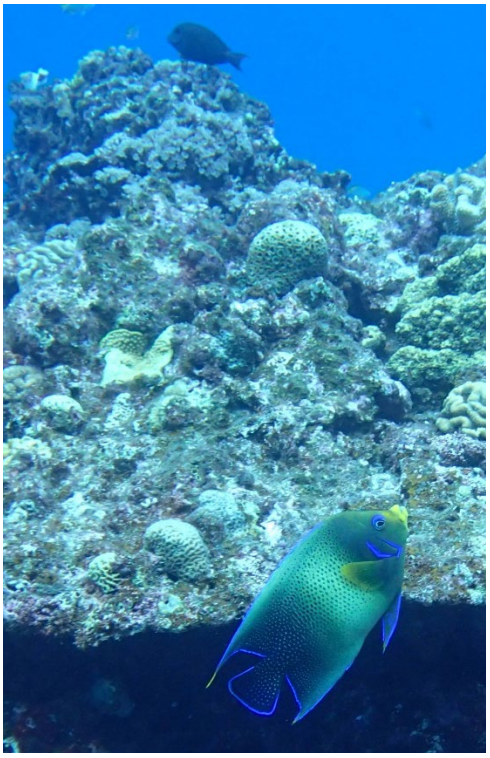
Tokyo Institute of Technology

Environmental Report 2021 Digest Version



Tokyo Institute of Technology

Contents

Tokyo Tech is actively working on Sustainable Development Goals (SDGs).

Team Tokyo Tech: The Painters of the Future

Kazuya Masu
President, Tokyo Institute of Technology

The impact that the ongoing worldwide COVID-19 pandemic that began in 2020 has had on human society has been far greater than we could have imagined. A new and different way of life, referred to by some as the "new normal," is taking shape. That clearly differs from the way we once lived our lives. By working together as a university to face the post-COVID future, Tokyo Tech will take measures to ensure the safe and smooth conduct of university education and research activities and contribute to the betterment of society.

Tokyo Tech, which aims to be one of the world's leading universities in science and technology, was designated by the minister of Education, Culture, Sports, Science and Technology as a Designated National University Corporation in March 2018. Given this status, we have a crucial duty to pioneer a new era through continuous dialogue with society and the discovery of hidden possibilities in science and technology.

We established the Tokyo Tech Academy of Energy and Informatics as a new initiative to fulfill that duty. This organization's goal is to guide us all to a more sustainable, human-centered energy society freed from usage constraints such as energy costs and CO_2 emissions through wise use of technologies such as AI analyses of big data. The Tokyo Tech Academy of Energy and Informatics program is designed to develop Multi-Scope· Energy WISE professionals — individuals who have mastered multidisciplinary energy science and will transform and design this new energy society using big data science and their social design skills.

Through this and other initiatives, Tokyo Tech seeks to contribute to society by producing individuals who possess advanced knowledge and skills as well as an understanding and respect for diversity. In addition to cultivating such talented people, we will provide society with excellent research results. We will also strive to solve global issues such as environment-related energy problems and to realize a more prosperous future society. In these and other ways, we will fulfill our mission and duty as an educational and research institution.

In this report, we have summarized our environmental safety and health activities for FY2020 in relation to the international Sustainable Development Goals (SDGs), focusing on environmental performance in accordance with the environmental reporting guidelines of the Ministry of Environment.

We hope you read this report and continue to support the university's activities.

September 2021

Tokyo Institute of Technology Environmental Policy

Enacted January 13, 2006

Basic Principle

As we strive to become the world's best science and engineering university, Tokyo Institute of Technology recognizes that environmental problems are not just issues for certain regions. They are major challenges on a global scale that pose an existential threat to all of humanity. To ensure that future generations have a viable global environment, Tokyo Tech will contribute to the creation of a sustainable society as it fulfills its mission as a research and education institute.

Basic Policies

In accordance with the basic principle "To share the global environment with future generations," Tokyo Tech will deal with the various problems facing the environment, based on the following policies, to create a twenty-first century civilization in which the earth and humanity coexist harmoniously.

Research Activities

We will further promote scientific and technological research that contributes to the creation of a sustainable society.

Talent Development

To foster the creation of a sustainable society, we will develop talented individuals with high environmental awareness, a rich knowledge base, and the potential to become leaders in various fields.

Social Contribution

We will contribute to Japan and the world through our research activities and talent development.

Environmental Management System

We will create an advanced environmental management system suitable for a world-leading science and engineering university, implement it effectively, and strive to continually improve it.

Reduce Our Environmental Footprint

We will establish environmental goals, develop plans based on those goals, and execute those plans to minimize our impact on the environment.

Promote Environmental Awareness

We will conduct environmental education and awareness-building activities that target every student and university employee, including executives, to increase their understanding of Tokyo Tech's environmental policies, etc. and the environmental awareness of everyone associated with the university.

Kusatsu-Shirane Volcanic Observatory
~ Volcanic Research and Social Contribution ~

Associate Professor (Lecturer) Akihiko Terada
Volcanic Fluid Research Center, School of Science

Japan has 111 active volcanoes, and the nation has experienced repeated disasters resulting from their eruptions. Tokyo Tech established a volcano observatory in 1986 in Kusatsu Town, Gunma Prefecture, a place famous for its hot springs. Faculty members stationed there to conduct observations and research on Mount Kusatsu-Shirane.

Tokyo Tech started observational research on Mount Kusatsu-Shirane around 1960. Our university has been participating the National Project for Prediction of Volcanic Eruptions to investigate volcanic activity all over Japan since 1974. When Mount Kusatsu-Shirane erupted in 1976, we detected signs of the eruption based on the results of volcanic gas observations, as a result, we issued a warning before the eruption. Based on these research results, Kusatsu-Shirane Volcanic Observatory (KSVO) was established. Since then, KSVO had grown its ranks of faculty members, advanced the construction of an advanced volcano observation system. In 2000, KSVO was reorganized to the Volcanic Fluid Research Center.

Mount Kusatsu-Shirane in early winter. The crater lake in the center is called Yukama. In the background is Mount Motoshirane, which erupted in 2018. Even further away is Mount Asama.

The term “volcanic fluids” collectively refers to the groundwater, hot spring water, volcanic gases and magma that flow in the shallow underground. These fluids are sometimes the source of the mechanical energy that drives eruptions. They also provide a variety of information to tell us what’s happening underground during periods of quiescence. Our center’s mission is to carefully decipher the information conveyed through the activities of volcanic fluids to advance the modeling of volcanic phenomena from various perspectives beyond the boundaries of physics and chemistry.

A drone collecting data and sample flying over Mount Kusatsu-Shirane

The center conducts continuous 24-hour multifaceted observations of earthquakes, crustal deformation and other items. The data we obtain is immediately transmitted to the Japan Meteorological Agency and other organizations for volcano monitoring. We also dispatch members to offer their expertise to the Kusatsu-Shirane Disaster Prevention Council (Kusatsu Town) and the Coordinating Committee for Prediction of Volcanic Eruption (Japan Meteorological Agency) with the hope that they can use our research results to mitigate disasters.

We were unable to provide advance warning to the public before the phreatic eruption at Mount Kusatsu-Shirane (Mount Motoshirane) in 2018. To study the process of phreatic eruptions — which are hard to predict — we have greatly revised our observation system. As a result, we built a new observation system that covers a wider area and deeper underground. We also introduced drones to enable remote observation and sample collection of volcanic gases, establishing them as an advanced volcanic observation tool. This has made it possible to conduct observations safely and quickly even during eruptions.

One of our new initiatives involves conducting basic research on how to detect the signs of eruptions from minute samples of the soil gases (such as nitrogen, carbon dioxide and oxygen) that permeate the ground. We are also considering the application of distributed temperature sensing technology — which uses buried fiberoptic cables as thermometers — to observe volcanoes. In this way, our goals is to both understand volcanic phenomena and improve volcano monitoring technology.

Volcanic Fluid Research Center, School of Science
Dr. Akihiko Terada, Associate Professor（Lecturer）

Q1: When was your first experience with research, and what was it like?

A1: My first research project was my graduation thesis. I determined the epicenter of the earthquakes occurring beneath Mount Fuji as well as of a special type called a low-frequency earthquake, which is directly related to magma. I was impressed that even seemingly complex phenomena follow simple physical laws.

Q2. What is the ultimate goal of your research? What you want to know most?

A2: I'm interested in volcanic eruptions, especially phreatic ones. I want to explain what triggers phreatic eruptions over the life of a volcano — which is measured in tens of thousands of years — and show whether we can predict them based on observational data.

Q3: How do you stay motivated in your research?

A3: I love studying volcanic phenomena, so I'm always motivated. I also try to get plenty of sleep, and to make plans that include specific goals and schedules so that I can monitor my research progress. This is harder than it sounds!

Q4: What are your aspirations for the environment and SDGs?

A4: There is a need for volcanic research data, particularly when volcanic activity increases, so I've always been aware of the connection and responsibility my research has related to society. I think it is the same for people researching environmental issues. I hope to broaden my perspective through these research activities.

Message to Students

As university students, you will likely have to attend courses on topics you are not really interested in. As a lecturer, I'd like to stress that these can actually be very valuable opportunities because you never know what will be useful later on. It's a good idea to learn everything you can as a student, even if it seems troublesome.

Volcanic Fluid Research Center: http://www.ksvo.titech.ac.jp/jpn/ (Japanese)

Researches on Next-Generation CO_2 Capture and Utilization Technologies ~Towards the Realization of Sustainable Carbon Neutral Cycle ~

Associate Professor Takuya Harada
Department of Chemical Science and Engineering
School of Materials and Chemical Technology

In recent years, people have become increasingly aware of the serious environmental issues that humanity faces — global warming.

An international treaty known as the Paris Agreement was adopted in 2015 with the goal of limiting global average temperature increases to below 2.0 degrees Celsius, and preferably to 1.5 degrees, for the mitigation of global warming. To fulfill this, we must cut global CO_2 emissions — said to be as high as 35 billion tons per year — to below net-zero eventually. As ambitious as this goal is, it still represents the bare minimum required to minimize extreme weather events, epidemics, ecological changes and other effects of global warming. On the domestic front, the government of Japan announced its 2050 Carbon Neutral Declaration in 2020. Industry, government and academia are working together to address this crucial challenge.

For the drastic reduction of CO_2 emissions, we must advance various low-carbon energy technologies such as solar photovoltaic power, solar thermal power, wind power and nuclear power while ensuring safety and local environmental conservation. At the same time, we also need to establish the way to convert the fossil fuels we have become so dependent on into clean energy sources emitting no CO_2. In other words, we need to build a so-called carbon-neutral cycle, as shown in Figure 1(a) — capturing CO_2 produced when fossil fuels are consumed and reusing it as new carbon resources and energy carriers. We expect this new carbon neutral cycle will allow the sustainable utilization of fossil fuels, the reduction of the load on low-carbon energy sources and the leveling out of energy fluctuations to deliver a new, stable, next-generation energy system.

In this challenge, we have focused on the advanced CO_2 capture and conversion technologies, such as low-energy-cost CO_2 capture, carbon-free hydrogen production, and high-efficiency CO_2 conversion processes. Among these endeavors, we expect that the molten ionic oxide-based CO_2 absorbents recently identified, as shown in Figure 1(b) will reduce drastically the energy consumption of CO_2 capture and utilization systems.

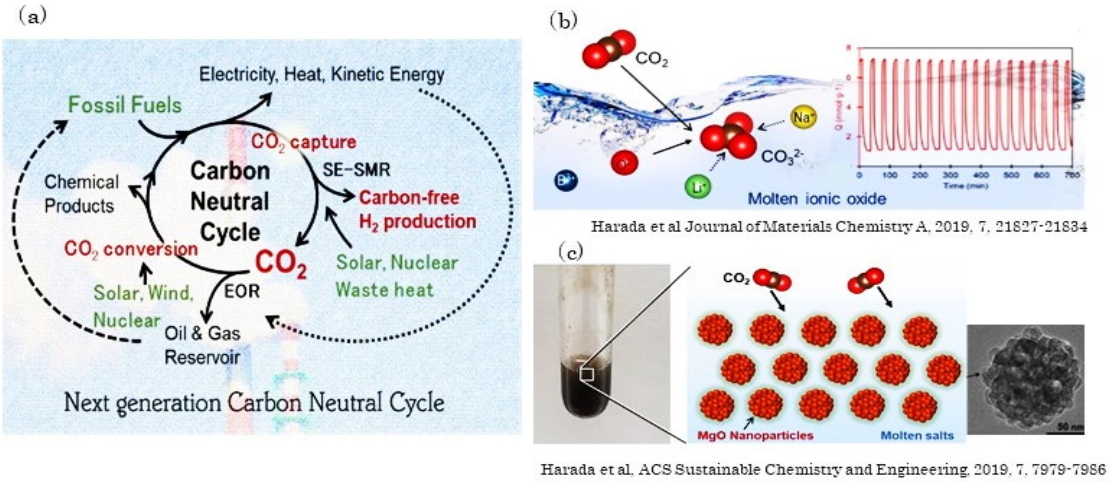


Fig.1 Schematic illustrations of, (a) next-generation carbon neutral cycle system, (b) high efficiency CO_2 capture by molten ionic oxide-based absorbents, and (c) non-aqueous colloidal absorbents.

Likewise, the nonaqueous colloidal absorbents developed by a new class of nano-hybrid technology, as shown in Figure 1(c) can serve as a new functional ionic medium allowing both selective gas separation of CO_2 and highly efficient CO_2 conversion. Further on, we will pursue various new innovative breakthroughs through the understanding of the truths and phenomena still hidden in nature, and learning plenty of engineering hints from them. We want to develop this new carbon neutral cycle together with Tokyo Tech students, who are highly motivated and full of future possibilities.

Last day, a student in my research group said to me: “The day might come when we ask our children and grandchildren, ‘Can you believe people used to emit CO_2 into the atmosphere?’ I hope that day does come, and soon!

Department of Chemical Science and Engineering,
School of Materials and Chemical Technology
Dr. Takuya Harada, Associate Professor

Q1: When was your first experience with research, and what was it like?

A1. My first experience in research came during my first year as a doctoral student. The research theme was on the correlation between critical current and magnetic flux pinning properties in high-temperature superconductors. It was a new challenge for me, and I had a hard time getting the results I modeled. However, as I proceeded to identify the causes of the results, I found out that a completely different phenomenon was occurring inside the material over my expectation. Through this experience, I realized how profound and interesting research is.

Q2. What is the ultimate goal of your research? What you want to know most?

A2: I am engaged in the researches on so-called carbon neutral cycle technologies, which involve capturing, converting and reusing CO_2. Nature has already achieved this as photosynthesis in plants. I am always impressed by the nature, realizing such an sophisticated CO_2 recycling system. My ultimate goal is the innovation of such a superb and sustainable chemical system by engineering.

Q3: How do you stay motivated in your research?

A3: My family is what really keeps me motivated. I also meet many people in my research. That includes the research advisors who gave me the research opportunities, colleagues who worked alongside, and students who have just joined me. The gratitude and joy I feel for these encounters is also a great motivator to advance my researches.

Q4: What are your aspirations for the environment and SDGs?

A4. I believe that environmental conservation is the most fundamental and crucial problem we must solve to continue living on this planet. The reduction of CO_2 emission is an urgent technological challenge to be solved now. I will do explore further to attain the solid contributions in these global activities.

Message to Students

Solving the global warming problem requires various technological innovations yet to be realized. Pioneering unexplored area is a difficult task, but I hope you follow this path with a strong will and solid perseverance to accomplish the great results and fulfillment.

Seeking to contribute to the world through the power of science and technology, Tokyo Tech established six new schools in April 2016 that integrate undergraduate and graduate education, allowing students to plan and individualize their academic path and producing graduates with superior expertise and leadership in science and engineering fields. Our enhanced educational system enables students to pursue independent learning and develop aspirations powered by their own efforts.

As part of this upgrade process, we also debuted an academic quarter system, a new course-numbering system, and other fresh elements. The updated educational system emphasizes studying a broad range of fields comprehensively and systematically based on the student's individual interests and intellectual curiosity. Our new system also emphasizes environment-related curriculums that foster a strong sense of ethics.

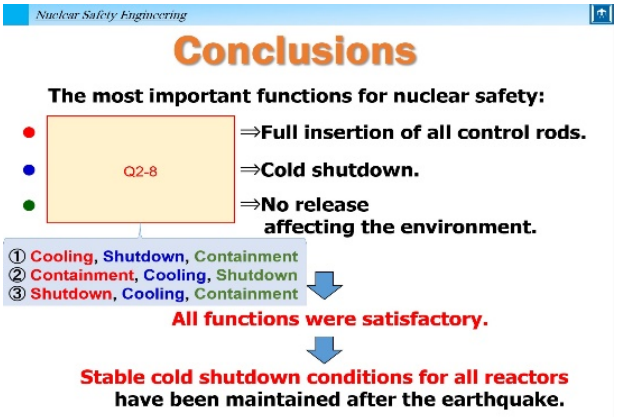
Here we will introduce the main environment-related courses we offer in our bachelor's and graduate degree programs (data below are as of AY2020).

[Nuclear Safety Engineering] Graduate Course: Graduate Major in Nuclear Engineering

Associate Professor Hiroshige Kikura
Laboratory for Zero-Carbon Energy
Institute of Innovative Research

The Great East Japan Earthquake and nuclear accident of March 2011 had a major impact on Japan's energy policy. It also greatly affected how Tokyo Tech approaches the topic of nuclear energy in terms of how we handle environmental issues and human resource development. This is especially true of the "Nuclear Safety Engineering" course, which educates students on nuclear safety topics ranging from basic concepts to engineering applications. While about 30 students from the Nuclear Engineering major and other majors used to take this course, in the immediate aftermath of the accident over 100 were. There were not enough desks in the classroom for all of them. Some had to sit in chairs in the aisles and use clipboards instead of desks. I was surprised by the depth of their interest in nuclear safety and environmental issues.

Ten years have passed since that time. Due to university education reforms, this and other classes are now taught in English. Tokyo Tech students were not especially strong in English, and many struggled to learn the technical terms at first. However, I believe this went a long way to improving their English-language proficiency. The number of students taking the course has fallen below that peak, but we still have more than fifty. Unfortunately, the AY2020 class was held online via Zoom due to the COVID-19 pandemic. We have adopted a multiple-choice quiz format with three answers to choose from (see figure at right) to keep the students interested.



This is a multiple-choice question based on the 2007 Chuetsu offshore earthquake at the TEPCO Kashiwazaki-Kariwa NPS. Which of the three answers is correct?

I want to continue to provide students with in-depth knowledge on the three basics of nuclear safety, "shutdown, cooling, and containment," and on the environmental effects of radiation.

Kikura Lab: http://www.zc.iir.titech.ac.jp/~kikura/publication.html

[Applied Environmental Engineering and Building Services] Undergraduate Course:

Department of Architecture and Building Engineering, School of Environment and Society

Professor Naoki Kagi
Department of Architecture and Building Engineering
School of Environment and Society

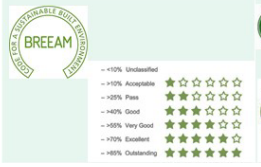
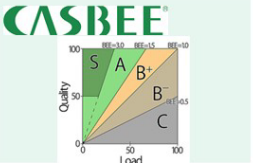
The field of architectural environmental engineering focuses on planning and creating safe, healthy and comfortable indoor environments. Building services is the technical field covering the facilities and systems to create such comfortable spaces. Tokyo Tech established the Environmental Engineering and Building Services course group to give students an integrated education on comprehensive environmental design. In this group, students can learn the theories of both fields, environmental engineering and technical issues, by dealing with environmental elements such as water, heat, air, light and sound, as well as complex problems involving these elements. The course group includes the 200-level courses “Environmental Engineering” and “Building Services” as well as the 300-level course “Applied Environmental Engineering and Building Services,” that is the culmination of the fundamentals of this field.

“Applied Environmental Engineering and Building Services” is an omnibus-style course taught by five teachers specializing in different fields within environmental engineering and building services. In the first half of their respective study topics, the teachers give presentations about each specialty. In the second half, students present their individual content on the topic in the class.

In the first session for my class, for example, I explain the environmental considerations that architects of environmentally friendly buildings should consider, the technologies used in them, and systems for evaluating and rating the environmental performance of buildings (see figure at right).

I also show examples of existing buildings with environmentally friendly technology and the connection between architectural design and environmental engineering.

Evaluating and rating the environmental performance of buildings

BREEAM	LEED	CASBEE
England	USA	Japan
Building Research Establishment Ltd	U.S. Green Building Council	Institute for Building Environment and Energy Conservation
1990-	1998-	2002-
Residence, Building, Block	Residence, Building, Block	Residence, Building, Block, City
Comprehensive Assessment	Comprehensive Assessment	Comprehensive Assessment by BEE=Q/L
		

Overview of National Building Environmental

In my second session, I give students a research assignment to find out the environmentally friendly technologies of their favorite buildings, and the items assessed in building evaluation systems. Students then share the information they gathered with each other, ask questions and engage in discussions. The students can get a lot of knowledge in a proactive manner. I also conduct building tours so that students can gain a firsthand understanding of methods to ensuring safe, healthy and comfortable architectural environments and how building services create them.

Kagi Lab: http://www.create.mei.titech.ac.jp/index.html (Japanese)

Breeding *Escherichia coli* for Environmentally Friendly Ammonia Production

Shoki Horiuchi
Hirasawa Laboratory Second-Year Master's Student
Department of Life Science and Technology
School of Life Science and Technology

Ammonia is used as a raw material for fertilizers and various nitrogen-bearing compounds, making it an essential chemical substance for human use (Fig. 1). It is also attracting attention as a fuel that does not emit CO_2 and is therefore expected to help make creating a decarbonized society possible.

Most ammonia is produced industrially using the Haber-Bosch process, which employs a metal catalyst and high temperature and pressure to make hydrogen and nitrogen react. Due to those extreme reaction conditions, this process consumes enormous amounts of energy. In fact, the Haber-Bosch process accounts for about 2 percent of annual global energy consumption. The production of hydrogen — the raw material for the reaction — also requires the use of fossil resources. The CO_2 emissions associated with the Haber-Bosch process exceed 3 percent of all emissions. There is clearly a need for an environmentally friendly ammonia production method to replace the conventional Haber-Bosch process.

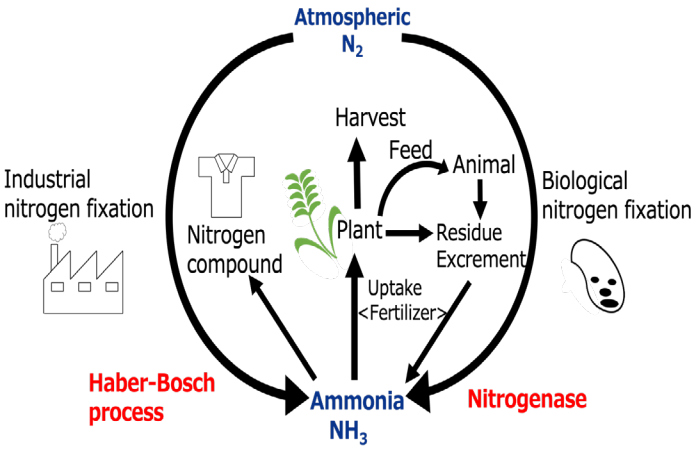


Fig. 1 The nitrogen cycle

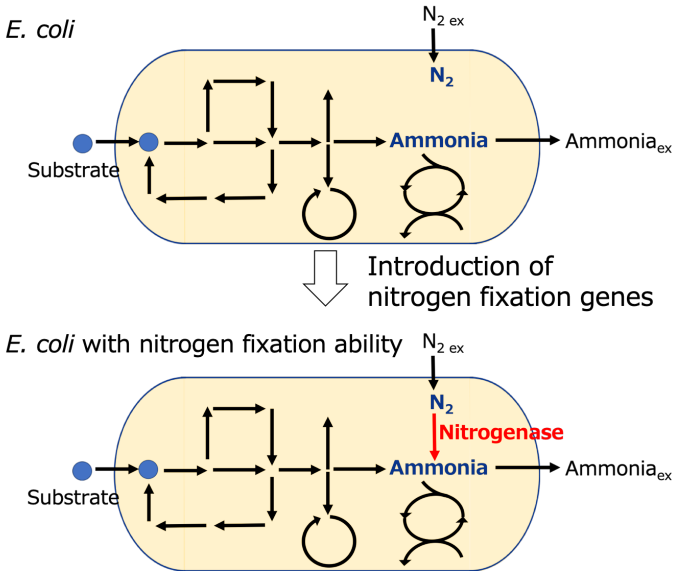


Fig. 2 Modification of metabolic pathways of *E. coli* by introducing nitrogen fixation genes with synthetic biology

Tokyo Tech has pursued research and development on the Haber-Bosch process in recent years. That has led to better reaction efficiency and new catalysts that produce reactions under less extreme conditions. Since fossil resources are needed to produce hydrogen, but the process still has a deep environmental footprint.

Biological nitrogen fixation, on the other hand, produces ammonia from atmospheric nitrogen via enzymatic catalysis under normal temperature and pressure. Nitrogenase, the enzyme that acts as a catalyst, has a complex structure consisting of multiple proteins. Its reaction mechanism is also known to be complex. Another drawback is that oxygen irreversibly destroys the metal cluster that catalyzes the nitrogen fixation reaction. If these problems can be overcome, ammonia can be produced using microbial nitrogenase. This process is expected to reduce the environmental impact of ammonia production.

Recent developments in genetics and molecular biology have given rise to recombinant DNA technology, making it possible to introduce new metabolic pathways that give cells various new functions. This breeding of useful microorganisms using synthetic biology has been attracting attention in recent years. For this reason, I am researching how to use synthetic biological methods to create microorganisms that can convert atmospheric nitrogen into ammonia — specifically, by endowing *Escherichia coli* with the ability to fix nitrogen (Fig. 2). I chose *E. coli* as the host because it has long been considered a model organism and because it is already being used in the industrial production of useful substances.

If producing nitrogenase-mediated ammonia using *E. coli* and other microorganisms becomes possible, it will have various applications, such as the production of fertilizers and fuels and as a nitrogen source for making other useful substances using microorganisms. It will also reduce the environmental impact of ammonia production and help humanity build a more sustainable society.

Hirasawa Lab: http://www.hirasawa-lab.bio.titech.ac.jp/ (Japanese)

Social Engagement Activities (Support of Disaster-affected Areas)

Special Class on Fish-Eating Culture

Working with former Fisheries Agency official and current Uekatsu Fisheries Corp. President Katsuhiko Ueda, the Kikura Lab (of the Laboratory for Zero-Carbon Energy) presented a special class about the fish-eating culture of Fukushima Prefecture's Namie Town at Namie Sosei Elementary and Junior High School. The class was broadcast via Tokyo Tech's original video streaming system. This initiative is based an agreement between Tokyo Tech and Namie Town designed to accelerate revitalization in the area.

You can find the FY2020 activity report here (pp. 10).
http://www.gsmc.titech.ac.jp/kankyouhoukoku/2020/edigest/top.pdf

VG Member Wins Award of Excellence

Tokyo Tech VG member Kei Matsumura won the Award of Excellence for a report titled "Learning Journey in Minami-Sanriku Town" he submitted to the 2020 Student Volunteering Reports event, which is sponsored by the Foundation for Student Support Center.

You can find the FY2020 activity report here (pp. 11).
http://www.gsmc.titech.ac.jp/kankyouhoukoku/2020/edigest/top.pdf

Tokyo Tech VG Environmental Conservation Activities

Tokyo Tech VG FY2020 Workshop
Is volunteering hypocritical?

1. Self-introductions [five minutes]
2. Guidance on today's theme [ten minutes]
3. Breakout discussion [thirty minutes]
(1) Opinions on the problem based on your volunteering experiences (three-five minutes each)
(2) Summary of the group's opinions (fifteen minutes)
(a) Largely shared views (b) Notable opinions, etc.
4. Exchange of opinions [twenty-five minutes]
(1) Team reports (a few minutes for both teams)
(2) Free discussion (ten minutes)
(3) Moment of contemplation (one-two minutes)
(4) How to respond to claims that "Volunteering is hypocritical" (one minute each)

February 10, 2021 Workshop

The COVID-19 pandemic forced Tokyo Tech VG (our student volunteer group) to curtail its usual volunteer activities in FY2020. In lieu of these activities, we held several online workshops to reflect on our reconstruction and recovery support activities in disaster-struck areas.

We were inspired by a workshop organized by Mirai Kaigi (Future Meeting)*1 that several Tokyo Tech VG members (including myself) attended in FY2019. By discussing our past activities with other participants, we were able to describe the changes in our thoughts and feelings in a paper*2. By recognizing such internal changes, which are difficult to notice in daily life, and by repeatedly refining the paper, we were able to face the limitations and uncertainties associated with our activities.

Using this paper as our platform at the first workshop, we all expressed our thoughts about volunteering. One thing shared was the anxiety we felt during community-building activities. We offered agricultural assistance and helped during footbath relaxation activities, but were our activities actually troubling locals? We also discussed the lack of confidence we felt related to what we could accomplish with just a few activities a year.

Each of us had to consider that new awareness. We held another workshop about four months later to reexamine the issues, under the theme "Is volunteering hypocritical?"

Here are some of the opinions expressed at this workshop:

A: If the initial motivation to volunteer is merely interest or curiosity about doing it, it is not possible to work 100 percent for the benefit of others.

B: Many volunteers volunteer because it can benefit them, such as how it looks good on a resume. However, the happiness derived from making others happy can be a motivation to continue.

C: Even if the motivation is selfish, volunteering is a meaningful activity if what you want to do ends up benefiting others.

D: I sometimes feel unsure about whether I can relate to local people. However, I think that having an outsider's perspective and doing activities that inform people about the current situation are both meaningful.

E: I think the process of thinking about what we can do for others is one of the appeals of volunteering.

F: If you don't have both an intrinsic motivation to help others and a desire to try, you won't be able to continue volunteering. I think it's vital to listen to those feelings and try volunteering, even if it's just out of curiosity.

Because volunteering activities can hardly be 100-percent altruistic, some may place too much emphasis on the hypocritical aspects of volunteering. However, the fact that Tokyo Tech VG members were able to articulate our thoughts, even if only a little, has reaffirmed our conviction to continue volunteering. As such, I feel this workshop was meaningful. Tokyo Tech VG will continue to emphasize our motto of "Do what we can" through our volunteering activities, and create opportunities to reflect on our thoughts.

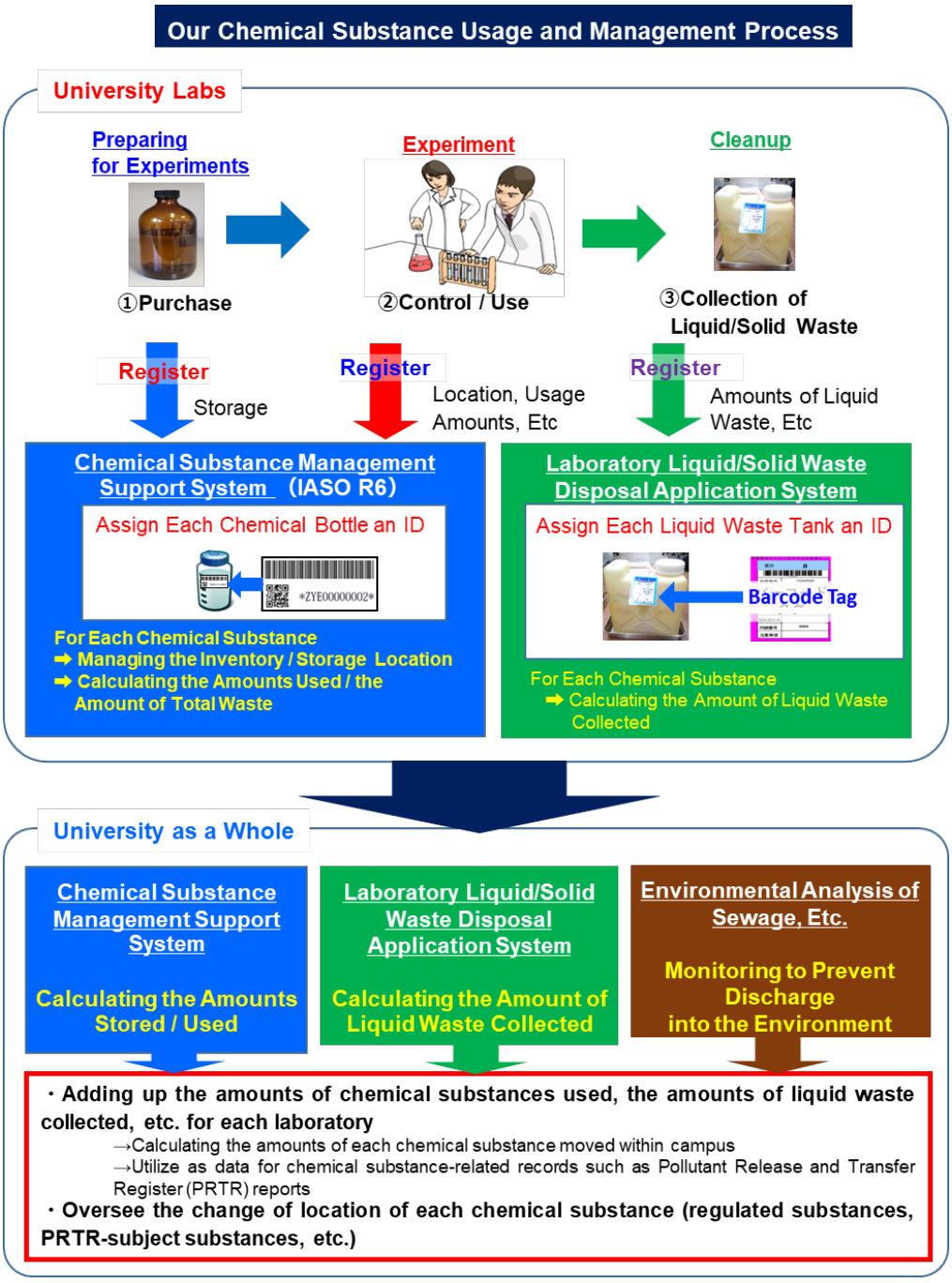
Tomoki Ichimura
Yuasa Laboratory First-Year Master's Student
Department of Architecture and Building Engineering
School of Environment and Society,

Note 1) Mirai Kaigi (Future Meeting) is a citizens' group that provides a place for dialogue between citizens involved in the reconstruction of Fukushima's Hamadori region. At the workshop we attended, participants took a bus tour of the Fukushima Daiichi nuclear power plant in the morning. In the afternoon, we discussed what we felt during the tour in the morning and our own activities related to reconstruction.

Note 2) Tatsuya Yumiyama, Shigeru Aoki, Tomoki Ichimura, Ryunosuke Ota (2020). "The 'N-Shaped Model' of Altruism: Volunteers Stumbling through Activities" *Shukyo to Shakai Koken* [Religion and Social Contribution] Volume 10, Issue 2.

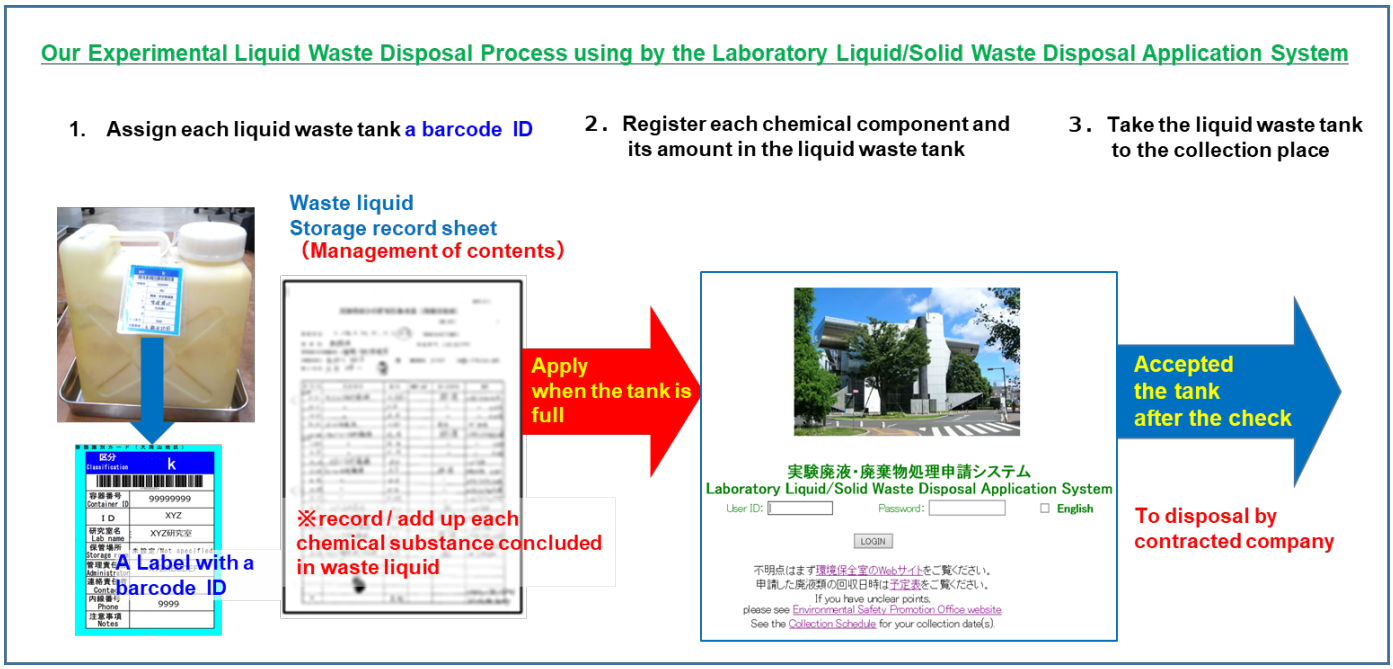
To ensure that we manage chemical substances properly, we have introduced IASO R6 (also known as the Tokyo Tech Chemical Substance Management Support System), which allows us to determine the inventory and use of chemical substances at the university in real time. We also have two ways to reduce the environmental footprint of the chemical substances we use. The first is a Laboratory Liquid/Solid Waste Disposal Application System that allows us to grasp the quantities of liquid/solid waste material generated during experiments. The second is to conduct environmental analyses and chemical analyses of waste material for chemical substances to ensure that they are not released into the environment.

Our Chemical Substance Control Process



Note: All laboratories that use chemical substances must register with IASO R6 and the laboratory liquid/solid waste disposal application system.

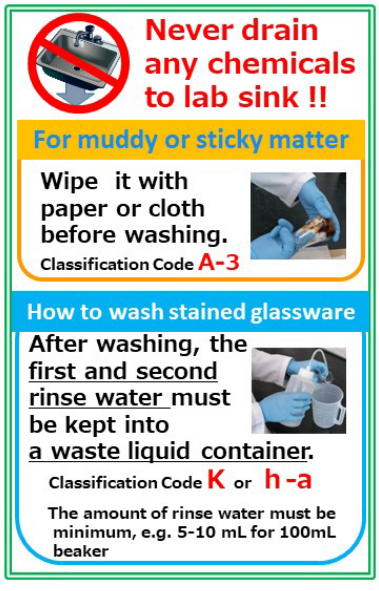
Our Laboratory Liquid/Solid Waste Disposal Process (from pickup requested by a laboratory to disposal by a contracted company)



Our laboratories use the Laboratory Liquid/Solid Waste Disposal Application System to manage waste according to the type of waste material, and identify the waste with tags on the tanks. Data on the composition and chemical analysis of the liquid waste logged in the system is then used to prepare waste data sheets (WDSs). Because the handling of experimental waste requires accurate information, WDSs are used to convey key details about the waste materials to the contractors tasked with their disposal.

Management of Laboratory Liquid Waste (Lab Sinks)

Because our lab sinks are considered washing facilities as specified in the Water Pollution Prevention Act, we have implemented a management system to prevent chemical substances from being flushed into lab sinks. Specifically, we use water to dilute chemical substances. Water from the first and second rinses is collected as waste liquid and disposed of by a contracted company (see the figure at right).



At the Ookayama Campus, rinse water from the third rinse and beyond is poured down lab sinks into the sewer system, where it merges with domestic wastewater and flows off the campus grounds.

On the Suzukakedai Campus, this waste water is purified at a treatment facility and reused as gray water in toilets and elsewhere before flowing off campus grounds as domestic wastewater. Unused gray water is discharged into public waters (a river that flows into Tokyo Bay). In accordance with Yokohama City ordinances, we installed automatic total nitrogen/phosphorus and chemical oxygen demand measuring devices to measure those substances in the gray water in real time before discharge.

Environmental Performance
Material Balance

Tokyo Tech's activities consume a great deal of energy and a wide range of materials. Most of the energy we consume is in the form of electricity and gas. The primary materials we use are chemical substances, paper, and water. While we need to use these to conduct our cutting-edge education/talent development activities and research activities, we're also engaged in minimizing the environmental footprint of our operations.

The following chart shows the amount of input needed for our research and education activities and other operations for fiscal 2020, as well as the emissions and waste generated. Inputs include energy and materials consumed, while outputs include waste and environmentally hazardous substances discharged outside.

Both inputs and outputs decreased in fiscal 2020 compared to the previous year for reasons related to the COVID-19 pandemic. This included the use of remote classes and telecommuting, fewer experiments being conducted, and fewer meetings (including a shift from paper to digital meeting materials).

INPUT		FY2019	FY2020
Energy	Electricity (1,000 kWh)	66,004	↓ 59,839
	City Gas (1,000 m^3)	613	↓ 430
	Fuel Oil (kl)	0.97	↑ 1.05
	Gasoline (kl)	0.2	↓ 0.1
Material	Chemical Substances (t)	2,335 types 75.3	2,288 types ↓ 60.3
	PRTR-related Substances (t)	32.3	↓ 25.5
	Paper (t)	53.6	↓ 28.3
	Water (1,000 m^3)	215.5	↓ 171

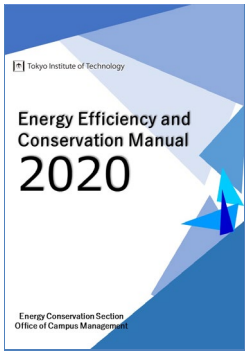
Implementation of Cool Biz
(March 1 to October 31)
We requested faculty, staff and students to cooperate with targeting a room temperature of 28°C, and to work in light clothing.

Implementation of Warm Biz
(December 1 to March 31)
We called for faculty, staff and students to target a room temperature of 20°C, and to wear clothing that is warm and easy to move around in.

RECYCLE	FY2019	FY2020
Paper (t)	307	↓ 258
Other Recycled Materials (t)	404	↓ 266
Graywater Reuse (1,000 m^3)	52	↓ 51

3R Movement
- **Reduce**
  Cut down the amount of trash we make
- Reuse
  Don't throw them away, use them again
- **Recycle**
  Transform an old item to a new use instead of throwing it away

OUTPUT		FY2019	FY2020
Atmospheric Emissions	Greenhouse Gas Emissions (t-CO_2)	31,449	↓ 24,353
	Purchased Electricity (t-CO_2)	29,927	↓ 23,273
	Fossil Fuels (t-CO_2)	1,374	↓ 963
	Water and Sewage (t-CO_2)	148	↓ 117
Waste	General Waste (t)	159.5	↓ 119.2
	Industrial Waste (t)	547.8	↓ 442.6
Water Discharged	Total Sewage Discharged (1,000m^3)	213.5	↓ 168.7
	Pollutant Emissions		
	BOD (t)	14.5	↓ 10.9
	Nitrogen (t)	9.8	↓ 5.5
	Phosphorus (t)	0.8	↓ 0.4



We created an energy efficiency and conservation manual to promote energy conservation.

Editorial Note

This year's "Tokyo Tech Environmental Report" was created with the UN's SDGs in mind. I want to express my heartfelt gratitude to everyone involved in its production.

I was appointed as the chair of the Environmental Report Preparation Working Group this year. Since I am a life scientist, I wanted to approach this project from the perspective of the environment and life. I took the four photos on the cover while scuba diving in the Kerama Islands in Okinawa. Moving clockwise from the top left, you can see semicircle angelfish, a green turtle among corals, oneband anemonefish, and Ocellaris clownfish and sea anemones. Whenever I fly to Okinawa, I get excited when I see Okinawa's beautiful emerald-green sea from the plane. Although Okinawa is surrounded by one of the world's most beautiful seas, coral bleaching has recently become a problem. It is feared that Okinawa's marine ecosystem will be severely damaged if the coral does not survive. Floating plastic bottles and microplastics in the ocean are also becoming a problem. We use a lot of disposable plastic products in our research every day. I have mixed feelings about this, and want to work with everyone to think up a solution that brightens our environmental future.

Environmental Report 2021 Preparation Working Group Chair
Yoh-ichi Tagawa

Suzukakedai Campus

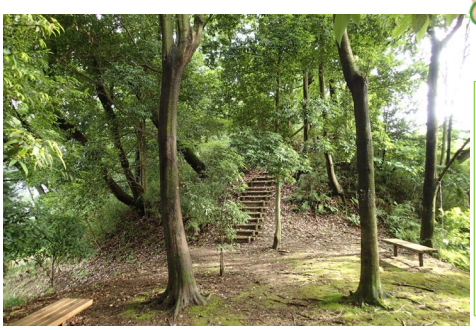
Here we introduce the lush natural environment of the Suzukakedai Campus, where cutting-edge research takes place.

Plane trees in early summer (top) and winter (bottom)

Plane Trees: When you enter the campus from the Suzukake entrance and go down the slope, you will see some large trees right in front of you. These are plane trees, of the genus Platanus, known as *suzukake no ki* in Japanese. Their leaves fall off in winter, but the hanging fruit resembling small round bells (*suzu*) remain while new ones are growing. The plane trees that are the namesake of the Suzukakedai Campus watch over our researchers every day.

The flower meaning of Platanus is "genius, extraordinary, curiosity," which is why the Japanese name of the plant is used for this new campus.

You might see these guys on campus!



A small hill we call "Mount Kato" is the *peripatos* of the Suzukakedai Campus and a place for students and faculty to refresh and exchange ideas.

The Suzukakedai Campus is home to many species. In spring, when you enter the campus through the Suzukake entrance, you may be greeted by the distinct "*chotto koi! chotto koi!*" (come here, come here!) call of the Chinese bamboo partridge and the pleasant, flute-like whistle of Japanese bush warblers. You may also encounter snakes and raccoons. From early summer, you can see popular insects such as jewel beetles and rhinoceros beetles, and may hear a chorus of frogs in a pond.

Please share information or photos of the flora and fauna you have sighted on the Tokyo Tech campuses with us at kankyouhoukoku@jim.titech.ac.jp

Tokyo Tech is striving to become one of the world's leading universities in science and technology. Our environmental efforts and education revolve around two pillars: 1) Pursuing research and developing practical applications related to environmental conservation; and 2) developing skilled individuals who will help protect the environment. We believe that reducing our overall environmental footprint is the foundation that supports these pillars.

Tokyo Institute of Technology Environmental Report 2021

Use the QR codes below to see the full version and digest of the Tokyo Institute of Technology Environmental Report 2021 (both in Japanese)

Environmental Report 2021

Digest Version

The Sustainable Development Goals (SDGs) are a set of 17 global goals and 169 specific targets to be achieved between 2016 and 2030. They were adopted at the UN Sustainable Development Summit held in September 2015. Through its activities, Tokyo Tech is diligently seeking to ensure that these SDGs are met.

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