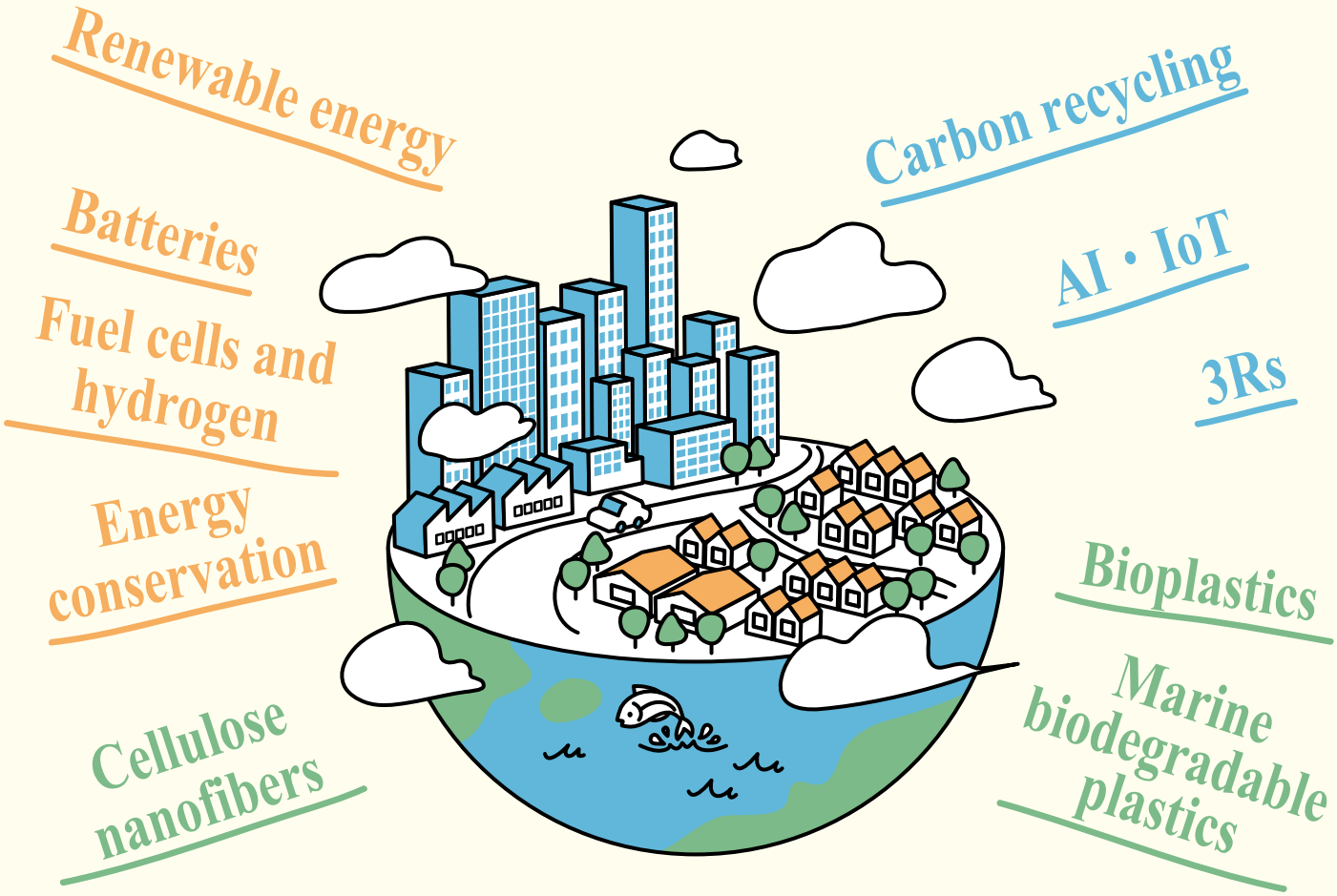
NEDO

focus NEDO

2019
No.73

Reporting on Today and Tomorrow's Energy, Environmental, and Industrial Technologies



[1st Featured Article]

Innovation for a Sustainable Circular Society

[2nd Featured Article]

Technology Strategy Center assesses the prospects for technological development

New Energy and Industrial Technology Development Organization

Road to WRS 2020

World Robot Summit

Taking on the World

An interview with Mr. Shiraishi, a man who has opened up a new world on his own without fear of failure. What is the significance of accepting the challenge of creating a new future?

Interview

DMG MORI SAILING TEAM

Mr. Kojiro Shiraishi

It is essential that you take the first step toward creating your first idea and then consider what exactly you want to do.

Born in Tokyo in 1967, Mr. Shiraishi became an apprentice to Mr. Yuko Tada (the winner of the first round-the-world yacht race) while he was still in high school. In 1994, Mr. Shiraishi became the youngest person (at that time) to complete a solo non-stop round-the-world yacht race. In 2006, he made history by coming second in the Velux 5 Oceans Race (Class I: 60 feet), another solo yacht race. In 2016, he became the first Asian to compete in the Vendée Globe, the world's toughest solo non-stop round-the-world yacht race. Unfortunately, he was forced to retire due to a mast problem. On October 30, 2018, he became the skipper of the DMG MORI SAILING TEAM, which DMG MORI Co., Ltd. established as Japan's first open sea sailing team. Around the same time, he announced that he would be entering the Vendée Globe to be held in November 2020 and attempting to build a state-of-the-art foil boat. (For further details, visit https://kojiro.jp)

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Contents

02 **Road to WRS2020**
Taking on the World
DMG MORI SAILING TEAM
Mr. Kojiro Shiraishi

04 **1st Featured Article**
Innovation for a Sustainable Circular Society

04 Message from the Chairman

07 Government initiatives for carbon recycling

08 NEDO Projects
• 01 Artificial photosynthesis
• 02 CO_2 separation and capture
• 03 Methanation

12 **2nd Featured Article**
Technology Strategy Center Assesses the Prospects for Technological Development

12 Interview with the Executive Director

14 Developing Technology Strategies for the Future

16 **Reports from the Field**
NEDO and Kawasaki City establish a new entrepreneur support facility called K-NIC in March 2019

Q Mr. Shiraishi, you are going to enter the solo round-the-world yacht race Vendée Globe in 2020. What does a challenge such as this mean to you?

My goal is not simply to take up challenges. Instead, I find that continuing to do what I enjoy naturally gives rise to challenges. It took me about 30 years until I first took up the challenge of entering the Vendée Globe in 2016, a round-the-world yacht race that I had long wanted to contest. Unfortunately, I ended up having to retire. I'm often asked if I feel pressure, but I think victory can depend on your luck on the day. Failure in your first attempt is nothing to be ashamed of because taking that first step forward and repeating new experiences enables you to improve your ability to succeed. You can accomplish things by accumulating experiences and actions. The most important factor is what you think before you get started. I believe that your first passions, thoughts, and dreams with respect to what you want to do are essential.

Q Yachts are equipped with a variety of different technologies. How do they influence races and yachts?

YOICHI YABE

Yacht races involve greater uncertainties than any other competition in the world. No matter how state-of-the-art a yacht's equipment may be, it won't sail if there is no wind and the wind is always changing. Even if we can avoid icebergs by using satellite technology to detect them, we still face a variety of new risks, such as nets and the huge number of containers that fall from tankers and other vessels. I can receive satellite calls during a race in the open sea thanks to the development of telecommunication equipment, so we may have lost a little romanticism because of that [laughs]. However, you can't build a good ship with just your technical capabilities and good-quality parts. My current dream is to win a race with a Japan-made yacht. I think we can build a top-class yacht by bringing Japanese technologies together.

Q Do you have a message for those competing in the World Robot Summit (WRS) and developing the technologies that will shape our future?

I'd like them to believe in themselves and do what they love. Competitions and races may be ranked, but that doesn't mean that only those who came first did their best. Experiencing pleasure, anger, sadness, and joy serves as an accelerator that drives your passions forward. I hope that they will look to challenge themselves in their chosen directions without fear. Each person faces his or her own challenges, so we should all do our best as we approach 2020 while at the same time placing importance on the direction and thoughts of the individual.

WRS Message
Robotics for Happiness

The World Robot Summit (WRS) is both a competition and an exhibition that brings together robot excellence from around the world. To help accelerate the adoption of robots in everyday life, society as a whole and the industrial sector as well as promote research and development into robotics through the World Robot Challenge (WRC) and the World Robot Expo (WRE), a pre-event for the World Robot Summit 2018 (WRS2018) was held from October 17 to 21, 2018, at Tokyo Big Site.

Dr. Tomomasa Sato, Chairman of the WRS Executive Committee and Emeritus Professor at the University of Tokyo

In the WRC, 126 teams from 23 countries and regions participated in nine challenges in four categories (Industrial Robotics, Service Robotics, Disaster Robotics, and Junior) to accelerate the development of robotic technologies by bringing together various technologies and ideas. In the WRE, 94 companies and groups disseminated examples of how the latest robotics technologies were being introduced around the world. In addition, 37 Stage Programs were held with the participation of more than 100 experts from both Japan and overseas and various Robot Experience & Demonstration Programs were conducted.

Based on our experience at WRS2018, we are working hard to prepare for the main event: World Robot Summit 2020 (WRS2020). We hope to see you at the venues in Fukushima Prefecture and Aichi Prefecture in 2020.

WRS World Robot Summit 2020

An international robotics event hosted by METI and NEDO where robotics specialists from all over the world come together to accelerate the research and development and social implementation of robots.

2020 FUKUSHIMA
Fukushima Robot Test Field
(WRC: Infrastructure maintenance and disaster response competition)
August 19–21, 2020 (Wed.–Fri.)

2020 AICHI
Aichi Sky Expo (WRC & WRE)
October 8–11, 2020 (Thu.–Sun.)

https://worldrobotsummit.org/en/

18 **Startup Support and Beyond**
The Future for NEDO Startups
Elephantech Inc.
Triple W Japan Inc.

20 **NEDO Information**
Useful information from NEDO

Reporting on Today and Tomorrow's Energy, Environmental and Industrial Technologies

"Focus NEDO" is the public relations magazine of the New Energy and Industrial Technology Development Organization (NEDO), introducing the public to NEDO's various projects and technology development activities related to energy, environmental and industrial technologies.

Please let us hear your views!
Reader Questionnaire

We welcome your feedback and opinions on the content and technologies introduced in this magazine. Your feedback will be used for reference purposes in our future public relations activities and magazine publications. We look forward to hearing from you!

A Few Words from the Editor

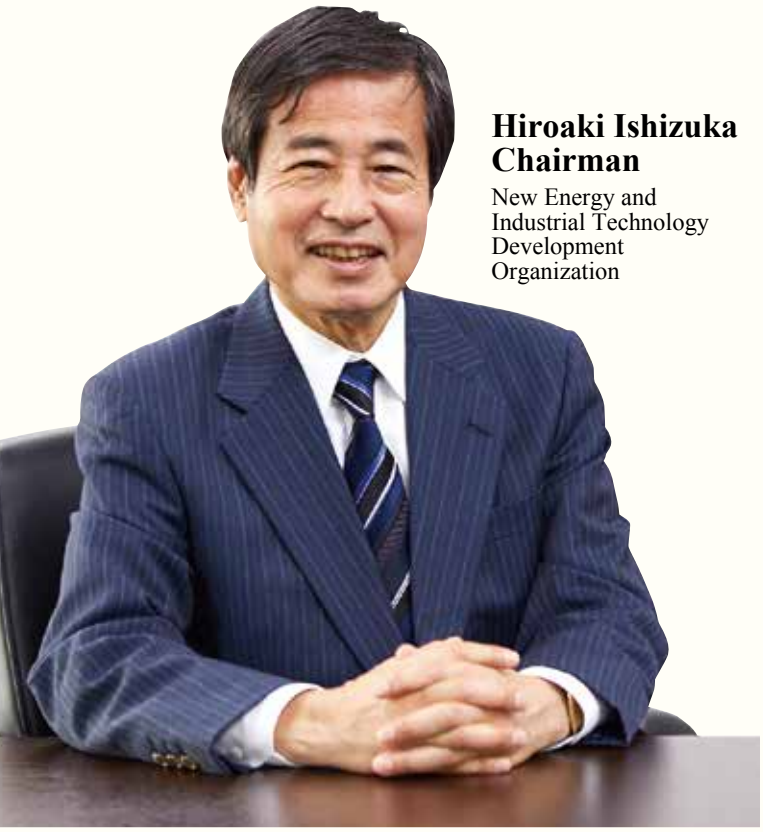
The promotion of initiatives for establishing sustainable material cycles in our society has accelerated around the world. The 1st Featured Article explains how NEDO is taking the initiative in solving the world's CO_2 problem, provides a message from NEDO Chairman Hiroaki Ishizuka, and describes a technology development project that is expected to reduce CO_2 levels. The 2nd Featured Article highlights an interview with Mr. Yoshinao Mishima, who became executive director of the Technology Strategy Center (TSC) in April 2019, regarding his aspirations and vision for the future. At the start of this magazine, we have launched a new series that focuses on the keyword "challenge." We interviewed Kojiro Shiraishi, who took up the challenge of contesting solo round-the-world yacht races and listened to his valuable views on important matters such as the challenges and technologies involved in the development of yachts operated using natural energy resources. Please make sure that you read our articles on K-NIC and hot startups, too.

Innovation for a Sustainable Circular Society

What can be done to establish sustainable cycles in society in the face of various energy and environmental challenges that draw our attention?
In line with its mission to address such challenges, NEDO presents its vision and relevant projects conducted in line with the three pillars described below.

Message from the Chairman

NEDO serves as an innovation accelerator to address rising levels of carbon dioxide.



Hiroaki Ishizuka
Chairman
New Energy and Industrial Technology Development Organization

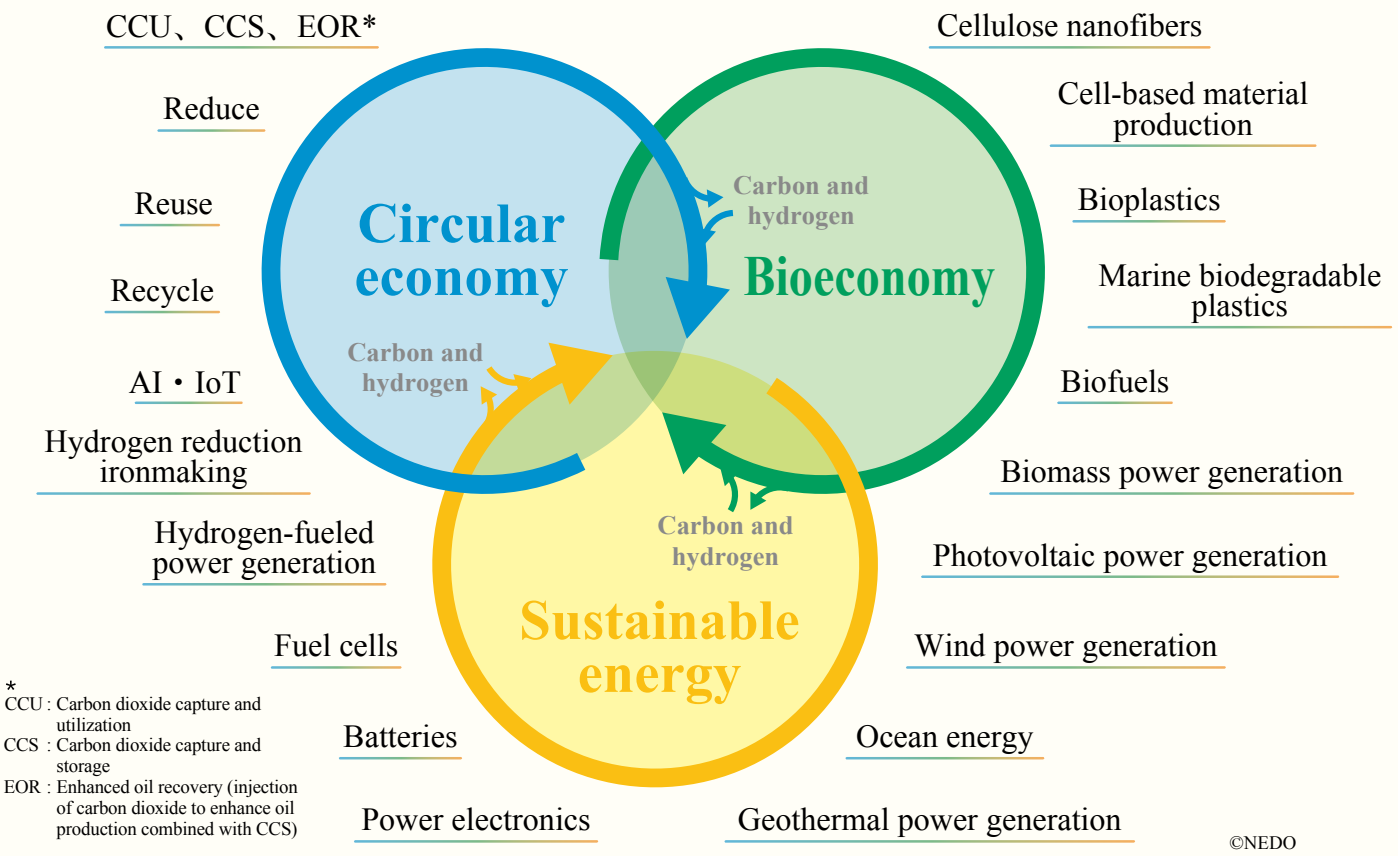
Imminent energy and environmental challenges

Seas polluted with plastic waste and other new global concerns are emerging in addition to the familiar issue of global warming. In 2019, Japan will chair for the first time the G20 Summit in Osaka after hosting the G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth in Karuizawa. Naturally, Japan's stance and initiatives with respect to addressing environmental challenges and ensuring sustainable development will attract greater attention than ever before.

The Paris Agreement, which was adopted at COP21 in 2015, aspires to keep global warming in the 21st century below 2.0°C above pre-industrial levels while striving to limit it to 1.5°C. Subsequently, in 2018, the Intergovernmental Panel on Climate Change (IPCC) presented a report on the impacts of global warming of 1.5°C and scenarios for limiting the temperature rise to that level. However, keeping the rise below the aspirational goal of 1.5°C is no easy task as net-zero emissions should be achieved by around 2050 by offsetting CO_2 emissions using forests and other carbon sinks.

Given the arduous tasks ahead, the Japanese Council on the Long-Term Strategy for Implementing the Paris Agreement met

Comprehensive strategy for establishing a sustainable circular society
(three pillars and examples of relevant technologies)



*
CCU : Carbon dioxide capture and utilization
CCS : Carbon dioxide capture and storage
EOR : Enhanced oil recovery (injection of carbon dioxide to enhance oil production combined with CCS)

in April 2019 at the Prime Minister's Office, where radical innovation was advocated as the essential means of securing a breakthrough for various environmental issues. In fact, radical innovation is something that NEDO has been facilitating for many years and I believe that the role played by NEDO as an innovation accelerator will gain further prominence.

Meanwhile, in December 2018, the Japanese legal framework was updated to encourage innovation. Under the newly introduced Moonshot Research and Development Program, NEDO can establish funding to encourage bold and ambitious research and development that defies conventional thinking. NEDO intends to make the most of this momentum to address environmental challenges on a global scale by driving innovation.

Three pillars for establishing a sustainable circular society

Energy and environmental challenges cannot be addressed by any single country alone. Such challenges require a globally coordinated approach. With due consideration given to sustainable development goals (SDGs) (*1) and ESG investments (*2), tangible contributions are expected from not only national governments and other public agencies but also private companies.

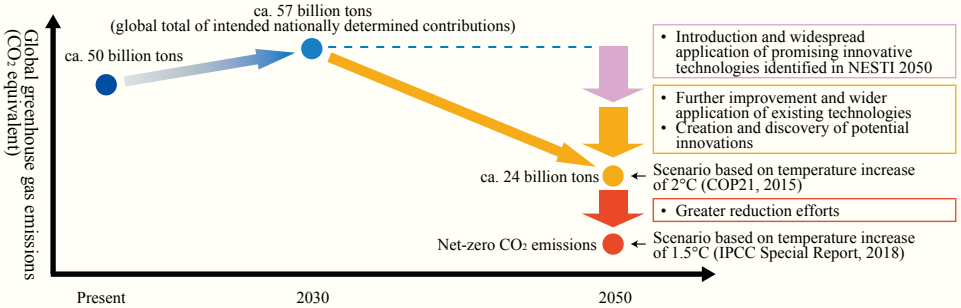
NEDO believes that the key to establishing sustainable circular society is the pursuit of sustainable energy, a circular economy, and bioeconomy in an integrated manner. The three

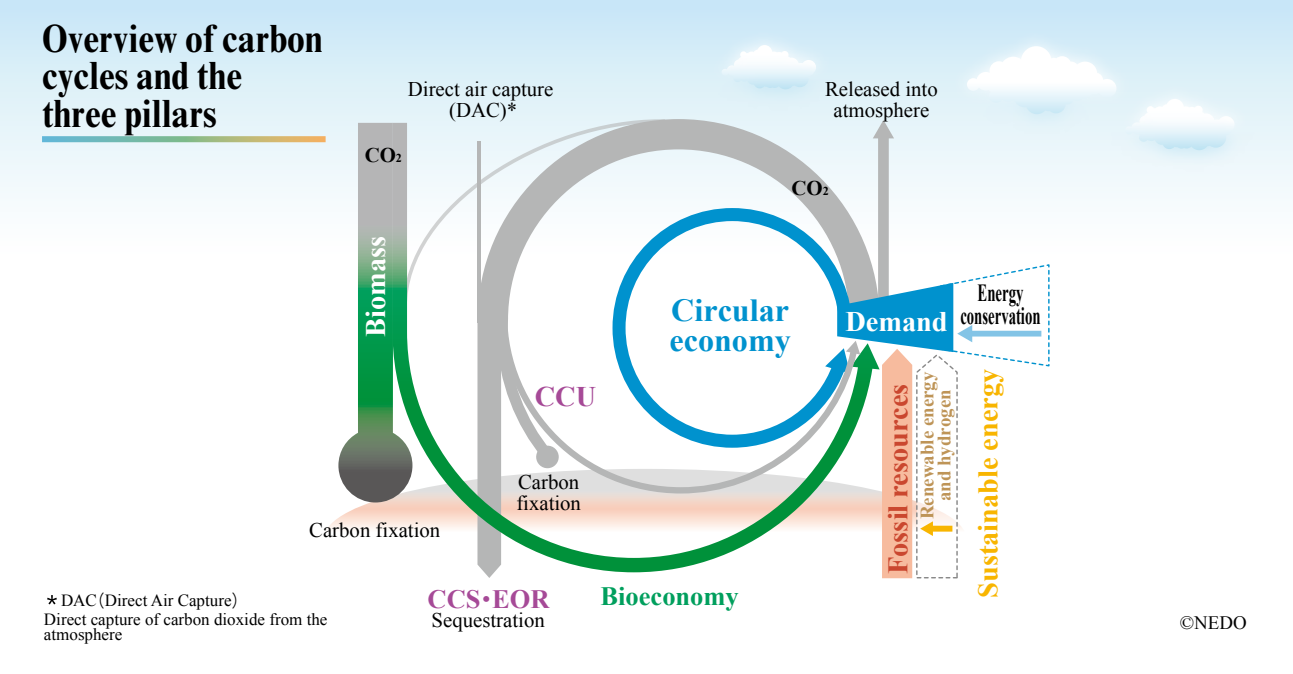
*1: International goals for the period from 2016 to 2030 as outlined in the 2030 Agenda for Sustainable Development, adopted at the UN summit held in September 2015.
*2: Investment prioritization based on corporate commitment to improve environmental and social practices as well as governance.

Global greenhouse gas emissions and reduction targets

*The arrows in the diagram corresponding to the following items do not indicate exact emission reduction amounts: "Introduction and widespread application of promising innovative technologies"; "Further improvement and wider application of existing technologies"; and "Creation and discovery of potential innovations."
*The changes in emission volumes between 2030 and 2050 are presented for illustration purposes only. It should not be assumed that such changes will occur in a linear manner.

Source: Prepared by NEDO based on the National Energy and Environment Strategy for Technological Innovation (NESTI 2050), Cabinet Office





pillars underpin the comprehensive strategy that NEDO is shaping to drive innovation that offers feasible solutions to address the challenges faced by our society. The first step towards delivering such innovations would be to simulate a tangible scenario up to 2050 by considering how much of the more than 50 billion tons of global greenhouse gas emissions can be reduced and what kinds of technologies would be required to do so. To do this, a careful balance must be struck between technologies and the associated costs by using a big-picture approach.

In terms of sustainable energy, NEDO has been promoting the development of renewable energy, the application of hydrogen energy, and the adoption of energy-saving solutions. These outcomes must be applied in not only the power sector, but also the transport sector and the rest of the overall energy system.

The concept of a circular economy has an aspect of sharing business such as car sharing, but it also has a meaning of establishing entirely new resource circulation society by adapting an advanced approach of materials recycling in which Japan excels. I believe that Japan should be actively taking leadership in the field of carbon recycling to utilize carbon resources effectively, going beyond the capture and storage of CO_2 from facilities such as thermal power plants.

Bioeconomy is a concept for establishing a sustainable society through the effective use of biological resources. Japan has built robust underlying technologies. Tangible examples include biomass-fueled power generation, thermal harvesting, bio-jet fuels, cellulose nanofibers, cell-based material production, and marine biodegradable plastics that hold the key to clearing our seas of plastic waste. These wide-ranging technologies must be made economically viable.

For each technology, it is necessary to clarify how much the associated costs can be reduced and by when as well as how much the practical application of the technology can reduce CO_2 emissions. The presentation of such a scenario can provide the starting point for a social debate to decide matters such as what price level is acceptable and whether a technology should be introduced to address an impending challenge even if it is costly. Through this process, we can apply technologies that will genuinely address the challenges faced by our society.

NEDO addresses social challenges

The Earth kindly acts as a host to the human race. Given this, our professionally active generation has a duty to maintain and sustain the natural environment. This is the most important mission to be pursued. Accordingly, NEDO conducts projects for developing and demonstrating technologies—all in response to the earnest need to address global challenges. Bearing in mind the gravity of this responsibility, the entire NEDO team will strive to drive innovation forward with the aim of dealing with rising levels of carbon dioxide in NEDO's capacity as both as an innovation accelerator that can help in the meaningful application of innovations designed to address social challenges and as a platform organization that can promote tangible technological development.

Hiroaki Ishizuka
Having graduated from the Department of Chemistry in the School of Science at the University of Tokyo, Hiroaki Ishizuka joined Mitsubishi Kasei Corporation in 1972. He was appointed to the position of Chairman of NEDO in April 2018, having earlier served as President of Mitsubishi Chemical Corporation and Advisor to Mitsubishi Chemical Holdings Corporation.

Government initiatives for carbon recycling

TOPICS

On January 23, 2019, the World Economic Forum hosted its annual meeting in Davos. At this event for the exchange of ideas on the world economy, environmental issues, and other such topics, Japanese Prime Minister Abe stressed the importance of innovation and the effective use of carbon dioxide. Soon after, on February 1, the Agency for Natural Resources and Energy in the Ministry of Economy, Trade and Industry (METI) established the Carbon Recycling Promotion Office to stimulate innovation related to the capturing and harnessing of carbon dioxide.

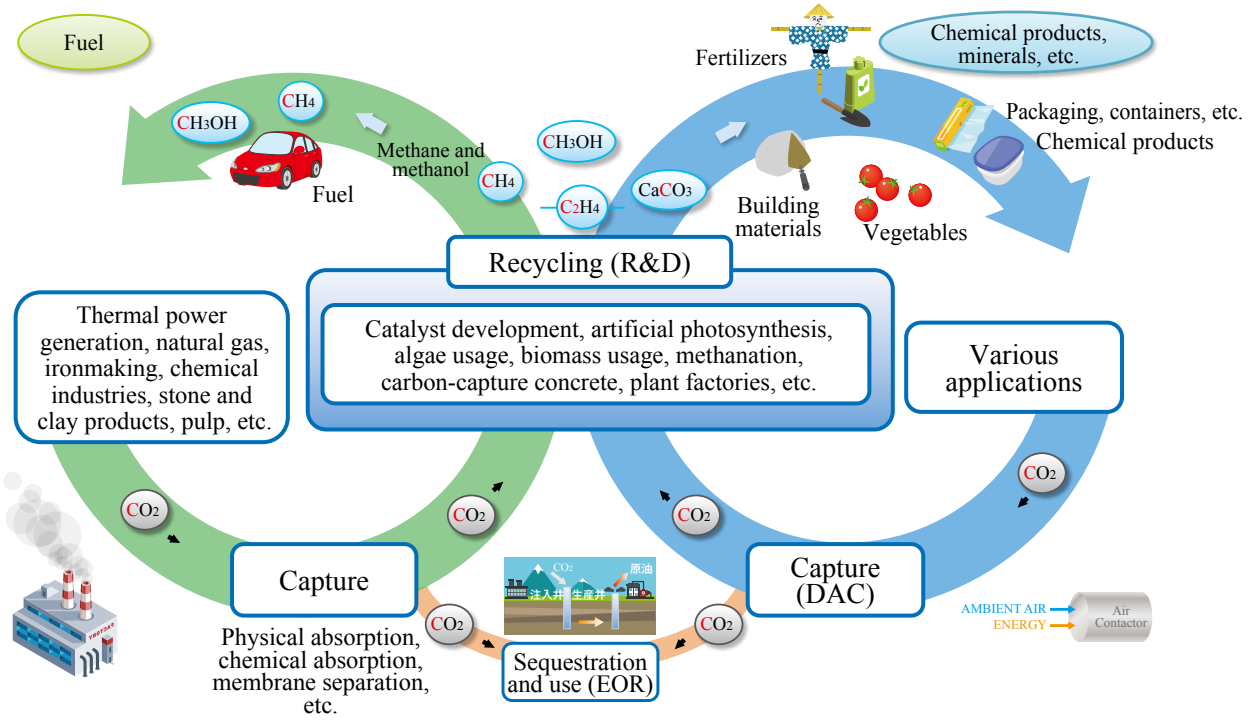
Carbon recycling is conducted to capture carbon dioxide as a resource that can be converted into a wide range of useful carbon compounds. According to the global 2050 target, every possible technical option must be pursued to achieve a radical reduction in CO_2 emissions associated with the use of fossil fuels. Carbon recycling holds great promise in this respect, so innovation for turning it into a viable option is deemed vital.

In June 2019, the Carbon Recycling Promotion Office formulated a roadmap for the relevant technologies, taking into consideration the 2050 target. This roadmap was introduced at the G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth, which brought together ministers of energy and the environment in Karuizawa from June 15 to 16.

Meanwhile, NEDO will jointly host with METI an international conference on carbon recycling on September 25, 2019. Stakeholders from various industries, the scientific community, and the governments of major countries will be invited to exchange their latest findings, identify opportunities for international cooperation, and discuss tasks for effectively promoting relevant innovations.

In tandem with government initiatives for pursuing carbon recycling, NEDO will help formulate the necessary roadmaps, host international conferences, and plan and facilitate related research and development.

Concept of carbon recycling



Source : Diagram created by NEDO based on the "Carbon Recycling Concept" paper prepared by the METI Carbon Recycling Office.

NEDO PROJECT 01

Ultimate solution for carbon recycling

Artificial photosynthesis

Artificial Photosynthesis Project

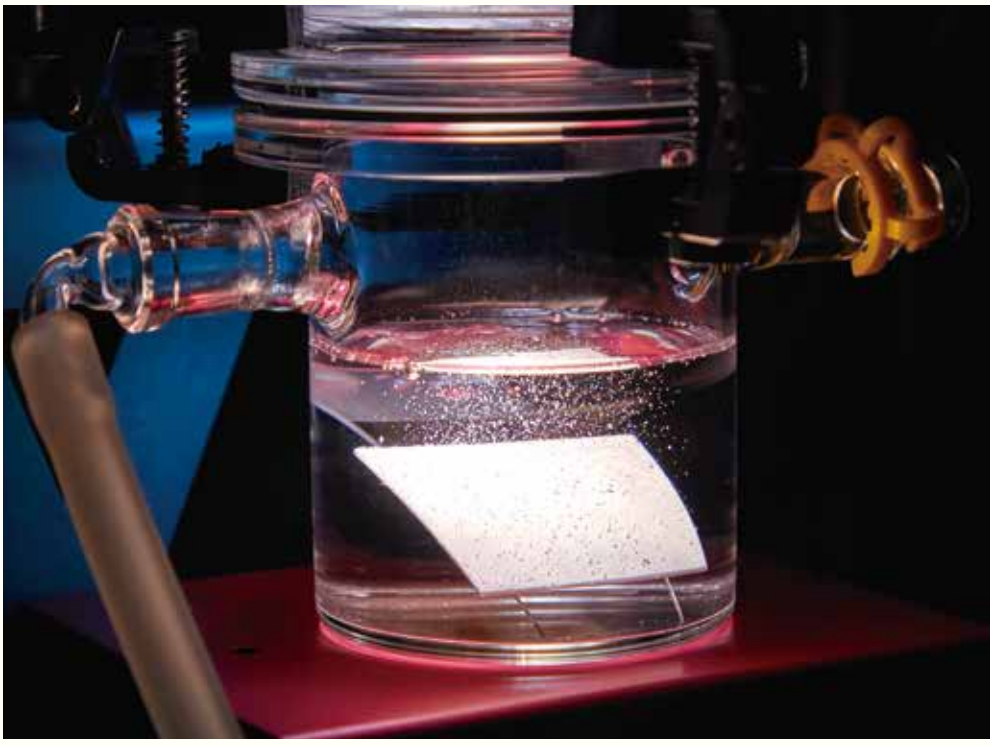
Japan leads the world in photocatalysis. Artificial photosynthesis realizes chemical production from carbon dioxide and water with photocatalysts. The NEDO has been conducting the project, which develops a key technology for carbon recycle society.

Paradigm shift in the chemical industry to use materials derived from CO_2 instead of fossil resources

The chemical industry provides materials for making essential products used in our daily lives. Indeed, the chemical industry plays a key role in supplying materials for all other industries. "The advanced Japanese chemical industry, in particular, is vital for manufacturing a wide range of internationally competitive products. Unfortunately, this key industry sources about 95 percent of its materials from naphtha and other fossil resources. Such dependency entails major problems. For instance, the industry is affected by the fluctuations in material prices and exchange rates. Worse still, it accounts for nearly 20 percent of industrial CO_2 emissions, the second largest share next to the steel and non-ferrous industry." This is how Mr.Yasushi Yamamoto, Project Coordinator in NEDO's Materials Technology and Nanotechnology Department, observes the situation as the manager of NEDO's project to develop processes for producing key chemicals with carbon dioxide (known as the Artificial Photosynthesis Project). The Japanese chemical industry must act proactively to ensure its survival and build a low-carbon society. Impending tasks include the diversification of materials away from fossil resources and reduction of CO_2 emissions.

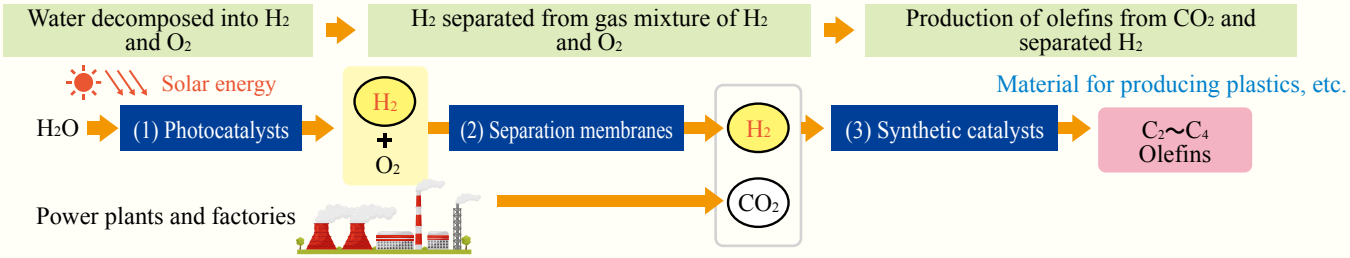
To address this issue, NEDO is carrying out the Artificial Photosynthesis Project to produce chemicals from water and carbon dioxide using solar energy.

Plants use sunlight to decompose water molecules and absorb carbon dioxide to produce organic materials like starch and glucose. The energy conversion efficiency of photosynthesis by plants is 0.3% at most. However, Japan Technological Research Association of Artificial Photosynthetic Chemical Process (ARPChem), an entity contracted to carry out this project, adapts this natural mechanism to artificial photosynthesis with a higher efficiency. More specifically, water is decomposed into hydrogen and oxygen with solar energy. Then, the hydrogen and carbon dioxide from power plants turn into olefins as raw materials for producing plastics and otherchemicals. If commercially applied, the artificial photosynthesis can make a significant contribution to slashing CO_2 emissions and producing chemicals with new materials without relying on fossil resources.



Hydrogen-oxygen production device equipped with photocatalyst sheet.
The sheet can enlarge the reaction surface area and reduce costs.

Framework of NEDO's Artificial Photosynthesis Project



Leading in the area of developing photocatalysis

In the Artificial Photosynthesis Project, we are working on three areas of research—namely, photocatalysts, separation membranes and synthetic catalysts.

The development of photocatalysts that can safely decompose water into hydrogen and oxygen is the most important part. Within FY2019, we are aiming to develop a photocatalyst that can achieve the solar energy efficiency of 7%. Dr. Tohru Setoyama, Executive Fellow of Setoyama Laboratory at Mitsubishi Chemical Corporation and the project leader, talks enthusiastically that "we will further improve the performance of the catalyst and achieve an efficiency of 10% by FY2021 for its practical application."

The development of separation membrane is proceeding for selective permeation of smaller hydrogen molecules from a gas mixture of hydrogen and oxygen from water decomposition. It is important to perform the explosive gas separation with membranes. In summer 2019, we plan to conduct field tests of water splitting with photocatalysts at a research facility run by the University of Tokyo in Ibaraki Prefecture. Practical application of artificial photosynthesis to address social challenges will be pursued by developing and exploring safe and durable modules.

Experimental equipment with hydrogen separation membranes

In the research field of synthetic catalysts, we established the world's first durable and efficient process to synthesize methanol from hydrogen and carbon dioxide. In addition, demonstration testing is underway with a pilot apparatus for synthesizing olefins from methanol with a synthetic zeolite catalyst, which highly performs under high temperatures and pressures.

This project involves many researchers from industry, universities and research institutes to effectively advance relevant basic technologies. Dr. Setoyama, the project leader, enthusiastically talks that "The project consists of academia, national institute and companies and they strongly collaborates." Mr. Hiroyuki Sato, Managing Director of ARPChem, says "the companies must fulfill their role to incubate and develop the potential of photocatalysts." NEDO will further sharpen Japan's leading edge in photocatalysis in pursuit of carbon recycle society.

Demonstration of durability of zeolite catalyst with small pilot apparatus for olefin synthesis

Yasushi Yamamoto (right)
Project Manager,
NEDO Artificial Photosynthesis Project,
Project Coordinator NEDO Materials Technology and Nanotechnology Department

Tohru Setoyama (middle)
Doctor of Engineering
Project Leader,
NEDO Artificial Photosynthesis Project,
Executive Fellow, Science & Innovation Center,
General Manager, Setoyama Laboratory
Mitsubishi Chemical Corporation

Hiroyuki Sato (left)
Managing Director, Japan Technological Research Association of Artificial Photosynthetic Chemical Process (ARPChem)

Photo taken in front of small plant for methanol synthesis.

NEDO PROJECT 02

Reduction of CO_2 emissions from thermal power generation

CO_2 Separation and Capture

Development of next-generation thermal power generation technologies/Demonstration of integrated coal gasification fuel cell combined power generation
Research, development, and demonstration of CCS/Research and development of CO_2 separation and capture technologies

Japan must curb CO_2 emissions produced by thermal power generation, whose share is rising to supply base-load power. To this end, NEDO engages in the development of CO_2 separation and capture technologies.

Demonstration plant for oxygen-blown IGCC

Cutting CO_2 emissions produced by thermal power generation

Thermal power generation supplies 70% of electricity demand in Japan. Coal is used as a cheap and reliable power source. However, coal generates a large amount of CO_2, which causes the greenhouse effect.

To resolve this issue, NEDO is conducting the Osaki CoolGen Project with the aim of improving the efficiency of coal-fired thermal power generation as well as pursuing the capture of carbon emissions.

In FY2018, a demonstration test for oxygen-blown integrated gasification combined cycle (IGCC) was completed which utilized coal gasification with oxygen and power generation with a gas turbine and a steam turbine. As the next step, a demonstration test for CO_2 captured IGCC is now underway with physical absorption method to separate CO_2 from the high-pressure coal-derived fuel gas before its combustion in the gas turbine. Physical absorption is expected to reduce the cost of capturing with less energy required compared to chemical absorption for CO_2 separation from the exhaust gas after the combustion.

Development of technologies to reduce costs associated with capturing CO_2

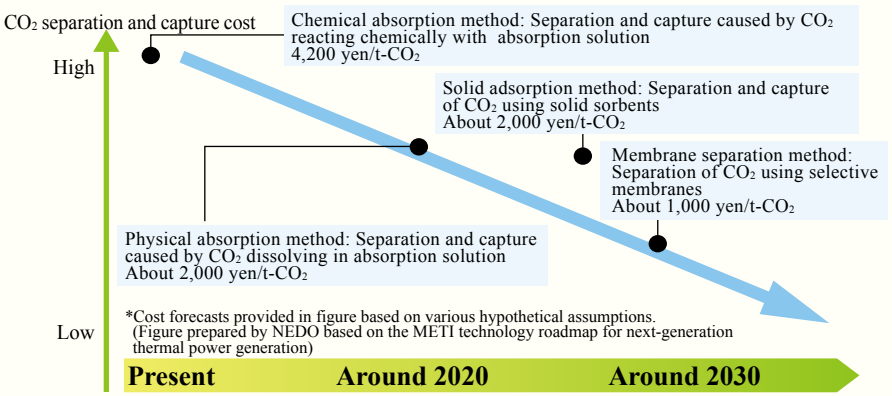
NEDO continues to develop new technologies aimed at further reducing the costs associated with capturing CO_2. Makoto Nunokawa, a director in NEDO's Environment Department, explains that "A large amount of energy is required to recover CO_2 from liquid absorption, so the discovery of a method that does not rely on liquid absorbents would offer a breakthrough."

Presently, the project is exploring the use of solid sorbents and selective membranes for CO_2 separation and capture. A bench-scale demonstration of the solid adsorption method is being conducted with a solid sorbent developed to separate the CO_2 from the exhaust gas after the combustion. Also, applicability tests of the membrane separation method are being carried out using a CO_2 permeable membrane to separate the CO_2 from a fuel gas made by coal gasification.

"The most significant innovation here is the use of solid sorbents and selective membranes. Japanese technological prowess shines bright with both of these outstanding materials," explains Nunokawa. NEDO continues to develop and establish new CO_2 separation and capture technologies such as these with a view to applying them in thermal power generation.

Makoto Nunokawa
Project Manager, NEDO Project on Research, Development and Demonstration of CCS Technology
Director, Clean Coal Group, Environment Department

Prospects for development of CO_2 separation and capture technologies



NEDO PROJECT 03

Turning CO_2 into fuel

Methanation

Development of next-generation thermal power generation technologies/Development of basic technologies for next-generation thermal power generation/ Development of CO_2 utilization technology project

Methanation from CO_2 is being considered as an economically viable and promising CCU technology to curb climate change. Methane holds great potential as an energy carrier.

CO_2 methanation testing facility currently under construction

Production of methane from CO_2 and hydrogen as new alternative source of energy

Methanation refers to the synthesis of methane from CO_2 and hydrogen. Since FY2017, NEDO has been researching technologies for synthesizing methane while making effective use of CO_2.

Takeshi Murakami, a chief officer of NEDO's Environment Department, explains why NEDO focused on methane. "Profits generated from turning CO_2 into fuels, chemical feedstock and other valuable materials provide an incentive for reducing CO_2 emissions. Because carbon dioxide can be effectively converted into large amounts of methane, this is one of the most promising options considering the feasibility and spillover effects."

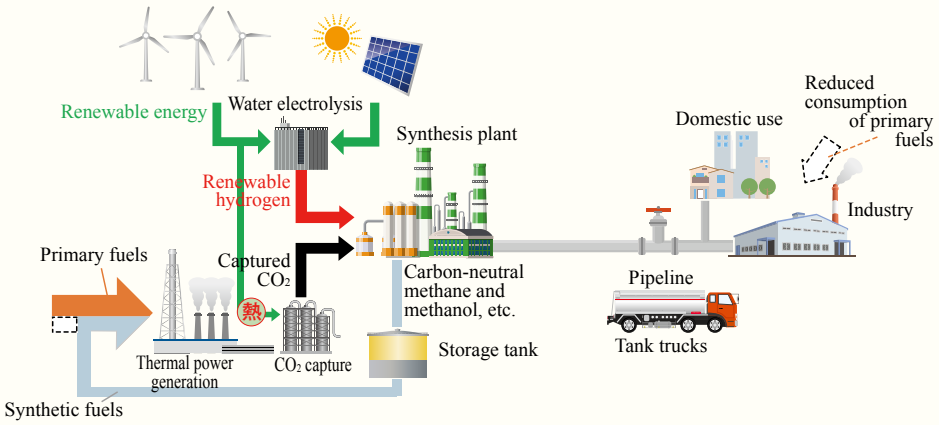
Methane, the main component of natural gas, holds great potential as an energy carrier. Existing infrastructure for natural gas can be directly employed for carrying methane without any need to construct new infrastructure. According to one estimate, Japan's CO_2 emissions can be slashed by almost 20 percent if imported natural gas is replaced with methane produced with renewable energy (carbon-neutral methane).

Demonstration begins in Niigata with a view to commercialization in the 2030s

NEDO aims to commercialize methanation in the 2030s. Toward this end, technology is being developed to devise and evaluate the process for producing methane with CO_2 collected from thermal power plants. In July 2019, NEDO will begin bench-scale testing at the Koshijihara Plant in the Nagaoka Gas Field of Niigata Prefecture, where INPEX produces natural gas.

Murakami forcefully explains, "Today, shell-and-tube reactors are mainly employed for methanation. The project carried out by NEDO employs a methanation unit with a plate reactor that demonstrates highly efficient heat recovery. In this project, the world's first bench-scale testing of methanation with a real gas, we are exploring technologies and systems that can gain acceptance in society and the marketplace."

Conversion of CO_2 into a resource is a huge step forward toward a sustainable circular society. It also helps ensure reliable access to new resources. NEDO continues to explore ways to effectively employ the technology to address social challenges.



Reduction of CO_2 by substituting natural gas with carbon-neutral methane

Takeshi Murakami

Project Manager, NEDO Project for Development of CO_2 Utilization Technology
Chief Officer, Clean Coal Group, Environment Department

Technology Strategy Center Assesses the Prospects for Technological Development

The NEDO Technology Strategy Center (TSC) conducts surveys and analysis of domestic and international trends in energy, environmental, and industrial technologies and formulates technology strategies. Here, we introduce some of the TSC's future policies and new prospects.

Interview with the Executive Director

The future of the TSC following its fifth anniversary

In April 2019, Mr. Yoshinao Mishima became executive director of the NEDO Technology Strategy Center (TSC). We asked him about his aspirations on assuming office and his vision for the future based on his experience to date.

Yoshinao Mishima

Executive Director, Technology Strategy Center (TSC)

1949: Born in Tokyo, Japan, in 1949.
1973: Graduated from the School of Engineering at the Tokyo Institute of Technology (Tokyo Tech).
1975: Completed a master's degree at the Graduate School of Science and Engineering at Tokyo Tech. After that, earned a Ph.D. from the Department of Materials Science and Engineering at the University of California, Berkeley.
1997: After working as an assistant research engineer, became a full professor at the Department of Materials Science and Engineering in the Interdisciplinary Graduate School of Science and Engineering at Tokyo Tech.
2012: Served as executive vice president (for education and international affairs), and then president of Tokyo Tech.
2019: Became executive director of the NEDO Technology Strategy Center (TSC) in April.

Considering technology development strategically to create a better society

Q: You became executive director of the NEDO Technology Strategy Center (TSC) in April. What were your thoughts on assuming office?

Mishima: I think two things are required in terms of industrial technologies: to create a better society and to further strengthen Japan's industrial competitiveness. Japan has the power to lead the world in several technology fields, but it is also important in today's rapidly changing society for Japanese industry to find and develop its own areas of specialty. At the same time, I think that the TSC's activities for formulating technology strategies are also extremely important in contributing to world peace and the development of a safe and secure society.

I specialize in research related to the strong structural materials required for bridges, ships, and aircraft. I have spent a long time in the academic world, and this theme is directly linked to the industrial world. Therefore, I look forward to the TSC providing a platform for exchanging opinions between the industrial world and the academic world, including universities and research institutions.

Q: With the TSC having marked its fifth anniversary, can you tell us a little about its current operations and systems?

Mishima: The TSC is committed to six missions. While taking on board the spirit of these missions, I feel that it is particularly important to map out the future of technologies from a broader perspective by collecting technical information on a daily basis based on a wider vision from both domestic and foreign sources and to revise our technology strategies continuously by identifying rapid changes in society. Given this, we need to build a team that transcends the boundaries of traditional fields. It is also important to check the significance of each industrial technology by promoting communication between people with science and engineering backgrounds as well as those involved in the fields of economics, international relations, and the arts.

In addition, the TSC has seven units for various technology fields. These units not only develop advanced and precise technology strategies individually, but also communicate with each other in the process of formulating cross-unit technology strategies. I think sharing information between different units will enable us to integrate different fields successfully.

Q: What role is the TSC expected to fulfill?

Mishima: NEDO tends to be seen as just a funding agency. However, under the R&D and Innovation Subcommittee established by the Ministry of Economy, Trade and Industry (METI) to study and deliberate on important matters related to economic and industrial development, the TSC is required to

TSC's Six Missions

1. Conducting surveys and analysis of domestic and international technology trends
2. Formulating technology strategies in key fields
3. Planning and designing strategy-based NEDO projects
4. Developing and improving management methods for cross-sectoral technology development and relevant tools, including databasesDeveloping and improving methods for cross-sectoral project management
5. Fostering human resources capable of project management
6. Increasing the awareness of technology development strategies in society by appropriately disseminating relevant information

TSC's Target Fields

discover innovative new technologies, thereby strengthening its technological intelligence capabilities.

How should technologies be used to create a better society? How should we formulate the necessary strategies and reflect them in our policies? The TSC is expected to play a role in deliberating on what is important for Japan, producing technology strategies, and providing the necessary evidence and knowledge to formulate policies. To this end, I would like to continue holding discussions with personnel from ministries such as METI and private companies, discover new innovative technologies from a broad perspective, and deliver the technologies required by society.

Responding to social changes quickly and meticulously from a global perspective

Q: How does the TSC examine technology strategies with a view to addressing social challenges?

Mishima: Recently, the Sustainable Development Goals (SDGs) have been attracting a great deal of attention. Many researchers hope that their developmental achievements will be useful to the world. Generally, research seeds tend to be discussed in terms of whether they are lagging behind or advancing compared to other countries, but it is also important to examine state-of-the-art technologies from the perspective of whether they can actually help to overcome challenges. I feel that it is important to put social challenges ahead of technologies in the development of technology strategies.

Two methods can be used to identify technical challenges: forecasting and backcasting. While the former explores how to utilize current technological seeds, the latter identifies technical themes by taking social needs as the starting point to envisage a future society and policies. Using different approaches based on both of these methods, the TSC is committed to identifying social challenges and developing technology strategies that are truly required by society while also including the integration of different fields.

Q: In the midst of a globalization of economic activities, what is the TSC doing to develop technology strategies?

Mishima: To implement technologies that are truly useful and required by society, we must firmly hold onto the value created by technologies as part of the country's strengths and not just regard the development of good technologies as a goal. Given this, standardization and intellectual property strategies are extremely important.

We need to continuously observe the strategies established by Japanese companies on their own from the perspective of completely different values from those held in Japan, such as how these strategies look to the rest of the world, how they are positioned globally, and if there is anything that has been overlooked. Therefore, collecting information on overseas technology trends will become increasingly important going forward. Centering on the Global Technology ResearchOverseas Technology Information Unit established in April 2018, we are proactively collaborating with the relevant organizations in various countries to exchange opinions.

Q: How do you see the TSC's prospects for the future?

Mishima: To develop technology strategies, we need to take sufficient time while also identifying rapid changes in society and responding to them quickly. In other words, we need to be both quick and meticulous in developing strategies. To address these matters fully, we need to be sensitive to changes and continuously monitor them.

In addition, it is important that, rather than just collecting information, we also disseminate the knowledge that we acquire through our information collection activities. We will endeavor to refine the functions that the TSC has built up over the past five years to gain even wider recognition.

Technology Strategy Center Assesses the Prospects for Technological Development

Developing Technology Strategies for the Future

The NEDO Technology Strategy Center (TSC) has been conducting extensive surveys on social needs, challenges, and recommendations presented by various institutions, companies, and universities both in Japan and overseas while also identifying important technology fields and taking these social challenges as the starting point to explore technology fields that can provide new solutions.

Advancement of the Backcasting Method

To identify important technology fields, you need not only a technology-based starting point but also an approach that is based on social challenges or an ideal future image. However, this approach gives rise to problems such as abstract discussions and the difficulty involved in incorporating potential innovations that have obscure relationships with social challenges.

Therefore, the TSC has incorporated a concept that it calls "transdisciplinary collaboration," which promotes the integration of different fields that have attracted attention in recent years, and a method called "horizon scanning," which offers insights into the future by overviewing and exploring information with regard to technology and various other fields to realize ideal future images and create new cross-sector players.

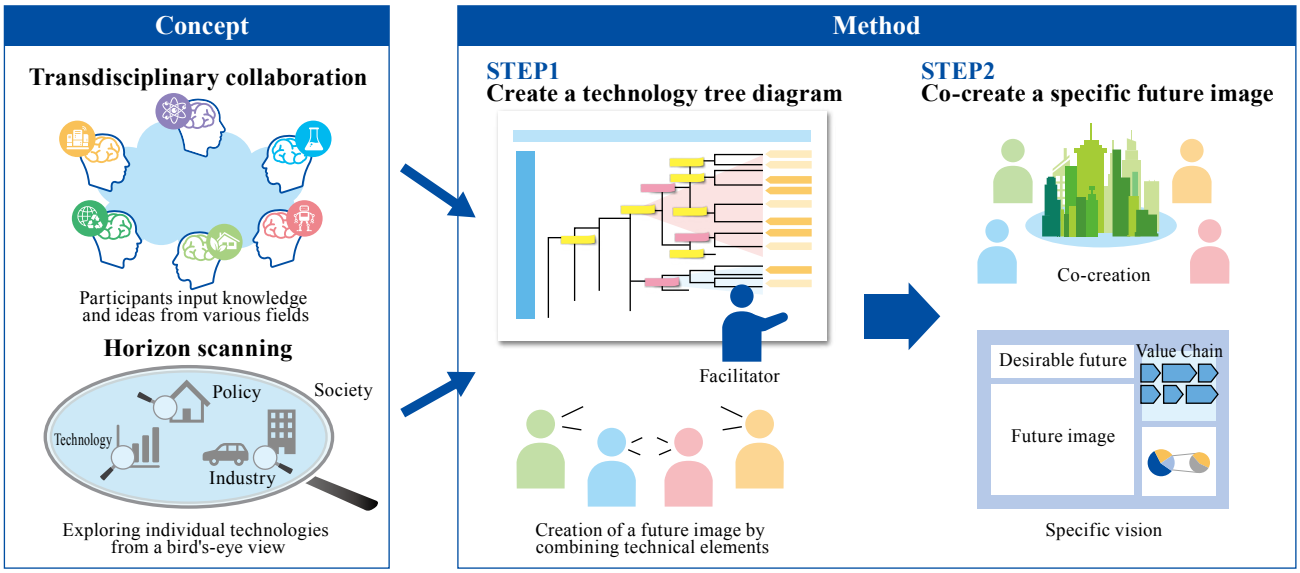
More specifically, participants with different fields of expertise collaborate to create a TSC-unique technology tree diagram, taking social challenges issues as the starting point. By holding discussions based on this tree diagram, they then create new ideas that they would have been unable to come up with on their own.

NEDO will leverage these programs to continue creating innovation seeds without being bound by conventional ideas.

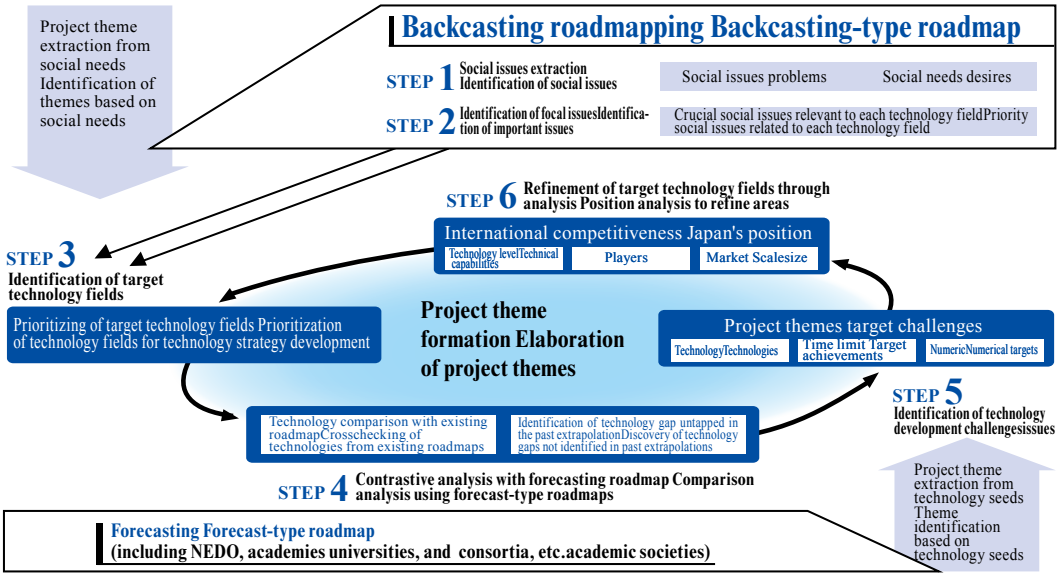
Discussions leading to idea creation

* Scan the website QR code on the right to download the technology tree diagram that was created in this program based on social challenges as the starting point.

Program for Creating Ideas by Using a Technology Tree Diagram Created Based on Social Challenges as the Starting Point



Process for the Development of Project Themes



Publication of TSC Foresight

To increase awareness of technology strategies within society, the TSC publishes TSC Foresight, which describes research and development trends and analysis results from both Japan and overseas that have been obtained by creating technology strategies for each field. At the time of publication, the TSC Foresight Seminar is held so that presentations and panel discussions involving field experts can be conducted to address the latest research and development trends and the direction of technology development. To view the materials used in the TSC Foresight Seminar, please visit our website.

TSC Foresight: List of Past Publications

Electronic, Information and Machinery Mechanical Systems

- Computing, Electron Devices and Materials
- Power Laser
- IoT Software
- Hardware for artificial intelligenceHardware Supporting AI

Nanotechnology and Materials

- Nanocarbon Materials
- Functional Materials
- Self-assembly and Self-organization for Material Manufacturing
- Structural Materials
- Instruments for Measurement and Analysis
- Metal Additive Manufacturing Metal Laminate Molding Process

Energy Systems and Hydrogen

- Hydrogen Energy
- Superconductivity
- Automotive Rechargeable Battery
- Energy Systems with Super-distributed Energy Resources and Demands(Integration Study)
- Energy Storage

Renewable Energy

- Geothermal Power Generation
- Photovoltaics
- Next-generation Biofuels (biojet fuels)
- Wind-power Generation
- Ocean Energy

Environment and Green Chemistry

- Global Warming Solution (HFC)
- Metal Recycling
- Chemicals Manufacturing Process
- Chemicals Production from Biomass Resources
- Continuous flow manufacturing processes for fine chemicalsFunctional Chemicals Manufacturing Process

New Technology Frontier and Multi-disciplinary Fields (Robotics & AI)

- Advanced Robotics (2.0 Area)
- Artificial Intelligence
- Unmanned Aircraft Systems (UAS)
- Artificial Intelligence in Food Industry
- Artificial Intelligence in Robotics

New Technology Frontier and Multi-disciplinary Fields (Biotechnology)

- Advanced Technologies in Biomanufacturing of Chemicals
- Novel Devices that Use Biological Functions (Living Devices)
- Utilization and control of microbiome Use and Control of Microorganisms

Reports from the Field

In this section, we report on events and opinions from the field that we could not cover in news releases, such as the latest technological development results, unprecedented demonstration projects, and new projects to be launched.

Featured News Release *pick up!*

NEDO and Kawasaki City Establish a New Entrepreneur Support Facility Called K-NIC in March 2019

K-NIC opening ceremony held on March 18, 2019

https://www.nedo.go.jp/english/whatsnew_00132.html

On March 18, 2019, NEDO and Kawasaki City established a facility called the Kawasaki-NEDO Innovation Center, or K-NIC, to support startups from discovery through to growth.

Jointly established by NEDO and Kawasaki City, K-NIC is aimed at providing a comprehensive service that combines NEDO's support for research and development-based startups and Kawasaki City's support for entrepreneurs.

This center aggregates a variety of functions, including consultation desks staffed by experienced entrepreneurs, investors, and specialists in intellectual property, marketing, and other such fields. It also provides consultation desks for various support projects run by NEDO and Kawasaki City, pitch events, and exchange opportunities. By building a virtuous cycle system for creating a stream of startups, K-NIC is expected to stimulate the economy and expand employment through the creation of innovation.

K-NIC (Facility Overview)

Name: Kawasaki-NEDO Innovation Center (K-NIC)
Location: MUZA Kawasaki Central Tower 5F, 1310 Omiya-cho, Saiwai-ku, Kawasaki-shi, Kanagawa, Japan
Business hours: 13:00–21:00 (last entry at 20:00)
Non-business days: Saturdays, Sundays, national holidays, and new-year and year-end holidays
* However, the center is open if an event is being held.
Targets: Research and development-based entrepreneurs and startups (mainly beginning-stage startups that are just about to or have just finished starting up) as well as entrepreneurs in a wide range of industries (ICT, social, etc.)
Founding organizations: NEDO and Kawasaki City
Operating organizations: NEDO, Kawasaki City, and Kawasaki Institute of Industrial Promotion
Support details: (1) Provides startup consultations, (2) holds events and seminars, and (3) provides co-working spaces

K-NIC can be used by a variety of people, including those wanting to start a new business and interact with other entrepreneurs (business companies, financial institutions, investors, etc.). For more information on matters such as usage of the facility, consultation sessions, and seminars, please contact the center at the following site: https://k-nic.jp.

Kawasaki-NEDO INNOVATION CENTER

Field Watch Report

NEDO NEWS

Accelerating support for startup companies
K-NIC opening ceremony

(1) Ribbon-cutting at the K-NIC opening ceremony
(2) NEDO Chairman Hiroaki Ishizuka delivering a speech
(3) Kawasaki City Mayor Norihiko Fukuda delivering a speech
(4)(5) Kawasaki Model Intellectual Property Matching Session (seeds-needs matching exchange)
(6) K-NIC Pitch Session for research and development-based startups based in Kawasaki as well as other startups that have previously participated in NEDO support programs

Held on March 18, 2019, the K-NIC opening ceremony was attended by a wide variety of guests, including NEDO Chairman Hiroaki Ishizuka and Kawasaki City Mayor Norihiko Fukuda (as representatives of the founding and operating organizations) and Atsushi Miura, a director from the Kawasaki Institute of Industrial Promotion (which also serves as an operating partner together with NEDO and Kawasaki City). To open the K-NIC facility, a ribbon cutting ceremony was performed at the beginning.

In his speech, Mr. Ishizuka expressed his hope that K-NIC would make Kawasaki City a hub for entrepreneurs and open innovation and, together with NEDO, contribute to the creation of innovation and the strengthening of Japan's industrial competitiveness. Mayor Fukuda commented, "Kawasaki is a rare city that has as many as 400 public and private research and development institutions, including small, medium-sized and large-scale enterprises. We want to create new things in Kawasaki by bringing together the collective wisdom of everyone there."

After the opening ceremony, events such as the Kawasaki Model Intellectual Property Matching Session (a seeds-needs matching exchange) were held, one of the activities of an on-site visit support system called the Kawasaki Model, which links the open patents held by large-scale companies and research institutes to the product development of small and medium-sized enterprises and entrepreneurs in cooperation with Kawasaki City, the Kawasaki Institute of Industrial Promotion, financial institutions, and other organizations. A K-NIC Pitch Session involving research and development-based startups based in Kawasaki as well as other startups that have previously participated in NEDO support programs was also held.

Going forward, K-NIC will provide various support services, including advice from experts from a variety of fields, pitch events for investors, and exchange programs for members, with a view to assisting entrepreneurs who want to commercialize their unique technologies in growth fields as well as startups who are entering new fields. We want a wide range of players—including aspiring business people, established companies, investors, and people who want to interact with entrepreneurs—to use K-NIC and accelerate open innovation together with all of our partners.

Kawasaki Model
http://www.city.kawasaki.jp/280/page/0000017805.html

NEDO R&D Venture Support Program
https://www.nedo.go.jp/activities/ZZJP2_100063.html

Startup Support and Beyond
The Future for NEDO Startups

NEDO Startups Future

Innovator File.1

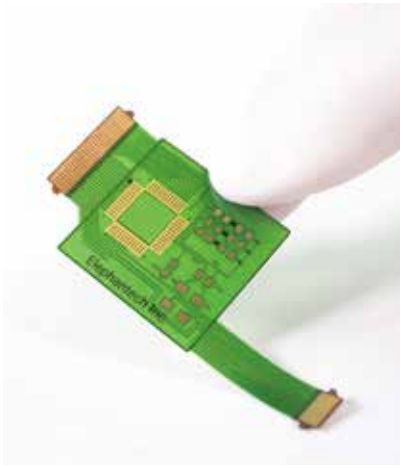
Elephantech Inc.

Shinya Shimizu, CEO

Manufactures and sells P-Flex™, a single-face flex PCB that is manufactured using inkjet printing technology and copper plating.

2014: Founded AgIC Inc. (predecessor) and won the top award at the Microsoft Innovation Awards 2014.
2016: Selected as a NEDO Seed-stage Technology-based Startup (STS).
2017: Changed its corporate name to Elephantech Inc. and raised funds of about 500 million yen.
https://www.elephantech.co.jp/en/

J-Startup



Q1. How do you use NEDO's support program?

Elephantech applied to NEDO's STS Program to commercialize its novel technology for manufacturing electronic circuits using inkjet printing. This technology reduces the amount of water and energy required in the manufacture of electronic circuits by 90%, which in turn dramatically reduces the costs. From the very beginning, we believed that it would have a huge impact if it could be successfully put to practical use.

However, no matter how great the potential, the development of a new underlying technology usually requires time and money. The problem we faced was that even if we solicited investments, the funds would be exhausted before the development milestones had been achieved, thereby making the next round of fund raising more difficult. Under these circumstances, NEDO's STS Program granted us a subsidy together with investments from venture capital firms, which allowed us to advance the development of our technology to the stage where we could acquire customers and launch a sample production. As a result, we were able to raise funds in excess of 500 million yen.

The development of an underlying technology that can revolutionize the world takes time, and it is hard to know whether it will be accepted by customers. Given this, I think it is important to promote customer acquisition and research and development in parallel and to advance the project stage in terms of both technology and marketing.

Q2. What is Elephantech's vision for the future?

We have advanced our product development and customer development, experimented with the adoption of mass production, and acquired multiple customers who want us to bring our product to mass production. As a result, we are working to raise more than 1 billion yen and build a mass-production line. With our current manufacturing technology as the core, we aim to introduce our printing methods in all areas with environmentally friendly ones by printing on 3D resin and using biomaterials.

We hope that those projects that have a high social impact, such as those related to resource saving and energy saving, will grow to form a number of long-term initiatives that, rather than seeking short-term profits, promote national technological competitiveness replace by raising capital through funds but also by utilizing the support offered by public institutions such as NEDO.

Equipment maintenance being conducted by employees

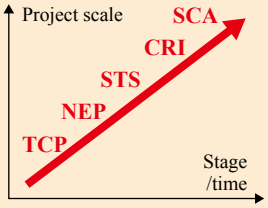
Comment from a NEDO Employee

Elephantech entered an existing market armed with a core technology that enables dramatic cost reductions. As it continues to grow steadily in a diversified small-lot production market by leveraging its technological advantages, this company is a role model that can show the way forward for Japanese manufacturing.

NEDO's Seamless Startup Support Services for R&D Related to Mining and Industrial Technologies Search in NEDO Venture Support

https://www.nedo.go.jp/activities/ZZJP2_100063.html

The program used by the startups described in this article



TCP Technology Commercialization Program

Support program for entrepreneurs originating from universities, research institutes, and startup companies

To revitalize the economy, it is important to foster entrepreneurs that have competitive new technologies. NEDO provides start-up support from a variety of perspectives to develop research and development-based startups and entrepreneurs. Here, we examine a notable start-up company that continues to grow toward the future.

J-Startup is a project that is aimed at incubating internationally competitive startups in Japan and sharing groundbreaking innovations with the world. J-Startup concentrates both public and private resources to provide intensive support for companies selected as J-Startup companies, thereby creating successful models. NEDO serves as the secretariat for this project together with METI and JETRO.

Innovator File.2

Triple W Japan Inc.

Atsushi Nakanishi, CEO

Planning, development, and sales of DFree, a wearable device that predicts urination timing and sends notifications to the user's smartphone or tablet.

2015: Founded Triple W Japan after starting its US operations in 2014.
2016: Selected as a NEDO Seed-stage Technology-based Startup (STS).
2017: Selected as a NEDO Startups in Corporate Alliance (SCA).
2019: Started sales of, DFree Personal, a service for individuals, at consumer electronics retailers in Japan.
https://www-biz.co/en/

J-Startup

Q1. How do you use NEDO's support programs?

We used NEDO's R&D support program to commercialize our technology of determining the size of a person's bladder using an ultrasonic sensor for nursing homes and for individuals. Specifically, we used subsidies from the development of the sensor technology and infrastructure through to the conducting of field trials at nursing homes and other facilities. While there are few venture capital firms that are willing to take a risk before the completion and commercialization of a product, I feel that the success rate of research and development-based startups will increase with the help of these support programs.

Q2. What is Triple W Japan's vision for the future?

We continue to improve our commercialized products. We will improve public awareness and recognition of our products through PR and marketing activities while also expanding the target scope of our customers, including those who are not targeted by our current products. In addition to excretion, we are also under research and development of future products that can determine people's health conditions and signs of illness by using ultrasonic sensors to detect changes in their organs. If there are simiar support programs that can be used before the completion of the product, I would like to use them to stimulate our business growth.

Received certification for Kawasaki Innovation Standard (KIS) Premium in March 2019.

Winner of four CES awards, including Best of CES 2019

The app indicates how full the bladder is and sends notification to the user's smartphone when its time to go to the toilet.

Comment from a NEDO Employee

When the adult diaper market surpassed the baby diaper market, Triple W Japan seized a business opportunity and launched a new business. Since then, it has cultivated the market from scratch by thoroughly investigating the market needs at welfare and nursing care facilities. Triple W Japan has stepped up to become a true role model for successful new market creation.

NEP NEDO Entrepreneurs Program

Startup support provided by escort-type support personnel

STS Seed-stage Technology -based Startups

Support for Seed-stage Technology-based Startups (STS)
Supporting seed-stage startups in collaboration with venture capital firms

CRI Collaboration with Research Institute

Support for Collaboration with Research Institutes (CRI)
Supporting research and development-based startups to facilitate the development of commercial applications

SCA Startups in Corporate Alliance

Support for Startups in Corporate Alliance (SCA)
Supporting research and development-based startups that carry out joint research with project companies

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