrogen utilization toward the realization of a future hydrogen society

Theme 3: Development of innovative energy storage technologies that can realize both low cost and high durability battery and heat storage for the effective use of variable renewable energy

Theme 4: Development of innovative materials and components that enable mass CO_2 reduction through large-scale implementation in society

Project Name: International Joint Research on Efficient Intermediate Temperature Solid Oxide Electrolysis Cell (2020–2023*) *scheduled

Entrusted party: Kyushu University

Outline of the project

Hydrogen, like electricity, is expected to be a clean energy carrier, and its uses are expected to grow into areas such as fuel cell vehicles. Widespread use of hydrogen can decrease CO_2 emissions. However, at present, hydrogen is produced from fossil fuels like CH_4. Storage of renewable energy is required to level its fluctuation since it has low energy density. In this study, we will develop intermediate temperature solid oxide electrolysis cells to effectively convert excess renewable power to hydrogen for storage, and aim to get an electrolysis efficiency level higher than 85% at an operating temperature of 500 °C.

Solar cell

Wind power

Excess electricity (5～15%)

Output suppression

Unused heat (Solar heat, wasted heat etc.)

O_2

H_2O

H_2

Average Storage

Steam electricity is highly efficient electrolyzer using heat energy

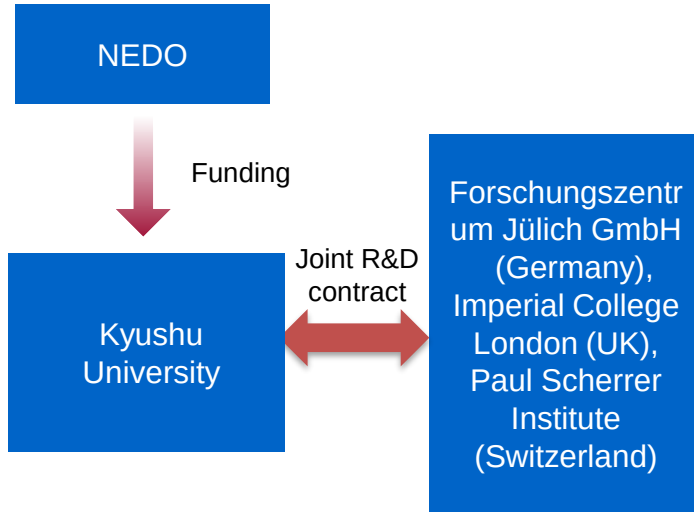
Operating temperature is Excessively high

Intermediate temperature operation

Transport beyond time and space

CO_2 reduction (Excess electricity) 13～20Mton

Project scheme



Significance of international R&D

In order to develop a highly efficient solid oxide ion and an oxide proton conducting electrolyzer, joint research will be performed under collaboration with Forschungszentrum Jülich to make a thin film electrolyte by a wet process, and with Imperial College London for developing an active air electrode, and the Paul Scherrer institute for preparing the interface structure control electrode. Through this joint research, it will be expected that device development will be accelerated, and cell performance can be significantly improved.

Expected outcomes

- Hydrogen production and storage using renewable energy, such as solar cells
- Production of low-cost hydrogen
- Expected economic effect:
  Assuming that the surplus power of renewable energy is 55 billion kWh (22% of the generated power), the amount of hydrogen that can be produced with a hydrogen production efficiency of 70% is 12 x 10^9 Nm^3.
  Price of hydrogen: 20 yen/Nm^3 (mass consumption)
  Economic scale: 24 billion yen
- Estimated reduction effects of CO_2 emission (13-20 x 10^6 ton-CO_2/year)

Project Title : International joint research for supply technology of high-pressure and purity of hydrogen by chemical compressor using formic acid. (2021～2024*)

Entrusted Party : National Institute of Advanced Industrial Science and Technology

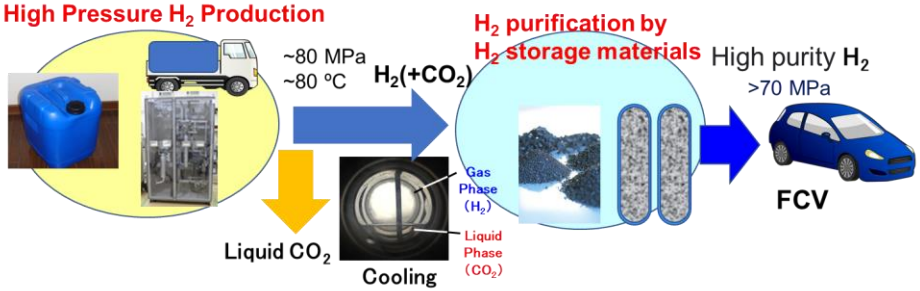
*scheduled

Outline of the Project

For the realization of a hydrogen society, there are still many technical, efficiency, and cost issues in the use of high-pressure hydrogen (35 to 70 MPa) for filling into fuel cell vehicles (FCVs), etc.

In the present work, a high-pressure hydrogen generation system including highly efficient catalysts for dehydrogenation of formic acid will be developed based on the characteristic of formic acid as a liquid organic hydrogen career. We will build up novel hydrogen compression technologies that enable to provide 70 MPa class of hydrogen through the dehydrogenation of formic acid as a chemical compressor without using a high-cost mechanical compressor. Furthermore, we will develop hydrogen storage materials, which can purify hydrogen under high-pressure conditions and supply it to FCVs depending on the demand.

We aim to establish the unprecedented and innovative high-pressure and high-purity hydrogen supply technology, which will greatly reduce the initial investment and maintenance costs of hydrogen refueling station.



Significance of International R&D

We will efficiently accelerate research and development under the international collaborations.

・Development of catalyst for high pressure H_2 production: King Abdullah University of Science and Technology

・Development of CO_2-resistant hydrogen storage materials to build up hydrogen purification, storage and supply technologies: Institute for Solid State Chemistry Bordeaux, Queen Mary University of London, Korea Advanced Institute of Science and Technology, Delft University of Technology

・Development of material synthesis method under high-pressure hydrogen: East-Paris Institute of Chemistry and Materials Science

Project Scheme

NEDO (New Energy and Industrial Technology Development Organization)

Funding

National Institute of Advanced Industrial Science and Technology

Joint R&D contract

- Institute for Solid State Chemistry Bordeaux (France)
- Delft University of Technology (Netherlands)
- East-Paris Institute of Chemistry and Materials Science (France)
- Korea Advanced Institute of Science and Technology (Korea)
- King Abdullah University of Science and Technology (Saudi Arabia)
- Queen Mary University of London (UK)

Expected Outcomes

Assuming that our technology will be widespread and the number of FCVs will be 800,000 in 2030 and 8,000,000 in 2050, the estimated annual CO_2 reduction in Japan is as follows.

・2030: 178 000 ton-CO_2/y
・2050: 1780 000 ton-CO_2/y

Further CO_2 reduction can be expected by expanding our technology for trucks and forklifts, etc. and reducing the construction costs of hydrogen filling stations by simplifying the hydrogen transportation, compression and purification system.