Create the Future,
Collaborate Together

AIST Report 2021

Social and Environmental Report

AIST

AIST VISION

Create the Future, Collaborate Together

Designing and co-creating the future with society.
Encouraging mutual respect and endeavors.

Our values

We respect creating diverse values through individual strengths and organizational power.

Our mission

We promote diverse activities beyond the conventional AIST roles through achieving excellence in research, discovering social issues and implementing solutions, underpinning intellectual infrastructure. and assisting with policy advocacy.

Our culture

We foster a culture that attracts diverse people with high aspirations and encourages mutual respect and endeavors.

Adopted in June 2021

Editorial Policy

The National Institute of Advanced Industrial Science and Technology (AIST) first published an environmental report in fiscal year (FY) 2004. Since FY 2010, AIST has published the AIST Report, which is an environmental report combined with a report on its activities on corporate social responsibility (CSR).

AIST Report 2021 Social and Environmental Report presents at the start the content and the significance of the wide-ranging reform of our organizational governance systems and the many policies taken to raise the values of AIST along with the President's message. Moreover, in order to communicate the future image of AIST, it offers the Opening Dialogue in which the future of science, technology and industry is discussed, and presents technologies that contribute to achieving "zero emission," a social issue that the entire world needs to tackle.

Additionally, the Report presents AIST's activities that cover a wide range categorized into contents for different readers such as those related to industry–academia–government collaborations, workers, and those of regional society. AIST aims for its activities to be understood by various stakeholders, and for building a deeper relationship of trust with society.

AIST's official website : www.aist.go.jp/

- Activities covered by the report
  Research activities at all AIST research bases
- Period covered by the report
  April 2020 to March 2021
- Areas covered by the report
  Key areas covered include organizational governance, human rights, labor practice, fair operating practice, community involvement, environmental report, occupational health and safety and open innovation activities.
- Rounding of numbers
  Numbers are rounded off to the specified whole number.
- Referenced guidelines and other sources
  - 2018 Environmental Report Guidelines, Ministry of the Environment
  - Law Concerning the Promotion of Business Activities with Environmental Consideration by Specified Corporations, etc., by Facilitating Access to Environmental Information, and Other Measures
  - Guidance on Information to be Provided in the Environmental Report (3rd Edition), Ministry of the Environment
  - ISO 26000: 2010 Guidance on Social Responsibility, Japanese Version, Japanese Standards Association
  - Global Reporting Initiative
- Scheduled date of the next edition
  September 2022 (Japanese edition)

Contents

The interviews were conducted in accordance with government guidelines and with adequate infection control measures in place.

For Increasing the Value of AIST

Taking the AIST Vision to heart: Create the Future, Collaborate Together.

The National Institute of Advanced Industrial Science and Technology (AIST) was launched in 2001 and this year reached its landmark 20th anniversary. Through R&D in a wide range of fields of industrial technology, we have helped raise Japan's strength in science and technology, develop new industries, and build intellectual infrastructure.

Looking back, society has changed greatly in these 20 years. The rapid advance of digital technology has transformed our daily lives and brought productivity improvements in many industries. In the past, environmental measures were a factor in increasing costs for business, however, now the United Nations Sustainable

Development Goals (SDGs) are a major consideration in business management strategies. In Japan, the decline in international competitiveness of a number of major industries over these 20 years has been striking. The population has started to fall, the birthrate continues to decrease, and the retired population continues to grow. A succession of natural disasters has brought the importance of national resilience into sharp relief. Measures to address climate change are an urgent matter for the whole world, and now we are facing the difficulties of COVID-19. As we face these various social problems, producing innovation through science and technology and seeking out solutions are increasingly important.

In FY 2020, AIST embarked on its Fifth Medium- to Long-term Plan with the mission of addressing social problems and strengthening industrial competitiveness. Multiple issues are entangled in each of the social problems I have mentioned; solutions cannot be found in individual specialist fields. AIST is unleashing its collective strength through collaborations and synergies among the diverse researchers and research domains in the Institute, and is working hard on R&D into solutions to social problems. To solve social problems, technologies that are developed must be incorporated into products and services and brought to social implementation. Promoting open innovation through collaboration with business and other alliances of industry, academia and government is crucial. Accordingly, AIST is setting up Open Innovation Laboratories (OIL) at universities to complement basic research, is setting up Cooperative Research Laboratories in the Institute as bases for collaboration with business, and is moving ahead with social implementation. To encourage even more of this open innovation, we must make AIST more attractive as a partner. This will be a key to increasing the value of AIST.

To maximize the value of AIST as an organization, we started last year by setting out our Management Policy for Research, which is the heart of AIST. The aim of the policy is to enhance our R&D strength and accelerate social implementation of research outcomes around three pillars: raising the quality of research topics identifying research topics by back casting from social problems; promoting synergies throughout the whole Institute covering a wide-range of research areas; and strengthening international standardization. To support activities in line with this policy, in April 2021 we conducted a massive reform of our organizational governance systems, drawing from corporate governance. The main reforms are as follows: separating executive functions from the Board; obtaining objective opinions from outside by increasing the number of external Vice-Presidents; rationalizing decision-making and performance monitoring in the Institute; appointing a chief technology officer and a chief management officer to improve executive functions; for the various departments concerned with research and the various departments concerned with administration and management, to cooperate under these two officers; and to create systems that help unleash our collective strength. Very soon, we will set out our management policy for AIST as a whole, including activities beyond research such as collaborative activities and organizational management, enhancing our efforts to achieve our mission.

At the same time, AIST's goals and what kind of organization AIST wants to be have been discussed at many levels within the Institute and we have adopted an "AIST Vision" that all employees should be able to profoundly agree with. Its title is "Create the Future, Collaborate Together." and it features a strong sense that all the people brought together in AIST should strive towards a new future. For individual intentions to lead to improved value of the Institute as a whole, it is important to raise engagement between the organization and the staff working in it. We intend to incorporate perspectives on improving engagement in the aforementioned management policy for AIST.

This report outlines AIST's new efforts and our activities in FY 2020. It is organized around four themes: AIST and environmental problems; AIST and industry–academia–government collaborations; AIST and the AIST staff; and AIST and regional communities. AIST is improving its research activities, presenting its activities to society, and enhancing the transparency of its activities. In this way, AIST is raising the understanding of stakeholders and winning trust from society.

For 20 years, AIST has actively supported bridging from research outcomes to business, and has pursued social implementation of technology through collaborations with industry. However, for AIST to be an institute with real value for Japanese society, we cannot stop at bridging but must be at the heart of a national innovation ecosystem and we must consistently work on solutions to the many social problems facing Japan and the world. Over the next 20 or 30 years, we will strive to create innovation as a unified institute with the newly adopted AIST Vision in our hearts.

We look forward to your continued understanding and support.

National Institute of Advanced Industrial Science and Technology
President and Chief Executive Officer

ISHIMURA Kazuhiko

Aiming to Fulfill the AIST Mission

Everyone at AIST is working to fulfill the AIST mission of "producing world-beating innovation that solves social problems and contributes to stronger economic growth and industrial competitiveness."

Ⅰ. Management Policies for Research (adopted September 2020)

We have established Management Policies for Research at AIST aimed at achieving the mission of the Fifth Medium- to Long-term Plan. Promoting further open innovation involving businesses and universities is critical to the mission. Three policies have been adopted to improve AIST's attractiveness as a collaboration partner and to maximize AIST's value.

1 Improving the quality of research topics

We will perform backcasting from society's needs to identify research topics and conduct research that contributes to finding solutions to social problems. We will produce outcomes that stand out at the world's top level, at the same time developing our research activities with a perspective on social implementation.

2 Promoting synergies throughout the Institute

We will pull down walls within the organization and encourage synergistic research. We will generate synergies through our collective strength as a general research institute with a wide range of research domains.

3 International standardization

From R&D onward, we will strategically promote the international standardization that is important for improving international industrial competitiveness.

Ⅱ. Review of organizational governance systems (conducted April 2021)

In line with trends for corporate governance reform in business, we conducted a wide-ranging review of our organizational governance systems, with the goal of further increasing the value of AIST by going beyond simply continuing previous efforts and establishing more effective governance.

●Working to assure appropriate decision-making

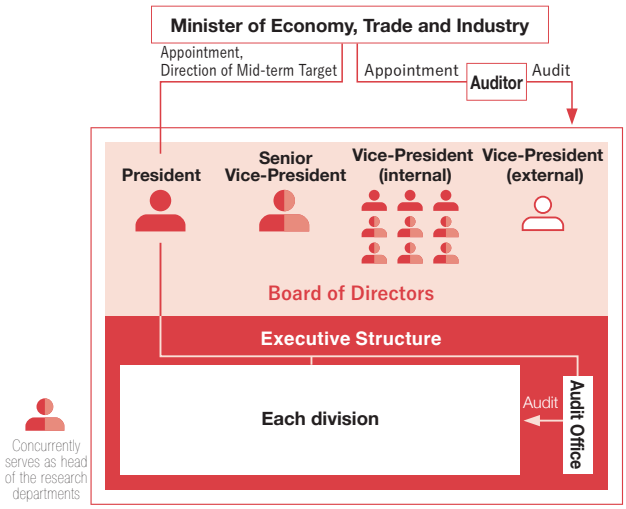
The AIST Board is set up to assist decision-making by the President; it puts the emphasis on discussions of important matters relating to management of the Institute as a whole. In order to better incorporate objective opinions from outside the Institute, Yanagi Hiroyuki (Chairman of Yamaha Motor Co., Ltd.) was invited to be a new vice-president (part-time). Dr. Kojima Keiji (President and COO of Hitachi, Ltd.) and Mr. Yanagi comprise a group of two external vice-presidents (part-time). As a result, functions of the Board as a venue for making decisions while exchanging opinions with vice-presidents from outside have been strengthened and the Board can more objectively determine how AIST's R&D can work for society.

In order to improve the Board's function of objectively monitoring performance, we decided to separate the roles of vice-presidents and heads of operating units (for example, the research domains) and to slim down the number of vice-presidents from ten (nine internal and one external (part-time)) to five (three internal and two external (part-time)). Hence, the Board will monitor executive systems while the heads of research domains and other operating units will be executive officers dedicated to executive functions. With this complete separation between administration and performance, we anticipate improvements in governance.

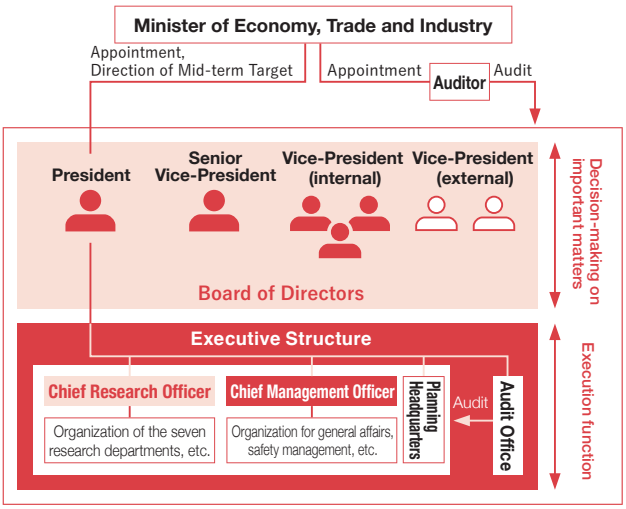
●Improving executive functions to unleash our collective strength

We have appointed a chief technology officer with responsibility for all research, with the aim of overall optimization of R&D, and set up systems to unleash our collective strength. In particular, for the most important part of our mission, "world-beating solutions to social problems," we are leveraging the strengths of the whole Institute with its seven research domains and driving research forward through synergies between the domains under the chief technology officer. Similarly, we have appointed a chief management officer with responsibility for organizational governance, including general administration and safety management. Through collaboration between the chief technology officer and the chief management officer, we intend to unleash our collective strength including organizational governance functions.

Before review



After review



Ⅲ. AIST Vision (adopted in June 2021)

Since AIST was launched as an independent administrative agency in 2001, it has continuously conducted research activities to deliver technologies for realizing a sustainable society, solving social problems, and generating economic development. Over this period, social problems have progressively become more complex and multifaceted; humanity is now facing challenges that have never been experienced before. As we pass the landmark 20th anniversary of the launch of the organization in these circumstances, we have re-examined the role AIST should play in society and what kind of organization it should be, and we have adopted the "AIST Vision." We will share with all the people collected at AIST our mission in society, the values that are important to us and the culture we are nurturing for the future, under the banner "Create the Future, Collaborate Together." AIST aims to be a more unified organization to realize a sustainable society.

1 Our mission

We promote diverse activities beyond the conventional AIST roles through achieving excellence in research, discovering social issues and implementing solutions, underpinning intellectual infrastructure and assisting with policy advocacy.

2 Our values

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3 Our culture

We foster a culture that attracts diverse people with high aspirations and encourages mutual respect and endeavors.

Prospects for Initiatives to Achieve AIST's Mission

AIST is in the process of reviewing its organizational governance systems (see page 4 for details). In order to get a greater number of objective views from outside the management of the Institute, in April 2021 AIST invited Yanagi Hiroyuki (Chairman of Yamaha Motor Co., Ltd.) to become a new vice-president (part-time). We asked him for his views and expectations of setting out management policies for research, the review of organizational governance systems, and about the adoption of the AIST Vision.

"Management Policies for Research at AIST in the Fifth Period," which was adopted in September 2020, incorporated the issue of advancing reform of business management. In these policies, working on synergistic research topics is important for going beyond individual strengths to produce synergistic effects as an organization. It is difficult for a single research domain to generate new value from innovative

outcomes; specialists from different fields must talk to each other and weave together their research. Synergizing research topics is a suitable and effective way to maximize the fruits of research. While improving the expertise and competitiveness of the individual research domains, management must also strike a balance between domain research and synergistic research and seek to create new value. I anticipate that we will soon see magnificent results from synergistic research topics.

In business activities too, customer needs rapidly become complicated and many different combinations are required to create new value. When we change combinations of technologies, change combinations of people, and change combinations of information, value that is different from before may emerge and innovation may occur. Because AIST has seven wide-ranging research domains, many different combinations can be imagined.

In April 2021, AIST conducted a review of organizational management systems to improve governance. I understand this as reflecting the basic goals of corporate governance in business management into the management of AIST: (1) supporting all executives to be able to make fast and firm decisions with appropriate levels of risk-taking; and (2) monitoring organizational management from the perspective of stakeholders. I see the review as a good opportunity to conduct management in a way that skillfully implements these two goals.

As a leading public research institution in Japan, I think that while proceeding with our work to solve social issues and achieve the SDGs, we should also be having deeper conversations on diversity and inclusivity, and we should be actively promoting greater information disclosure and transparency.

AIST Vision was adopted in June 2021. In setting out this vision, I heard that more staff than ever before were asked to join the discussions. It is a wonderful initiative. I work for Yamaha Motor Company, which in 2012 created the brand slogan "Revs your Heart," which invoked a strong sense of wanting to achieve the company goals extolled in our brand statement. After experiences of previous slogans that had failed badly, we devised a process for setting and embedding a slogan. More recently, workplace-driven initiatives invoking the slogan have emerged organically; it has become ingrained in the staff and at the same time has spread to customers.

In AIST too, I would like to see all staff sharing the spirit of the AIST Vision, "Create the Future, Collaborate Together." and for it to become familiar to people in the businesses and universities we work with.

Finally, I want the AIST brand to shine out as we pursue day-to-day research activities and collaborations with companies and universities. What I mean by "brand" here is the power to give the organization character, developing personnel who are brimming with passion to express that character, and passing on that power to others. By thoughtfully working on what research themes to address, how to develop our personnel, and what kind of characteristics the organization should have, we can inspire many stakeholders to take greater interest in AIST. I am looking forward to a research institution that can make even greater contributions to society in many different forms.

From an online interview, August 4, 2021
(conducted by AIST Public Relations Department)

PROFILE

AIST Vice-President (Part-time)
Chairman of Yamaha Motor Co., Ltd.

YANAGI Hiroyuki

Graduated from University of Tokyo Faculty of Engineering and joined Yamaha Motor Co., Ltd. in 1978. Appointed President and CEO of Yamaha Motor Co., Ltd. in March 2010. Appointed Chairman and Representative Director of Yamaha Motor Co., Ltd. in January 2018. Chairman and Director of Yamaha Motor Co., Ltd. (current position) since March 2021. Appointed Vice-President (part-time) at AIST in April 2021.

Professor Emeritus, the University of Tokyo
President, Innovative Structural Materials Association
President Emeritus, National Institute for Materials Science

KISHI Teruo

Vice-President, AIST,
Director, Public Relations Department, and Director,
Innovative Human Resources Department

Meeting chair: **KATO Kazumi**

Future of Science, Technology and Industry

The creation of innovation leading to industrial competitiveness

Japanese industry has great strength in the field of materials, but how can it raise its profile in global markets? University of Tokyo Professor Emeritus Kishi Teruo, who has led research into materials development at universities and national research institutions, and President Ishimura Kazuhiko, who has a wealth of experience as a manager in the materials industry, discussed Japan's strengths and problems and looked ahead to the future of science, technology, and industry in Japan.

Opening Dialogue

President and Chief Executive Officer, AIST

ISHIMURA Kazuhiko

Why has Japan's industrial competitiveness declined?

Kato: Today, I would like to discuss a wide range of topics from the perspective of materials technology, covering not only the materials industry but also the current state of Japanese industry in general, challenges to improving competitiveness, and also the contributions that materials technology makes to society. First, I would like to hear about the current state of manufacturing industry and the materials industry in Japan.

Kishi: Japanese manufacturing industry is seen as a global leader in competitiveness in the fields of cars, machinery, and materials. However, there is great concern that competitiveness in fields such as semiconductors and electronics has declined. The cause is a situation in which we lead in innovation in a broad sense of the word, but struggle to produce technological innovations that feed into business. It is also said that the slow pace of digital transformation in Japanese industry is at the root of the problem. I would really like to hear President Ishimura's opinion on how we should understand that point. Given this situation, my hope for the future lies in environmental and energy fields. The importance of these fields is going to increase dramatically and Japan's materials industry will play a major role. Japan's manufacturing industry currently seems smaller than it actually is because of the rise of China and other Asian countries. Rather than being pointlessly pessimistic, we must carefully examine which fields Japanese industry is competitive in and what are the causes of competitive decline. Focusing on materials technology, the world still expects plenty of competition from us.

Ishimura: Indeed, it is important to examine Japan's strengths and weaknesses. For example, Japanese companies once dominated the global market in liquid crystal display panels. Japanese business had continued to steadily research liquid crystal technologies and kept stepping up investment. However, South Korea and Taiwan quickly caught up in the technology and, at a stage when the technology was almost perfected, China made overwhelmingly huge investments and all at once had taken a 40% share of the global market. It seems to me that competitiveness in liquid crystal display panels was determined by differences in capital more than technological leadership. Still, in the field of liquid crystal display panels, Japan is strong in the areas of parts and materials, as Professor Kishi said, and I'm told that we still hold at least 50% of the global market share for key components such as polarizers and glass substrates.

The slow pace of digital transformation has been mentioned as a cause for the decline in industrial competitiveness. It does seem that digital transformation is necessary for improving competitiveness and should be pursued, but it is only part of the story. We cannot succeed in competition without digital transformation, but pursuing digital transformation is no guarantee of success. Digital transformation can only be one of our tools.

I think a more fundamental cause of Japan's industrial competitiveness declining is that, since the period of high economic growth, we have not succeeded in building the ecosystem of cooperation between industry, academia and government that is necessary to produce innovation. Japanese manufacturing

industry has grown stronger by improving existing technologies, but has not managed to give birth to technologies and industries that can change the world, such as the Internet; this is where Japan's industry is lacking. and is to which the issues that AIST must address from now on are deeply related.

Deploying data science in the materials field and propelling innovation

Kato: Although Japan's manufacturing industry is losing competitiveness, particularly in fields such as semiconductors and electronics, the materials industry has much potential. What kinds of initiatives will be necessary to produce innovation originating from Japan in the materials field?

Kishi: As an example, Japan currently boasts world-best capabilities in technologies for making materials such as carbon fiber reinforced plastics (CFRP) and ultrahigh tensile strength steels. However, what constitutes competitiveness has changed in the last ten years. The greater diversity of composite materials and the arrival of failsafe materials—skillfully introducing defects to make materials that turn out to be even safer—have increased the number of new factors to be considered. Data science concepts are very important for integrating and mastering these factors. In the context of materials development, I also think it is vital to create venues for open innovation that bring together technologies and people with diverse backgrounds.

Ishimura: That means we should leverage data science with our diversity of people and technologies, provide venues to bring everyone together, and propel open innovation. AIST is running a project to blend materials informatics with computational science. We have also started a project on process informatics to employ and improve data science in processes for making materials. We are collaborating with Tohoku University to use mathematics to work on "inverse problem" research, designing materials from required properties. From conversations I have had at research sites, material manufacturing processes can be completely modeled by computational science. I just felt amazed that everything down to the material production processes that have been the basis for differentiation in the materials industry in Japan can be analyzed. Japan must take the lead with this technology. If it does not, it will lose in international competition.

Japan's materials technology contributing to the SDGs

Kato: The 17 sustainable development goals (SDGs) for building sustainable societies were defined by the United Nations in 2015. Do you think materials development can make a great contribution to the SDGs, and if so, then how?

Kishi: The SDGs are regarded as goals we should meet but, given that they cover the whole world, I see them as an ideal indicating how things should be. When I was working as a science and technology adviser to the Minister for Foreign Affairs from 2015, we pledged to create international roadmaps and platforms for the SDGs and we incorporated them into G20 declarations. I also took part in a United Nations STI for SDGs* symposium, talking about the great contribution of materials developed in Japan—such as semiconductors and organic thin films for solar

power generation and lithium batteries for electric vehicles—could make to reducing CO_2 emissions and addressing climate change.

*: Science, Technology, and Innovation for Sustainable Development Goals

Ishimura: I agree that the contribution of materials technology makes to the SDGs will be significant. When the SDGs were set, I was working as president of AGC (AGC Inc.). If the SDGs are treated as another obligation unrelated to business, then they will just be a cost for companies. However, as Professor Kishi says, the SDGs are a new conceptual framework and, if the world operates in accordance with this concept, the trends of goals that companies set themselves will be determined by the SDGs. Business itself will change. The SDGs concern 17 goals, not all of which our companies can help with, but some of the goals relate directly to business activities. When companies reconsider the SDGs with the understanding that problems regarding SDGs may be solved by business activities, backcasting from solutions for social problems will probably enable them to draw up new business models. This thinking can also be applied in AIST. The mission of solving social problems declared in the Fifth Medium- to Long-term Plan overlaps with some of the means to achieve SDGs. We can perform backcasting to identify research topics and proceed with research activities. Many of the problems may be addressed with materials science. For example, if we achieve technological innovations for materials in fields

such as batteries and power semiconductors, we can solve energy problems sooner.

Challenges in training research personnel

Kato: I would now like to broaden the conversation beyond the field of materials and ask for your thoughts on policies to strengthen Japan's industrial competitiveness. First, I want to ask about securing excellent personnel.

Kishi: Looking at Japan as a whole, there are two major problems with human resources. One is the low number of women in the sciences. While I was science and technology advisor to the Minister for Foreign Affairs, I visited about 30 countries. Wherever I went and took part in meetings, half of the participants were women. The proportion of women entering science-focused universities in Japan is stuck at 20 to 30%, and the proportion of female researchers seems to be very small. The other problem is failure to invest in personnel. As far as I know, Japan is the only developed country where salaries are not paid to graduate school students. If universities are not developing good quality personnel to start with, the consequence is that national research and development agencies such as AIST cannot expect to flourish.

Soon, the retirement age will be extended by five years. We must train personnel who can be accomplished researchers until the age of 65. To this end, we should prepare an environment in which, for example, researchers can devote themselves to their preferred research and go abroad to form international networks through the decade of their 30s. Working with people around the world in their personal networks, they can grow into genuine experts who will generate open innovation themselves. The abilities and the international networks they cultivate during the decade will also lay the foundations for them to be dynamic researchers up to 65.

Ishimura: The truth is that Japan has not invested sufficiently in human resources. I think that if Japan is to survive in science and technology, the country must vigorously invest in education starting from the kindergarten and elementary school stages. Failing to do that will make things difficult regardless of the efforts of universities. Unfortunately, there is an attitude that the motive for businesses to cooperate on research with universities and national institutes is that research costs can be borne by government bodies. I think switching to an attitude of paying appropriate amounts to make use of the excellent technologies and knowledge of universities and national institutes will greatly improve the working conditions of researchers.

What Professor Kishi says about training personnel in national institutes is correct. For example, when AIST proceeds with social implementation of research outcomes, there are many jobs to be done in project management. Currently, these jobs are almost always conducted by the researchers themselves. To create a system in which researchers can concentrate on research, we must separate out the management aspects and entrust them to specialist personnel. To this end, I want to make all staff, both in research and in general administration, to be able to plan out clear career paths in which they can demonstrate their abilities as the right people in the right places until they reach the age of 65. For AIST to become a research organization that society puts more trust in, as I mentioned before, we must perform backcasting from social problems to select research topics. However, research based on social problems does not need to take 100% of our efforts. Researchers should be able to spend some of their time pursuing research interests. The results from such research interests may grow and transform the world; these shoots must not be trampled underfoot. All this is being discussed internally.

Kishi: How much researchers can follow their own preferences in research is a difficult question. I think it may be the question that management should put most effort into. Another big problem is that research personnel in Japan have surprisingly little mobility. This has been commented on continuously for 50 years and is still the biggest issue in the Basic Plan for Science and Technology.

Ishimura: We must provide incentives for personnel to move. For example, people can come into AIST and improve their earnings, or AIST researchers can move to companies taking their research themes with them from AIST, succeeding in business by using the research results, and then rising to executives in the companies. Personnel moving in these ways is likely to lead to improvements in Japanese R&D in general and to invigoration of industry.

The importance and challenges of open innovation

Kato: The topic of open innovation has cropped up throughout this conversation. What do you think is lacking in open innovation in Japan.

Kishi: It could be taking an international perspective, assuring diversity, and thinking about obtaining appropriate funding and distribution of funds, including private capital. If we are slow to implement open innovation, Japan's research strength will undoubtedly decline. However, while pursuing open innovation, we should take care over questions of research integrity, assuring reliability and fairness in research. Particularly in recent times, importance has been placed on this question in the matter of technology leakage. Advancing open innovation while assuring fairness in research and preventing technology leakage is not simple. We are facing a huge challenge.

Ishimura: AIST also recognizes the matter of research integrity as a serious issue and is paying close attention to government discussions. Regarding open innovation, for example, data from 2018 shows that

private business in Japan spent 14 trillion yen on R&D. In Germany, which is often compared with Japan, R&D spending from private business was 9 trillion yen, less than Japan. However, of this R&D spending from business in Japan, the amount invested in open innovation with universities and public organizations was a mere 0.7%, 100 billion yen, which was far below Germany's 5.6%, 500 billion yen. In addition, private sector investments in national research organizations in Japan were a mere 0.3%, 38 billion yen. This is also a huge issue for AIST. We at AIST must continue our efforts to perform backcasting from social problems to identify research topics, raise the quality of research, and help companies understand the importance of our research and recognize that collaborating with AIST will produce results for business.

AIST as the Sun at the heart of the Japanese research system

Kato: Finally, I want to bring this conversation to a conclusion by asking what form AIST should take in the future.

Kishi: I have five thoughts to share. The first is to raise standards as an institute. The organization should be divided into groups and should raise the standards of young groups without compromising the capabilities of already existing excellent groups. This is the scheme I have implemented at the National Institute for Materials Science and it got results. The second is to make researcher assessments easier to understand. How to assess the mission of the national institute and the independent research of individuals is an important question. The third is technology bridging. Bridging is an important role for the Institute in linking basic research with applied research and industrial research. If, for example, basic research is not supported, the seeds for bridging will disappear. I want AIST to cover a broad scope, including research that sprouts new buds over a wide range, and to be like the Sun at the center of the whole Japanese research system. The fourth is an increase in scale. As a research institute responsible for industrial technology, AIST is still small and I suspect that it needs to increase its number of employees. In particular, scale is important for the data science field and for the regeneration of regional economies. The fifth is to strengthen international networks of individual researchers and to develop international industry–academia–government collaborations at the organizational level. I have given you quite a range of thoughts here, but they are what I feel as an AIST alumnus. I hope this helps.

Ishimura: Thank you for that. Last autumn I put forward three management policies for R&D: improving the quality of research topics; producing synergistic results in the seven research domains; and deploying standardization as a strength of AIST. We are now conducting discussions on management policies for AIST as a whole to play its part as the core participant of a national innovation ecosystem. The five matters raised by Professor Kishi are very important and should be discussed in more depth.

Kishi: I have high hopes. I am confident that AIST can become a world-class research institution.

Ishimura: Thank you for this very stimulating conversation.

Kato: Thank you both for your time today.

(AIST Tokyo Headquarters, July 15, 2021)

PROFILE

Professor Emeritus, the University of Tokyo
President, Innovative Structural Materials Association
President Emeritus, National Institute for Materials Science

KISHI Teruo

Ph.D., the University of Tokyo Graduate School of Engineering, 1969. Professor and Director at the Research Center for Advanced Science and Technology, the University of Tokyo from 1988. Appointments as Head of the National Institute for Advanced Interdisciplinary Research, Ministry of International Trade and Industry, and Director of the National Institute for Materials Science. Science and Technology Adviser for the Minister for Foreign Affairs (Special Assistant), September 2015 to March 2020.

President and Chief Executive Officer, AIST

ISHIMURA Kazuhiko

M.Eng, the University of Tokyo School of Engineering, 1979, and joined Asahi Glass Co., Ltd. (now AGC, Inc.). Served as Chairman and Director of AGC Inc. before being appointed President of AIST in April 2020.

Vice-President, Director, Public Relations Department, and Director, Innovative Human Resources Department, AIST

KATO Kazumi

Ph.D., Nagoya University Graduate School of Engineering, 1989. Posts at AIST include Chief Researcher and Deputy Director of the Inorganic Functional Materials Research Institute, Materials and Chemistry domain. Appointed Vice-President of AIST in April 2017.

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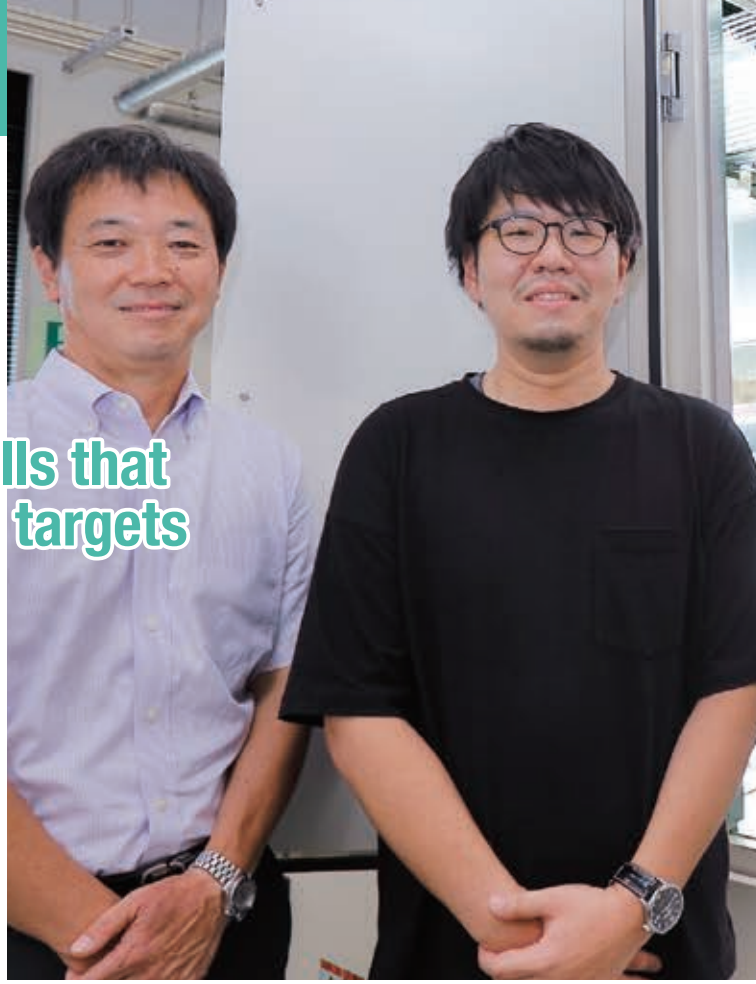


An electric vehicle that can drive 50 km each day just from the power generated by on-vehicle solar cells is no mere dream or tale of the distant future but a target for 2030. R&D into using ultrahigh-efficiency solar cells for space applications here on Earth has already reached the stage of development of equipment for mass production.

III–V compound solar cells with world's highest efficiency

Solar cells installed on-site are a prominent form of renewable energy. It is no longer unusual to see mega solar farms in various parts of Japan. However, there are limits on the locations where solar farms can be set up. Achieving both higher conversion efficiencies and lower costs of solar cells is an important factor of Japan's energy policy.

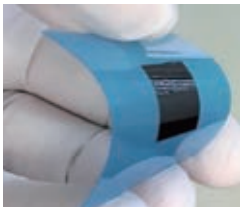
Currently, the world's most efficient solar cells for converting sunlight to electric energy are multijunction solar cells using III–V compound semiconductor materials. III–V compound semiconductors are formed of group III elements such as gallium (Ga), indium (In) or aluminum (Al) with group V elements such as phosphorus (P) or arsenic (As). In a multijunction solar cell, materials (cells) with different absorption wavelengths are connected in series. A multijunction solar cell can utilize sunlight efficiently over a wide range of wavelengths. However, although these cells have ultrahigh efficiency, they are very expensive. Previously, they have been limited to space applications such as satellites, where areas for solar cells are small, loading weights must be as light as possible, and energy must be provided efficiently. They were too expensive to use in our ordinary life. AIST is now working on technological development so that high-efficiency solar cells like those used in space can be used at low cost on Earth, facilitating widespread use.

World-first growth of a high-quality aluminum material for solar cell applications by HVPE

We asked Sugaya Takeyoshi of the multijunction PV team what needs to be done to use these cells on Earth.

"The current cost of solar cells used in space is around 7000 yen per Watt. Our goal is to bring this down to around 200 yen per Watt. We have to achieve improved conversion efficiency while lowering costs. There are two major factors in the high cost: no method has been established for high-speed growth of crystals, which is one of the steps in producing solar cells; and the gallium arsenide (GaAs) plates that are used as substrates for growing the crystals cannot be reused. We have been working on the epitaxial growth technology known as HVPE (hydride vapor phase epitaxy), which can grow materials with a high speed at a cost of around a tenth of previous methods. However, there was a major problem with this technology."

The major technological problem that Sugaya refers to is that crystal growth by HVPE of aluminum materials, which are crucial to improving the performance of solar cells, was not possible. Nobody had previously attempted to employ solar cells of high-quality aluminum-based materials produced by HVPE. Shoji Yasushi, a researcher in the team, worked on the problem: "When I used a metal chloride of an



A flexible solar cell

The Global Zero Emission Research Center Multijunction PV Team

Team leader **SUGAYA Takeyoshi** & **Researcher** **SHOJI Yasushi**

aluminum material in the HVPE equipment, aluminum monochloride (AlCl) was produced and reacted with quartz used in the equipment, which damaged the equipment and introduced impurities into the film. Theoretically, if the reaction temperature was lowered, aluminum trichloride ($AlCl_3$) would be produced instead, which has lower reactivity with quartz, preventing this problem. Moreover, if high speed growth of an aluminum material was possible, we could hope for a technology that enables reuse of gallium arsenide substrates, which was one of the factors in the high cost. Even so, I embarked on these experiments with doubts as to whether this would really work and whether damage to the equipment really could be prevented. Whether we could fabricate high quality solar cells with HVPE equipment depended on the results of this experiment, and I was determined to make a breakthrough."

The result was success, the first in the world, in growing a film of a high-quality aluminum material by HVPE and employing this film in a solar cell. This makes high performance at low cost possible; the team has achieved world-leading high efficiency in solar cells by using HVPE. Now that the possibility of producing high-performance, compact, lightweight solar cells at low cost has been demonstrated, the goal is to develop vehicle-mounted solar cells that are capable of long-range transport.

Creating ideal multijunction solar cells with Smart Stack

In addition to eliminating costs, it is important to achieve further improvements in efficiency. Sugaya and his colleagues have been working to improve AIST's own multijunction technology, "Smart Stack."

"Smart Stack is a bonding technology for arraying palladium nanoparticles at junction boundaries of multijunction solar cells with minimal electrical and optical losses. Increasing the number of different kinds of solar cell facilitates improvements in conversion efficiency. For practical purposes, however, triple-junction is a realistic limit. “While the use of InGaP for the top cell and GaAs for the middle cell has almost been determined, there are various candidates for the bottom cell. We think the most promising candidate is a thin, high-performance CIGS solar cell, whose elements are copper (Cu), indium (In), gallium (Ga) and selenium (Se). The surface of CIGS material has large surface irregularities and is difficult to bond, but can be bonded with Smart Stack. We have produced a triple-junction solar cell with a CIGS bottom cell, and recorded a world’s highest conversion efficiency of 28.1%. The goal of exceeding 30% has come into view."

Hydride vapor phase epitaxy (HVPE) equipment

A dream electric vehicle that 80% of users can drive without charging

Research is now moving on to the development of HVPE equipment for mass production. What kind of future will arrive when we achieve large-scale production of lightweight, ultrahigh-efficiency solar cells?

"First, we will mount these solar cells on unmanned aerial vehicles (UAVs) used for communication that fly in the stratosphere. These are known as 'flying base stations.' We expect the solar cells to supply energy to the UAVs, which will contribute to providing reliable communications without interruption even during disasters.

"Our final goal is to mount the solar cells on cars. Our preliminary calculations are that if we achieve a conversion efficiency of 35% and mount solar cells over an area as small as 3 m^2, 80% of users in Japan can drive daily without external charging. We aim to bring these to market in 2030 and to have solar cells mounted on all electric vehicles by 2050."

As solar cells become more widely used on UAVs and cars, the market will grow and we anticipate that prices will fall. When prices come down, there will be greater scope for other applications such as, for example, applying solar cells to the walls of commercial buildings and installing them on lightweight roofs of factories."

Low-cost, ultrahigh-efficiency solar cells will help us achieve a zero-emission society. Now that we can confidently see a road to practical use, we are moving ahead with research into social implementation.

From artificial photosynthesis to solar chemical manufacturing; taking a short cut to practical application with technologies to amaze the world

Artificial photosynthesis has long been a dream of not just scientists but the whole of humanity. Technologies from AIST, whose work has been leading the world, have been moving towards practical application. Of particular interest are original technologies for producing a range of useful chemicals. We listened to the stories of researchers who have worked for many years in this field, turning artificial photosynthesis technology from a dream to a technology that can actually be used.

Revolutionary new technologies from AIST that are impressing the world

Among the uses of solar energy, artificial photosynthesis is "the fourth technology" after solar photovoltaic cells, solar thermal power generation and biomass. The characteristics of artificial photosynthesis are that it uses non-degrading inorganic materials and can convert solar energy directly to chemical energy that can be stored. Many scientists are working on R&D into artificial photosynthesis as a next-generation technology that will lead to solutions to energy problems.

AIST has developed world-leading new technologies in the field. In 2001, we were the first in the world to use a powdered photocatalyst to completely split water with visible light. In 2003, we developed photoelectrode membranes coated with a powdered photocatalyst of bismuth vanadate ($BiVO_4$), which subsequently caused great excitement worldwide. We have achieved world-beating conversion efficiencies with both photocatalyst systems and photoelectrode systems.

Sayama Kazuhiro of the Artificial Photosynthesis Research Team says "This field is not long established; there was a time when just conducting research would result in top-level articles. However, to solve humanity's energy problems, solar energy conversion systems must be used in daily life. We still have a long road to practical application and there are many hurdles to overcome."

AIST is working on two ways to overcome these hurdles. One is AIST's own photocatalysis–electrolysis hybrid system. The goal of this system is to mimic the workings of natural photosynthesis to produce hydrogen at low cost. The other is using photoelectrodes to produce useful chemicals. So, just what kind of technology is that?

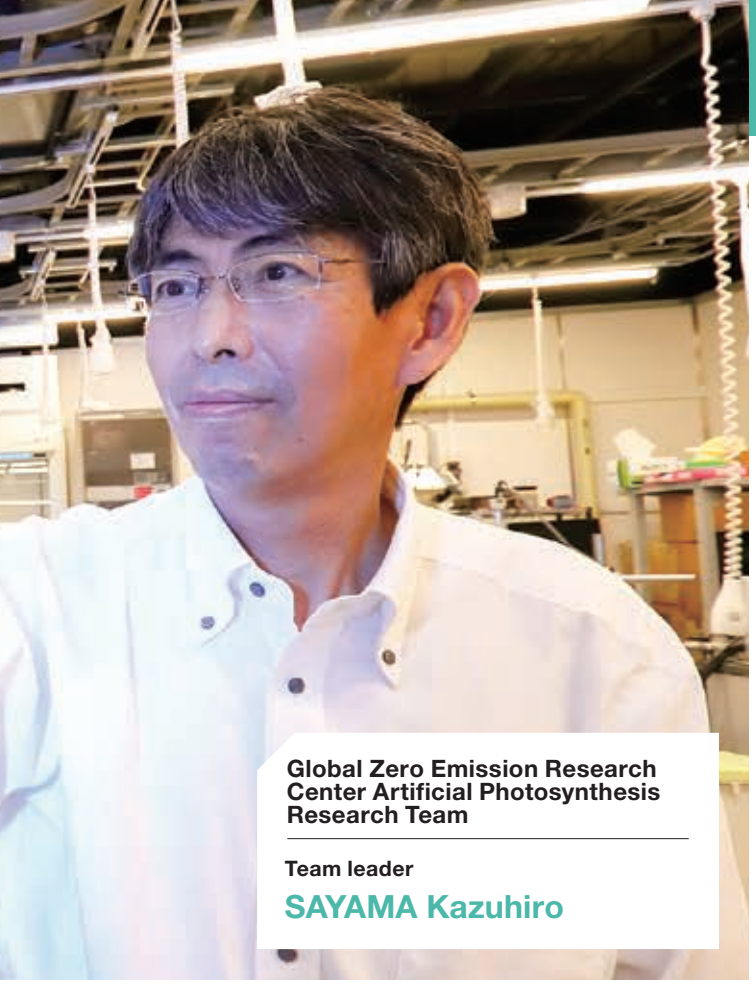
Production of useful chemicals bringing a series of successes

"Using photoelectrodes to produce useful chemicals" refers to technologies that use sunlight to simultaneously produce chemical products and hydrogen. Before the concept was announced in 2015, almost no research was focused on the oxidation reaction side, the opposite of hydrogen production; the field was a blank page.

"In artificial photosynthesis, as in plants, a fuel such as hydrogen is produced on the reduction side while oxygen is produced on the oxidation side, and only the energy of the fuel is used. At one time, this concept was taken for granted. However, humans are different from plants and do not have to stick to producing oxygen. We started from the idea that it would be good to produce chemicals with significantly higher added value than oxygen at the oxidation side."

A photoelectrode membrane coated with a photocatalyst is used in a pair with a counter electrode. An ion exchange membrane is provided between the photoelectrode and the counter electrode to prevent a reverse reaction. The team has succeeded in using photoelectrodes to alter feedstock solutions and efficiently produce various useful chemical products that can lead to bleaching agents, disinfectants, raw material for pharmaceutical discoveries and so forth. Meanwhile, hydrogen is simultaneously produced from water at the counter electrode. The two electrodes are both put to use and neither is redundant.

In 2018, the team developed a technology to



Global Zero Emission Research Center Artificial Photosynthesis Research Team

Team leader

SAYAMA Kazuhiro

synthesize nylon feedstock from cyclohexane at room temperature and pressure. In 2021, in cooperative research with America's Brookhaven National laboratory (BNL), they succeeded in producing hydrogen peroxide at two electrodes from just carbonated water, sunlight, and oxygen. They achieved world-beating efficiency with a simple arrangement that consumes no electric power at all. This is quite a series of successes.

"Using sunlight to quickly produce large amounts of hydrogen peroxide, hypochlorous acid or the like has an economic disadvantage in that sunlight varies with the weather. Even so, we can, for example, make small amounts of hypochlorous acid on remote islands and in deserts and use it for purifying water. We are looking at a path of development and practical use for high-sustainability niche applications like this local production and consumption of a chemical substance, and then moving on to progressively grow the scale of applications."

Producing hydrogen from seawater; a new concept arising from cross-disciplinary synergy

Seawater and sunlight are plentiful on the Earth. The team has developed artificial photosynthesis technology that combines the two to selectively produce only hydrogen and oxygen. "When seawater is used for oxidation, a competitive reaction between hypochlorous acid and oxygen arises. However, if manganese is applied to a small portion of the surface of a photoelectrode, only oxygen is produced at that photoelectrode, and if cobalt is applied, only hypochlorous acid is produced. We are now able to control reactions in seawater."

In actual large-scale seawater–hydrogen electrolytic production systems, hypochlorous acid is a damaging substance that causes corrosion and degradation of the system. Therefore, this technology for selectively producing oxygen or hypochlorous acid is giving impetus to efforts to produce hydrogen from seawater at low cost.

Sayama says that there is another, even more important research result. "The only substance that generates oxygen alone from seawater while not producing any hypochlorous acid at all is manganese. In photosynthesis in plants, manganese is employed as a catalyst for oxygen production. From long discussions with experts on natural photosynthesis, I have learned that it is not clear why in the evolution of plants manganese was selected for natural photosynthesis. Our current results may provide a clue to solving this mystery. Pursuing research through synergies with the research communities of other fields and finding triggers for new scientific developments and innovations is one of the interesting things about research."

We are eagerly anticipating academic contributions as well as practical applications.

As practical application accelerates, the concepts of artificial photosynthesis are changing

To develop excellent photocatalysts and photoelectrodes, huge amounts of work are needed from material searches, to producing samples and evaluating the samples. Therefore, Sayama has independently developed and is incrementally improving a "rapid automatic search machine." Last spring, he started up machine No. 3 (upper left photo), which creates desired materials in short times by utilizing rapid automatic screening and machine learning.

Sayama says "Under the Paris Climate Accord, Japan has set a greenhouse gas emissions reduction goal for 2030 and is committed to carbon neutrality in 2050. Now a deadline has been set, we are keenly aware that what we need to research has changed and we must try to raise our pace." The prospect is that artificial photosynthesis will soon change our language and ideas towards goals such as solar hydrogen production, solar fuel production, and solar chemical production. The day of artificial photosynthesis is steadily approaching.

Photocatalyic activity evaluation apparatus

Achieving carbon neutrality by 2050 Developing multiple scenarios to make technology work for society

Innovative energy and environmental technologies are needed to tackle climate change. An expert team for assessing studies develops not technology but scenarios of technology implementation. It scientifically assesses how new technologies will affect the global environment, society, and economy, and shows multiple pathways for creating sustainable systems by implementing the technologies.

Assessment studies connecting cutting-edge technology to our society

The Global Zero Emission Research Center (GZR) has ten research teams. The Environmental and Social Impact Assessment Team plays a slightly different role from the others. We asked about the role to Morimoto Shinichiro who leads the team.

"The research teams at GZR are working on R&D relating to energy and resources for achieving a zero-emission economy. The impact of technologies need to be assessed appropriately and 'scenarios' for introducing the technologies are highly required. Our role is to create these scenarios by our assessment methods which is applicable for different technologies. We conduct our research with various approaches: for example, process simulations to assess the impacts of introducing technologies at factory scale; environmental economics techniques to assess social acceptance; and AI to analyze correlation between lifestyle and energy consumption in households."

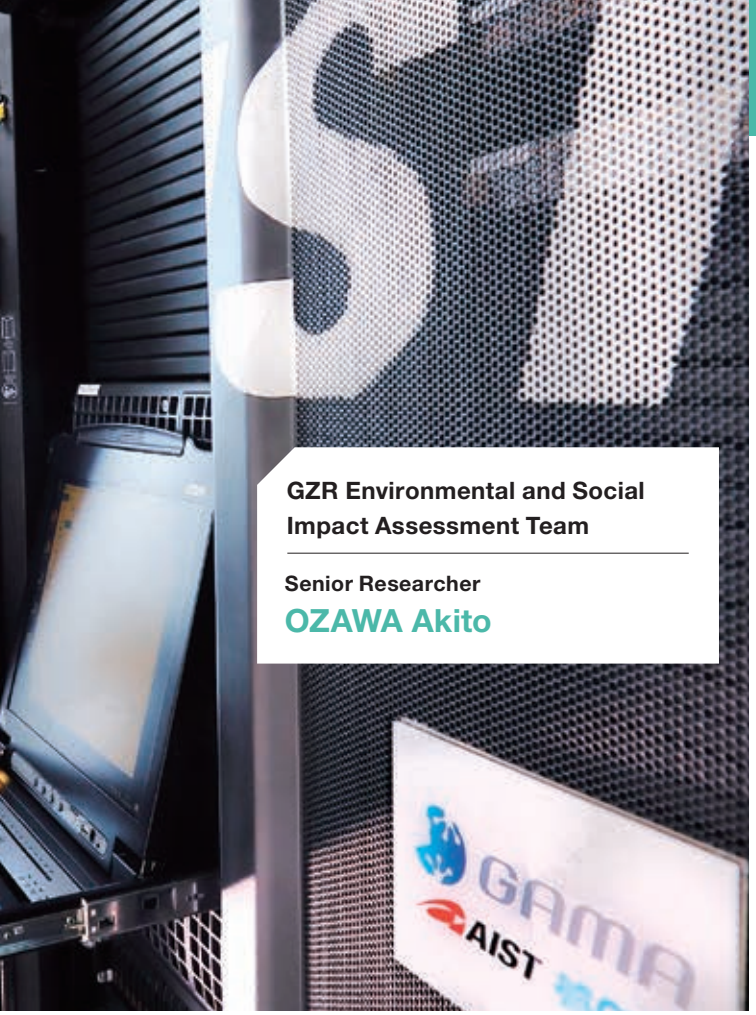
The results of our research is useful for making government and business strategies to achieve zero-emission economy. We play an important role in providing information that is useful for assessing impacts of a wide range of research fields in the energy and environmental domains, including research by GZR.

Scenario analysis for finding multiple pathways

As an example of the team's research, Ozawa Akito, a team member, introduced us his study on long-term scenarios using energy models. He has employed the energy models "MARKAL" and "TIMES," developed by the International Energy Agency (IEA). The models have been used in many countries as a tool to support decision-making in energy and environmental policies, technology development strategies and so forth.

In a study published in 2018, Ozawa and his colleagues used these energy models and found that the CO_2 emissions from the electricity sector should be reduced to zero by 2050 if Japan is to reduce CO_2 emissions from energy use by 80% from the 2013 level by 2050. Four types of low-carbon power generation, i.e. renewables, nuclear, fossil power with CCS (carbon capture and storage), and hydrogen, should play a vital role in the future energy system in Japan. The analysis also indicated that the contribution of these four power generation technologies will vary depending on future efficiencies and potentials.

He said "The important thing for us is not to focus on a single scenario. Scenarios are like maps; there is not just one route from your current location to your destination. When we plan several possible routes before starting off, things can go smoothely and achieve the goal even when one of the routes hits a dead end. Therefore, when we develop scenarios, we should consider the possibilities and uncertainties of



GZR Environmental and Social Impact Assessment Team

Senior Researcher

OZAWA Akito

the future, and seek multiple pathways."

Since results of assessment studies could vary depending on various assumptions even when the same energy model is used, researchers have to make accurate decisions for making better assumptions. Ozawa said that the research environment in AIST is excellent for such decisions.

"AIST possesses massive amounts of knowledge about energy technologies. Moreover, when we want to learn about the latest trends and prospects of any technology, we can always find an expert of the technology somewhere in the Institute. Assessment studies cannot be accomplished with published literature alone. We have a huge advantage that we can learn directly from experts on technology development."

Big data analysis with a supercomputer

In March 2021, GZR introduced a supercomputer called GAMA (Gigantic Analysis platform using Modelling and AI). GAMA handles large-scale time series data gathered from society, including smart meter data, and data obtained from experiments by the researchers at GZR, and gains collective intelligence from the data.

"GAMA has a great advantage in handling big data and analyzing data with deep learning and AI using dedicated computers. GAMA performs an analysis in hours or days which might have taken weeks or months previously. This is delightfully convenient."

Ozawa explained that the choice of the name "GAMA" was inspired by a gama toad, for which Mt. Tsukuba is famous. GAMA may well come to symbolize the GZR research base at Tsukuba.

Targets to be achieved for carbon neutrality

Since the COP21 Paris Agreement of 2015 and the IPCC "Special Report on Global Warming of 1.5°C" of 2018, the number of nations and regions that commit themselves to carbon neutrality by 2050 has expanded, and reached 126 including Japan (as of April 2021).

Ozawa's current research interest is formulating scenarios for achieving carbon neutrality by 2050. In particular, he focuses on examining carbon dioxide removal (CDR) technologies. "Carbon neutrality requires technologies that artificially remove emitted CO_2 as well as technologies that reduce CO_2 emissions. It is extremely important to formulate scenarios about what kinds of CDR technologies will be developed in the future and how they will be introduced into society."

At present, we are witnessing a tide of actions aiming at carbon neutrality around the world. Let us ask him whether the carbon neutrality goal can be achieved by 2050.

"It is undoubtedly a tough challenge. But I really think these targets must be achieved. In my opinion, we must tackle climate change for future generations to live safely and happily, no matter how strenuous our efforts may be. I believe our work contributes to the realization of carbon neutrality."

The Environmental and Social Impact Assessment Team assesses AIST's innovative world-leading technologies by various metrics for properly implementing these technologies.

The GAMA supercomputer
R: Team leader MORIMOTO Shinichiro

AIST and Environmental Problems

To build a sustainable society, AIST brings the results of research and development to society. To incorporate environmental considerations into the research and development process, AIST has set an Environment and Safety Policy and complies with laws and regulations in its business activities.

See pages 58-61 for more details▶

Charter of Environment and Safety

- We strive to promote research activities that contribute to the global environmental protection and the security of mankind and pursue our work to realize a safe and reliable society of high quality of life harmonious with the environment.
- In compliance with the applicable laws and regulations related to environmental protection, we establish the autonomous standards of the institute such as Safety Guidelines, etc. and with this in mind, we shall endeavor to conserve environment and promote health and safety at all times.
- We promote the dissemination of information related to the environmental protection and make every effort to be in harmony with and coexist with the local community. Naturally, in case of disasters or emergencies, we take prompt and proper measures to deal with the situation. Furthermore, in conformity with the 'principles of disclosure,' we shall endeavor to return the knowledge acquired and accumulated to society.

Environmental Policy

To build a sustainable society, AIST has a Charter of Environment and Safety in place. Its aim is to bring the results of research and development to society, as well as to incorporate environmental considerations into the research and development process. Under the Charter of Environment and Safety, we have set an Environment and Safety Policy to proactively work with a keen awareness of the importance of ensuring global and local environmental conservation, and the health and safety of everyone working at AIST. This is done keeping in mind AIST's characteristic as a research institute that handles a wide variety of chemicals and poisonous substances.

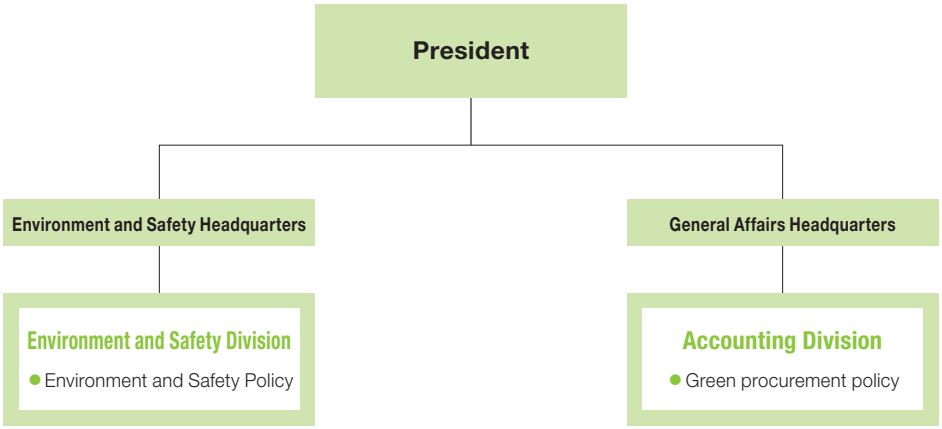
Environment and Safety Policy

1. We proactively conduct research that contributes to conservation of the environment and the development of a healthy and safe society.
2. We comply with laws, regulations, ordinances, and agreements on the environment, health and safety, set our own management standards, and seek to further improve environmental conservation, health and safety.
3. We seek to reduce the consumption of energy and resources and the generation of waste, and thus aim to reduce loads on the environment.
4. We seek to prevent pollution and work-related accidents, to take prompt and appropriate actions in the event of an emergency, and to prevent the spread of damage.
5. We are developing a management system for effectively and efficiently conducting activities to ensure environmental conservation, health and safety with the participation of all members of AIST; we seek continuous improvement.
6. We actively disclose environmental, health and safety information by publishing environmental reports and disclosing information to promote communication with society.

We also set a policy for promoting the procurement of eco-friendly goods and services in accordance with the Act on Promotion of Procurement of Eco-friendly Goods and Services by the State and Other Entities, Green Purchasing Act, and the Act on Green Procurement.

Implementation Structure of Policies Related to Environment and Safety

AIST's headquarters organizations and operating units work together closely to implement our environmental initiatives covering the whole of AIST.



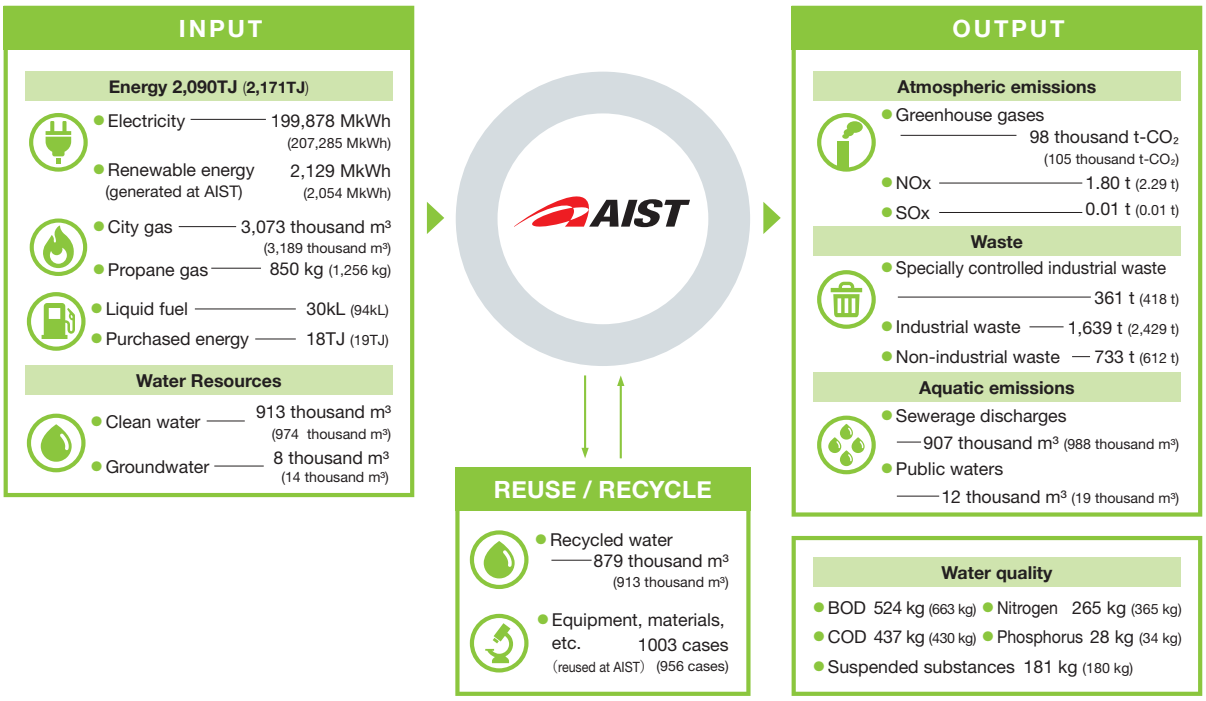
Environmental and Safety Management System

AIST has its own environmental and safety management system (ESMS) in place which is eco-friendly and appropriate for a research institute. It combines two subsystems: an environmental management system and an occupational health and safety management system.

At each AIST site and research base, PDCA (Plan-Do-Check-Act) cycle is implemented, and know-how for workplace safety and health is carried on as we strive to reduce potential danger and prevent accidents

Overview of Environmental Burdens

( ): FY 2020 results



Appropriate Management of Chemical Substances

AIST has introduced the Chemical and Gas Management System that enables management of possessed and used quantities of chemicals so that researchers can appropriately self-manage the wide range of chemicals used in research activities. Through this system, the Environment and Safety Headquarters enforces proper management by understanding the kinds and quantity of chemicals possessed by researchers and appropriately calling for attention to the laws and regulations and the amounts possessed.

Response to PRTR system

Based on the PRTR system and ordinances and guidelines of the Tokyo Metropolitan Government, the Osaka Prefectural Government, the Fukushima Prefecture, AIST grasps the amounts of chemicals discharged to the atmosphere and moved as sewage water or waste material. For FY 2020, chloroform, n-hexane, hydrogen fluoride and its water-soluble salts, ferric chloride, N,N-dimethylacetamide are subjected to the PRTR system, acetone, chloroform, ethyl acetate, methanol are subjected to the ordinance of Tokyo, volatile organic compounds are subjected to the ordinance of Osaka, and ammonia, hydrogen peroxide, sulfuric acid are subjected to the guidelines of Fukushima.

Consideration for Biological Diversity

To comply with the Cartagena Act* for the conservation of biological diversity, AIST requires the researchers and the research support staff involved with recombinant DNA experiments to undergo education and training, and reviews the experiments based on the opinions of the committee of external experts. We conduct on-site inspections of all laboratories conducting recombinant DNA experiments to verify all is managed correctly according to the law.

When experiments on animals are conducted at AIST, the experimental design is reviewed for the 3R principles (Replacement, Reduction and Refinement) outlined in the Act on Welfare and Management of Animals. and the results of self-assessments are posted on our public website. We have been subject to external inspections and certification by the Center for Accreditation of Laboratory Animal Care and Use of the Japan Pharmaceutical Information Center.

* The Cartagena Act: In Japan, the Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms came into effect in 2004. It aims to ensure safe handling of living modified organisms that could have adverse effects on the conservation and sustainable use of biodiversity.

Consideration for Water Resources

Prevention of water pollution

Wastewater from laboratories are sent to wastewater treatment plants and processed to abide by the Water Pollution Prevention Act and to meet municipal effluent standards. It is then discharged into the public sewerage system. To prevent water containing hazardous substances from leaking into groundwater, AIST builds dikes and conducts periodic inspections of buried research wastewater pipes and groundwater quality to check for abnormalities.

Wastewater treatment plant at AIST Tsukuba

Use of reclaimed water

For the efficient use of water resources at Tsukuba Central and AIST Tokyo Waterfront, research wastewater is neutralized, treated with reducing agents, and reused as recycled water. It is used for cooling laboratory equipment and flushing toilets. In FY 2020, 49% of the total water use was recycled water.

Water reuse plant at AIST Tsukuba

Consideration for Atmospheric Emission

Reduction of fluorocarbon emissions

In accordance with the Act on Rational Use and Proper Management of Fluorocarbons, AIST requires periodic inspections and spot checks of refrigeration and air conditioning equipment that uses fluorocarbons as refrigerants, to restrict emissions of fluorocarbons into the atmosphere. In FY 2020, a total of about 273t-CO_2 was released, and it was less than the amount (over 1,000t-CO_2) required to report under the Act.

Prevention of air pollution

Regarding boilers for air conditioning that are major sources of NOx and SOx, we measure the effluent gases twice a year so that they do not exceed the emission standards under the Air Pollution Control Act. Regarding NOx, in FY 2020, the measurement results were all within the limits. Of SOx, there has been little emission since 2017, and the results fall far below the emission standard. In addition, when replacing equipment, we choose chiller units with high energy-saving effects and downsized units to reduce emissions.

Energy-saving Efforts

We work to reduce energy consumption per unit to an annual average of over 1% in the medium to long term, an amount required under the Act on the Rational Use of Energy. To achieve the target, we actively install devices with high energy-saving effect when renovating facilities, in addition to taking energy conservation measures by appropriate temperature settings of air-conditioners. Our existing solar power systems are being used effectively, and renewable energy systems have been installed in our new buildings. Presently solar power systems are installed at AIST Tsukuba, AIST Tohoku, Fukushima Renewable Energy Institute (FREA), AIST Tokyo Waterfront, AIST Kashiwa, AIST Chubu, and AIST Kansai. Wind power generation is installed at FREA.

Energy consumption per unit average of FY 2016–2020: 98.7% (96.7% compared to the previous year)
Amount of renewable energy generation: 129,024 kWh (about 1% of total electricity consumption of AIST)

Green Procurement Efforts

Each year AIST discloses its policy for promoting the procurement of eco-friendly goods and services, in accordance with the Act on Promotion of Procurement of Eco-friendly Goods and Services by the State and Other Entities (Green Purchasing Act), and the Act on Green Procurement. Moreover, in accordance with the Green Purchasing Act, automobiles were leased in a comprehensive evaluation bidding system from the best company after prices and environmental performance (fuel consumption) were evaluated, and the environmental threshold system was adopted for power supply and waste contracts with companies that cleared the standard after evaluating their reduction efforts for global warming gas emission and compatibility to the certification system for excellence and that placed the lowest bid.

FY 2020 procurement rate of designated procurement items defined in the Green Purchasing Act: 100% (excluding media cases, automobiles (general official vehicles), electric refrigerators, air conditioners, LED lighting devices.)

Applying the 3R principles

AIST seeks to reduce waste by applying the 3R (Reduce, Reuse and Recycle) principles and thus reduce environmental loads. We are focusing particularly on the reuse of research equipment, because this reuse can also contribute to cost savings. An AIST intranet-based article recycling system has been in place for items no longer necessary, including research equipment, office electrical equipment, furniture and consumables, to promote reuse within AIST.

Cases of reuse for FY 2020: 1,003

Response to Environmental Accidents

AIST conducts contact, communication, and an emergency action drill once a year to minimize damage in the event of an environmental accident such as a leakage of oil or a chemical. We have a communication system that once the Environment and Safety Headquarters and operation rooms of research sites are contacted can immediately deal with an accident if it occurs. After expeditious measures, related organizations are notified. The Environment and Safety Headquarters analyzes the cause of the accident and takes measures to prevent a recurrence of such an incident.

Environmental accident drills of FY 2020: 19 accident drills across all research bases and others (supposing damage of research wastewater pipes, leakage of research wastewater while transporting)

Emergency accident drill supposing research wastewater leakage after polyethylene tank with wastewater overturned (bath agent water was used).

Environmental Education

We provide training every year on issues with significant environmental impacts such as how to treat liquid wastes and vent gases from research and how to sort and remove waste.

TOPICS

Equipping the Global Zero Emission Research Center

In accordance with the Environment Innovation Strategy, a basic policy document produced by the government in 2020, AIST established the Global Zero Emission Research Center (GZR) at the end of January 2020, an organization whose purpose is to establish innovative technologies that will enable global carbon neutrality.

To equip a base for research activities, the main building and some of the other buildings at AIST Tsukuba West were renovated in FY 2020.

As a result of careful design and construction with various energy efficiency features to provide a suitable base for an organization conducting R&D for achieving a zero emission society, one of the renovated buildings, Tsukuba West 4A, was certified "5* ZEB," which is the highest level of the Building–Housing Energy-efficiency Labelling System (BELS).

BELS is a system for labelling the energy efficiency performance of buildings that is specified to enable easy comparisons of energy efficiency performance between different buildings. ZEB (which is short for "Net Zero Energy Building") identifies a building that, while providing a comfortable indoor environment, brings the primary energy balance of energy consumption in the building below net zero. According to levels of energy efficiency performance, stars are assigned in five levels, and the highest level (5*) is divided into three ranks: in descending order, "5* ZEB," "5* Nearly ZEB" and "5* ZEB Ready." AIST achieved "5* ZEB" (awarded April 1, 2021) by renovation of an existing building.

Tsukuba West building group 4 equipped for energy efficiency including building West 4A, which attained 5* ZEB, with 179 kW capacity of solar panels on the roofs (equivalent to that of 35 ordinary houses)

Entryway approaching the foyer of the renovated main building

Industry–Academia–Government Collaboration and AIST

Data of Research Activities (FY 2020)

See pages 52-53 for more details▶

Research presentations (in journals)	4,523 cases	Innovation coordinators	65 people
Research presentations (oral)	4,348 cases	Technology consulting	687 cases
Number of joint research	1,086 cases	Technical advice	2,193 cases
Joint research revenue	72.6 million yen	Number of AIST staff contributing in international standardization activities	491 people
Number of commissioned research projects	94 cases	Number of proposed standards	34 cases
Fund received for commissioned research	9.8 million yen	Number of overseas organizations with whom AIST has concluded MOUs	25 institutes
Acceptance number of external researchers for joint research	1,990 people	Number of foreign researchers	439 people

Data of Personnel Training and Use (FY 2020)

Number of users of the cross-appointment program	56 people	Number of students who finished courses at AIST Innovation School	38 people
Number of users of the AIST Research Assistant Program	465 people	Number of students who finished courses at AIST Design School	46 people
Number of technical trainees	1,351 cases		

Technology bridging

AIST conducts cooperative research, contract research, technology consulting, technical advising, contract testing, provision of research samples and so forth, and contributes to R&D and product development by businesses. At hubs such as the Cooperative Research Laboratories and Open Innovation Laboratories, AIST collaborates with companies, universities and others to investigate possible applications of technology and promotes open innovation.

Provide a Platform for Industry–Academia–Government Collaboration and Promote Acceptance of Researchers

See pages 52–53 for more details. ▶

●Active invitation of external researchers

Number of external researchers for joint research accepted in FY 2020: 1,990

AIST provides researchers from our joint research partner institutions with an access to AIST's state-of-the-art facilities to conduct effective joint research.

●A platform for industry–academia–government collaboration

AIST recruits members from, and collaborates with, various companies and organizations to organize thematic research association (AIST Consortiums). We explore potential application of cutting-edge technologies and aim at promoting R&D and creating new markets.

●Joint and commissioned research projects conducted in past years

Our joint research is R&D projects between AIST and our cooperative partners—companies, universities, or public research institutions with common objectives and goals—with the aim of creating innovative results that cannot be achieved by individual research. Commissioned research is a type of R&D project conducted solely by AIST under contract with a company or other organization. Through this research, companies can use AIST's research potential to offset their lack of necessary technology to proceed with their own R&D project. Technology consulting is a system by which AIST—a multidisciplinary group of professionals—provides solutions based on its cutting-edge research capability and abundant knowledge to overcome challenges that companies cannot solve by themselves. In FY 2020, 687 cases were implemented.

Marketing Activities toward Creation of Innovation

At AIST, the Research and Innovation Promotion Headquarters, research domains, and research units are working together to promote collaboration with partners by improving the flamework of cross-sector marketing activities spanning different domains and regional research bases in order to quickly and accurately understand diverse needs according to the characteristics of different industries.

Innovation coordinators (IC) are responsible for liaising with external bodies such as companies and universities. As of March 2021, 65 ICs focus on transferring technology to society. AIST supports setting up new business and creating new products and services in companies starting from coordinated menus made with various companies using its technology consulting system. Through technology consulting based on analysis of company needs, we propose research themes that span across a number of research domains based on company-wide business plans of partners. We also conduct "co-creation consulting" with companies to consider search of new business seeds and setting of coordinated themes from the concept stage.

These comprehensive, cross-sector marketing activities are contributing to the creation of innovation through new business and connections between different fields.

Cooperative Research Laboratories

In order to conduct R&D that more closely relates to the strategies of companies, we are collaborating with partner companies and have set up Cooperative Research Laboratories in AIST bearing the names of these partner companies. The partner companies provide researchers and research funding, and AIST provides research resources including researchers, research facilities and intellectual property. The researchers loaned from the companies and AIST's researchers work on R&D in cooperation. As of March 2021, we were operating 17 Cooperative Research Laboratories. We hope they continue to make an impression as platforms for collaboration and synergy involving companies, universities and other research institutes. In FY 2020, we established the Komatsu–AIST Human Augmentation Cooperative Research Laboratory, Sumitomoriko–AIST Advanced Devices of Polymer Materials Cooperative Research Laboratory, HORIBA Institute for Particle Analysis in AIST TSUKUBA.

Open Innovation Laboratories

AIST has set up Open Innovation Laboratories ("OILs"), which are industry–academia–government collaborative research bases sited on university campuses. As of July 2021, 9 OILs were in operation. By sharing research bases, they seamlessly conduct basic research, application research, development and testing. They focus on faster research and active mobility of human resources using the cross-appointment program, and also on practical training of doctoral students and postdoctoral researchers through the Research Assistant Program. This initiative synergizes the basic research of universities and other organizations with AIST's goal-oriented basic research and application technology development, facilitating transfers of technology to industry toward solving social issues. In FY 2020, we strengthened the bridging function through cooperation with universities as seen in the increase of collaborative research contract cases with private companies, and acquisition of public funds for the establishment of a place for co-creation with universities. Using OIL as hubs, we will continue to promote integration of different fields and put our efforts into strengthening the platforms for collaboration and synergy.

Participation in Technology Research Associations

AIST has become a member of Technology Research Associations, the member of which jointly carry out research and development of technologies used in industry by sharing their resources such as researchers, funds, and equipment. AIST participates in the associations' projects from planning and performing research to utilizing research outcomes.

Particularly by sharing our "personnel" and "premises" with the associations, we aim to serve as a field where various people from different organizations can share their knowledge toward co-creation. We thus aim to help promote open innovation.

Specifically, AIST staff members participate in the associations' projects as researchers, project leaders or board members. We also give access to our facilities to researchers from industries and universities participating in the associations for carrying out intensive research.

●Technology Research Associations in which AIST participated (FY 2020)

	Name	Appointment of board members (as of July 2020)
1	Photovoltaic Power Generation Technology Research Association (PVTEC)	○
2	Consortium for Lithium Ion Battery Technology and Evaluation Center (LIBTEC)	○
3	Fuel Cell Cutting-Edge Research Center Technology Research Association (FC-Cubic)	○
4	Photonics Electronics Technology Research Association (PETRA)	○
5	Technology Research Association for Next Generation Natural Products Chemistry	○
6	NMEMS Technology Research Organization (NMEMS)	○
7	Control System Security Center (CSSC)	○
8	Technology Research Association of Magnetic Materials for High- Efficiency Motors (MagHEM)	○
9	International Research Institute for Nuclear Decommissioning (IRID)	○
10	Manufacturing Technology Association of Biologics (MAB)	–
11	Thermal Management Materials and Technology Research Association (TherMAT)	○
12	Innovative Structural Materials Association (ISMA)	–
13	The Research Association of Automotive Internal Combustion Engines (AICE)	–
14	Technology Research Association for Future Additive Manufacturing (TRAFAM)	○
15	Geological Carbon dioxide Storage Technology Research Association (CCS)	○
16	Technology Research Association of Secure IoT Edge application based on RISC-V Open architecture (TRASIO)	–

TIA Collaborative Research Program (“Kakehashi”)

“Kakehashi” (a Japanese word for a “linking bridge”) is a program that promotes collaboration among the six organizations of TIA (AIST, National Institute for Materials Science, University of Tsukuba, High Energy Accelerator Research Organization, the University of Tokyo, and Tohoku University). Since it started in FY 2016, “Kakehashi” has been supporting feasibility studies with the aims of finding “seeds” and “sprouts” of research and technology at various stages, nurturing “buds” through collaboration and transferring “fruits” to industry. It has helped advance development of a remote work support system that enables a non-expert to perform high-level work under the instruction of an expert in a remote location by using an optical see-through head-mounted display.

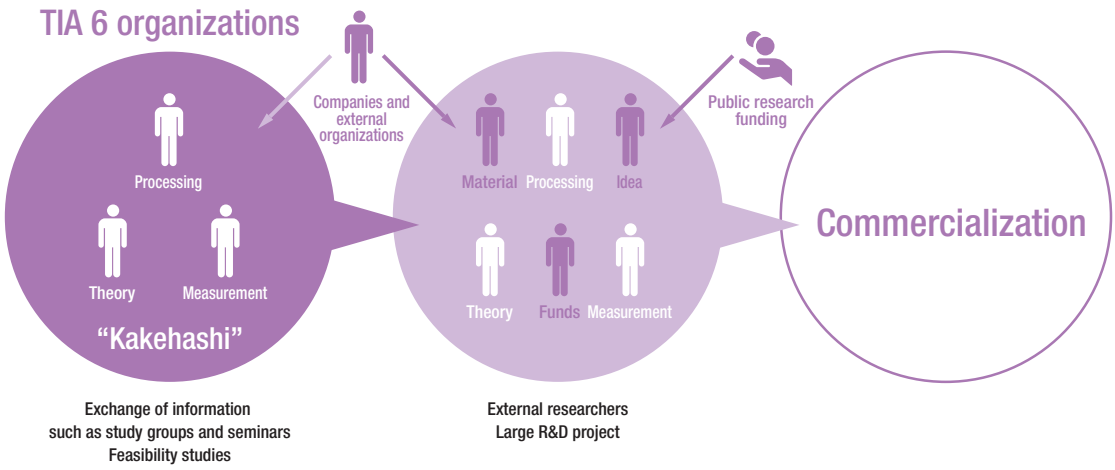
●Activities in FY 2020

The 52 “Kakehashi” feasibility studies in FY 2020 covered 6 areas such as healthcare, biotechnology, and electronic devices, of which 19 were from AIST. We provided not only financial support but also held on-line events and provided referrals to websites on issues related to various stages in research development.

●Company-proposed themes

We started implementation of “Kakehashi” themes proposed by companies with TIA mediating to organize “Kakehashi” teams in FY 2018. In FY 2020, there were a total of 6 cases (of which 2 were from AIST), including 2 cases of electronic devices, 2 cases of green, 1 case of material processing, and 1 case of basic research.

●Image of “Kakehashi”



Promoting International Standardization

See page 52 for more details ▶

Standardization themes that crossover a number of industries are increasing such as for various connected products with the advancement of digital technology. Under such circumstances, AIST established the Standardization Promotion Center on July 1, 2020, in order to further strengthen cross sectoral standardization activities that span over industry and research based on political and industrial needs. Moreover, we newly established a position, “Standardization Officer (SO),” as an expert who consistently leads the standardization activities. SO considers dissemination measures and coordinates between stakeholders using expert knowledge on standardization.

At international organizations such as International Organization for Standardization(ISO) and International Electrotechnical Commission (IEC), 64 AIST researchers are actively serving as chairs, committee managers, or convenors while 427 in total are participating as experts with specialized knowledge contributing to the development of standards.

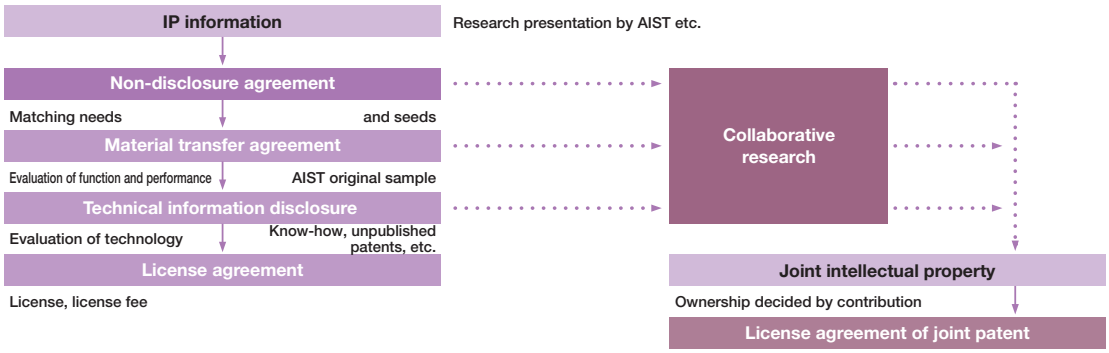
In FY 2020, we proposed a total of 34 domestic and international standards, including the Japanese Industrial Standards (JIS) for the testing method for decolorization of bone china dishes due to dishwasher use, and IEC standard for the evaluation method of bare silicon and epitaxial wafers.

Technology Transfer Activities

It is AIST's mission to contribute to the development of the economy and industry by disseminating its research achievements in society. To achieve this mission, AIST develops a strategic approach to obtain intellectual property (IP) rights, and appropriately maintain and manage such IP rights so that the research achievements lead to technology transfer.

Specifically, based on the needs of the partner in cooperation for AIST's intellectual property, we perform the necessary procedures (signing of a non-disclosure agreement, a material transfer agreement, a technical information disclosure agreement, a license agreement and such), and promote wide dissemination of AIST's research outcomes in society.

●Technology transfer process



Deploying and developing human resources

AIST promotes staff exchanges to facilitate the development and utilization of personnel who will produce innovation. AIST's efforts to develop training activities include AIST Innovation School and AIST Design School.

Cross-appointment Program

See page 52 for more details ▶

To create a cross-institutional research system, in November 2014 AIST established a cross-appointment program. This program allows a researcher to enter into employment contracts with multiple institutions and he/she can work in research, development, and education according to one's role in each institution.

Interchange of researchers between AIST and the other institutions increases mobility of human resources among academic, industrial, and governmental sectors. As a core institution for transfer of technology, AIST is expected to adopt superior technology seeds produced by fundamental research by universities and to promote transfer of technology for practical application of research outcomes and creation of new industries.

We accept 37 researchers from 16 universities, 1 private company, and 2 institutions, and send 6 researchers to 5 universities and 1 private company. (As of April 1, 2021).

AIST Research Assistant Program

To develop human resources with world-class, high-level expertise and practical research ability that produce results leading to innovation, AIST provides the AIST Research Assistant Program to hire graduate students with high levels of ability. This program allows talented graduate students to focus on research for their degrees without financial difficulties. By participating in AIST's R&D activities which meet social needs, students can develop the ability to plan and conduct the advanced research, which is crucial for R&D activities. In FY 2020, 465 students in graduate programs engaged in R&D at AIST.

Employment requirements for AIST Research Assistants

(as of May 2021)

Candidate	Graduate students in master's programs	Graduate students in PhD programs
Requirements	R&D and paper-writing abilities that help promote of AIST's R&D projects, and independent execution of duties with staff guidance.	Superb R&D and paper-writing abilities that contribute highly to the promotion of AIST R&D projects, and independent execution of duties with staff guidance.
Days of employment	Avg. 4-14 days/month	Avg. 10-14 days/month
Salary	1,500 yen/hour (approx. 80,000 yen/month for 7 working days)	1,900 yen/hour (approx. 200,000 yen/month for 14 working days)
Number of graduate students employed in FY 2019	465	

Voices of research assistants

- I think the biggest appeal of the AIST Research Assistant Program is that it gives you the chance to learn the significance of your research and also how it is connected to society. (Second-year student of doctoral program)
- It is a perfect environment for a person who wants to demonstrate his ability in high-level research. (First-year master's program)

Technical Training

See page 53 for more details ▶

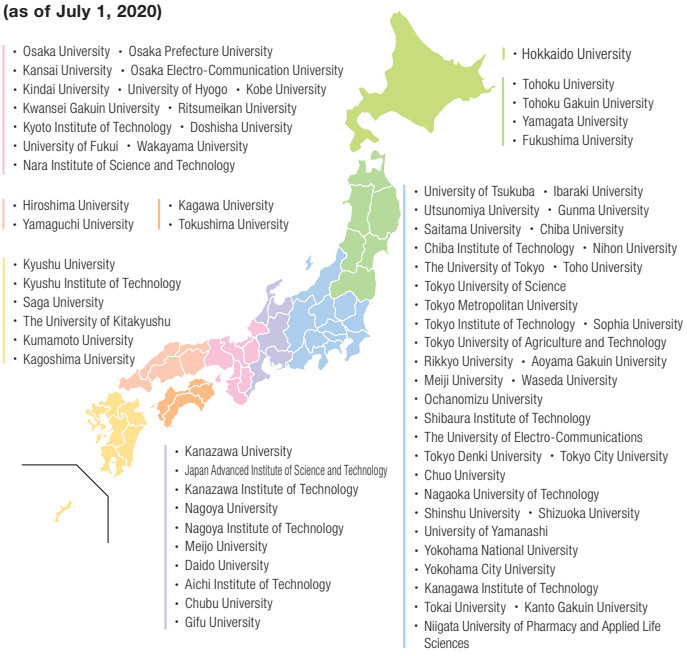
The technical training is a program in which AIST accepts researchers, engineers, and students from companies, universities, and public research organizations for defined periods and provides them with an opportunity to study technologies under the instruction of AIST researchers. The program may also be used for the purposes of short-term technical training (internships) and educational programs for academic credits, which are both designed mainly for university students.

Partner Graduate School Program

Using the knowledge and experience gained at AIST, AIST researchers teach as guest professors at graduate schools that have cooperation agreements with AIST. Within this program, AIST also provides technical training to the graduate students on the site of AIST. This program is deemed to be part of the students' academic degree programs.

74 Universities with partner graduate school agreements

(as of July 1, 2020)



Innovation School

AIST Innovation School aims to train human resources able to contribute to innovation.

To address increasingly complicated social issues, we need to develop innovative technologies by combining the ideas and technologies of AIST and external organizations. For this we need personnel who can play a central role in collaboration. AIST actively accepts postdoctoral researchers and graduate students, and provides lectures and training to learn and develop 3 skills: "research skills" that are learned through scientific and technological knowledge in specific areas of expertise, "cooperation skills" acquired through working with experts in different fields, and "resourcefulness" nurtured through communication, the ability to develop one's own career.

In FY 2020, we conducted lectures, seminars, and long-term business training as part of the training course of "human resources for innovation," and 15 postdoctoral researchers completed the course. We ran a half-year course on "basic research skills" as an education program for graduate students, and 23 students completed the program of lectures, seminars, and technical training.

Social gathering with seniors

●Curriculum of the Innovation School

1 Lectures and exercise at AIST

- Lectures on philosophy and research management and on postdoctoral human resources expected by companies
- Lectures on intellectual property, research ethics, companies and industries
- Lectures on research cases (of AIST), how to create an innovative project, how to write papers
- Exercise on skills in presenting research in ways that can be understood by people from different fields
- Acquisition of business manners, communication skills, how to develop one's career

2 Research at AIST

- Working on research topics in laboratories
- Experiencing research at AIST

3 On-the-job training with companies

(2 months or more, part of the training course of "human resources for innovation")

- Research development activities, productization, speed of technology development, importance of cost awareness at companies
- Experiencing teamwork, importance of collaboration with other departments

●Expanding the vision of young researchers

Through the lectures and training with companies, students of the school commented that it broadened their perspectives: "It was meaningful because I was able to hear viewpoints that covered all from companies, national research institutes, and researchers," "I was able to experience corporate research firsthand." New experience and broadened perspectives brought the following comments: "Experience in an industry that deviates a little from my own career may be needed to make innovation happen," "I was specifically able to image work in companies and can proactively continue my activities with employment in mind.

Companies that have accepted trainees say that "The students have excellent ability and they inspired our employees," or "We saw how they made an effort to achieve their goal." The companies rate the trainees' research capabilities and work attitudes highly.

Since the school started, 335 postdocs have completed the training course of "human resources for innovation." They have discovered their new potential and are working in a variety of areas at companies, universities, and public research institutions.

AIST Design School

This is said to be the age of VUCA (volatility, uncertainty, complexity and ambiguity), an age of rapid change in which it is unclear what issues should be addressed. In particular, there has been a huge change in lifestyles since the beginning of 2020 because of the COVID-19 pandemic, there are great expectations of science and technology, and technologies such as AI and robotics have the potential to progress at speeds beyond the capacity of humans to adapt to change. Business too is moving from "what things should we make?" to "why do we make things?" so that those things can be considered worthwhile innovations. It has become more difficult to launch new ventures.

In these times, processes leading to social implementation of new technologies require speed through agile development (smart development), which is different from a traditional linear process from original idea to R&D, field testing, and then commercialization. Society, including AIST, must be flexible in thought and not shackled by previous successes, must have the space and time to improve its capacity to adapt to rapid change, and must seek innovation while having the imagination to create new social systems. To respond to the requirements of society described above, we opened the AIST Design School in 2018 as a forum for AIST researchers and participants from business to cultivate the capabilities (competencies) mentioned above. In FY 2020, 46 students completed courses at the school (13 students and 4 teaching assistants on Masters courses, 14 on short courses, and 15 on single-session courses).

In FY 2020, with a view to preventing COVID-19 infections, the school quickly switched to 100% remote teaching, and designed and employed a curriculum that compares well with the offline teaching of previous years. It has continued to receive requests for advice and consultancy from companies, universities, and local governments in Japan.

A scene in online teaching (FY 2020)

Competencies being cultivated

- Insight skill: Identifying what you really want to do so you can envision the future by reference to yourself
- Foresight skill: Looking beyond your own discipline to envision an ideal future
- Co-creation: Creating new value through discussions with others on visions of the future
- Phronesis: Linking these thoughts and ideas to social implementations

Curriculum

- Creative leadership training in a collaboration (concluded in December 2019) with KAOSPILOT in Denmark, which is considered the most radical business school
- Future insight with a professor from Hitotsubashi University
- Design thinking with a professor from the University of Tokyo who taught for years at Britain's Royal College of Art (RCA)
- System thinking, art thinking, etc.
- Providing a venue for next-generation leadership development to apply these kinds of thinking while giving thought to social problems that affect residents, high school students and other people in the neighborhood of AIST Kashiwa

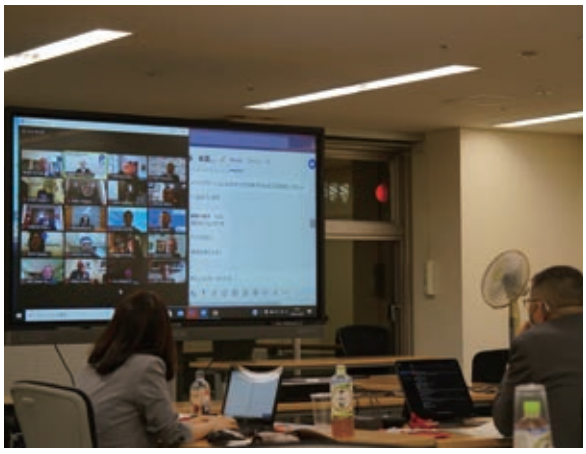
Strengthening international collaboration

AIST is building a global network with prominent research institutes around the world, and is promoting efficient and effective research cooperation through international collaborative research, workshops and seminars, and personnel exchanges which include dispatching and inviting researchers.

Increasing Global Presence

AIST has been raising its international profile not only by conducting world-leading research but also by strengthening collaboration with overseas research institutes and through inter-organization personnel exchanges. As an effort to enhance collaborative relations with overseas institutes, AIST, together with RIKEN, organized the Ninth Global Summit of Research Institute Leaders in October 2020. The purpose of this summit was to bring together the heads of the world's leading research institutes to discuss the future of science and technology, the role of each institute, and collaboration among research institutes. The ninth summit was attended by leaders representing 26 research institutes from 17 countries, who engaged in vigorous discussion on the theme "Multilateral Collaboration during the COVID-19 Pandemic." AIST was represented by President Ishimura, who in his opening remarks spoke of the need for public research institutes to cooperate with one another and take the initiative to create new innovation for effective measures to overcome the crises caused by COVID-19.

In addition to sharing the effects COVID-19 has had on their respective institutes, the representatives recognized that, in order to move forward in these unprecedented times, we must demonstrate to society the transparency of our research activities and earn the trust of society through these research activities.



A view of the summit

Strengthening International Collaboration to Address Global Issues

AIST has concluded Memoranda of Understanding (MOUs) on comprehensive research collaboration with 25 leading institutes representing various countries/regions worldwide and is engaged in the development of international research networks. In accordance with these MOUs, we aim to tackle global issues through joint research and personnel exchanges with overseas research institutes.

At the same time, through international collaborative research, workshops and seminars, and international conferences, AIST is forming a global network with influential research institutes in countries around the world and is promoting efficient and effective research cooperation. In light of the global spread of COVID-19 in 2020, we mostly conducted exchanges online. At "High Level Forum 2020 Edition," which was held online in December 2020, we exchanged information on examples of innovation and strategic approaches adopted by the main science cities, R&D bases and so forth in different countries as the effects of COVID-19 spread. AIST was represented by Kanayama Toshihiko, Emeritus Advisor, who reported that in Japan, environmental improvement for developing technologies to tackle COVID-19 has been undertaken as a government subsidized project.

Speaking at High Level Forum

●LIST of MOUs

● : Comprehensive MOUs ★ : Specific MOUs (excerpts)

EU
- ●Joint Research Centre (JRC)

Norway
- ●Norwegian University of Science and Technology (NTNU)
- ●The Foundation for Scientific and Industrial Research (SINTEF)
- ●Institute for Energy Technology (IFE)

Germany
- ●Fraunhofer-Gesellschaft (FhG)
- ●German Aerospace Center (DLR)
- ★German Research Center for Artificial Intelligence (DFKI)

Finland
- ●Technical Research Centre of Finland (VTT)

Russia
- ★Russian Scientific Research Institute for Metrological Service (VNIMS)

USA
- ●Sandia National Laboratories (SNL)
- ●National Renewable Energy Laboratory (NREL)
- ●National Institute of Standards and Technology (NIST)
- ●Pacific Northwest National Laboratory (PNNL)
- ★United States Geological Survey (USGS)

Netherlands
- ●High Tech Campus Eindhoven (HTCE)

Turkey
- ★General Directorate of Mineral Research and Exploration (MTA)

Mongolia
- ●Ministry of Mineral Resources and Energy (MMRE)

China
- ●Chinese Academy of Sciences (CAS)
- ●Shanghai Jiao Tong University (SJTU)
- ★National Institute of Metrology (NIM)

UK
- ★The University of Sheffield

Switzerland
- ★Swiss Federal Laboratories for Materials Science and Technology (Empa)

Korea
- ★Korea Institute of Geoscience and Mineral Resources (KIGAM)
- ★Korea Research Institute of Standards and Science (KRISS)

Canada
- ●National Research Council Canada(NRC)
- ★Department of Natural Resources Canada (NRCan)

Portugal
- ★Institute for Systems and Computer Engineering, Technology and Science (INESC TEC)

Taiwan
- ●Industrial Technology Research Institute (ITRI)

Mexico
- ★National Center for Metrology (CENAM)

Vietnam
- ●Vietnam Academy of Science and Technology (VAST)

Singapore
- ★Agency for Science, Technology and Research (A*STAR)

Austria
- ★Geological Survey of Austria (GBA)

Italy
- ★National Institute of Geophysics and Volcanology (INGV)

Thailand
- ●Thailand Institute of Scientific and Technological Research (TISTR)
- ★National Institute of Metrology (NIMT)

France
- ●Centre National de la Recherche Scientifique (CNRS)
- ●Commissariat a l'energie atomique et aux énergies alternatives (CEA)
- ★International Bureau of Weights and Measures (BIPM)

Myanmar
- ★Department of Geological Survey and Mineral Exploration, Ministry of Mines (DGSE)

Brazil
- ★National Institute of Metrology, Standardization and Industrial Quality (INMETRO)

New Zealand
- ●The University of Auckland
- ★GNS Science (GNS)

India
- ●Council of Scientific and Industrial Research (CSIR)
- ●Department of Biotechnology (DBT), Ministry of Science and Technology

Australia
- ●Commonwealth Scientific and Industrial Research Organization (CSIRO)

as of March 2021

Accepting Foreign Researchers

See page 53 for more details ▶

To enhance cooperation with overseas research institutes and to develop an international network of researchers, AIST welcomes foreign researchers from universities and research institutes around the world. In FY 2020, a total of 439 foreign researchers engaged in research at AIST.

By region, researchers from Asia accounted for more than 70% of the total, followed by Europe.

Because of the global spread of COVID-19 in FY 2020, the numbers of technical trainees and foreign researchers accepted were smaller than in typical years. Through efforts such as conducting training online, we worked to overcome the constraints of distance and cooperate with research institutions in other countries.

TOPICS

A New Style of Cooperative Research (Online Visit)

A new kind of overseas visit: the launch of Online Visit

In light of the COVID-19 pandemic, AIST is promoting R&D to prevent infection and stop the spread of COVID-19. At the same time, AIST is pursuing a number of work reform initiatives to smoothly continue work under the constraints of counter-infection measures. With regard to international collaboration, travel to and from other countries has become difficult. As a result, opportunities for people to learn about AIST have been greatly reduced. Under these circumstances, as a trial, we launched an online visiting service (Online Visit) in March 2021. This service provides overviews of AIST and our research achievements to staff members of public organizations (research institutions, governments, public benefit corporations, etc.) and university students. Currently, research achievements that are of interest to the visitors can be selected from 15 topics relating to AI and information technology, life science and biotechnology, materials, robotics, electronics, manufacturing, energy and environment, and standardization. These are not one-way video transmissions but interactive programs including presentations and question-and-answer sessions with staff of the Global Collaboration Office.

Along with accepting applications for the service on the AIST website, we have sent information regarding the said service to research institutions in various countries with strong ties to AIST, as well as to universities with records of previous visits to AIST, and received many queries in response .

Recently, staff of an embassy in Japan who took part in an Online Visit showed great interest and asked enthusiastic questions about the achievements of AIST in developing technologies to counter COVID-19 and in printed electronics (i.e., creating electronic circuits with printing technologies).

We will continue to periodically update and expand the content of the program.

https://unit.aist.go.jp/colpla/go2020/en/online_visit.html

AIST and It's Staff

Human rights

A wide variety of people work at AIST in addition to executives, permanent employees and contract employees, including temporary employees, visiting researchers, technical trainees, contractors, visitors participating in industry–academia–government programs, and visitors participating in international programs. Everyone performs their duties with the awareness that it is important to have an attitude of respect and support for each other, regardless of title or position.

Protecting Human Rights in Research

AIST conducts ergonomic research involving human subjects, and medical research carried out in compliance with our Ethical Guidelines for Medical and Health Research Involving Human Subjects. Medical research at AIST consists of applied biomedical engineering experiments and experiments with human derivative samples.

In FY 2020, we implemented 190 research projects involving ergonomic experiments, 114 research projects involving experiments with human derivative samples, and two research projects involving applied biomedical engineering experiments.

Regarding an ergonomic experiment, the experimental protocol is reviewed by the Committee on Ergonomic Experiments, which consists of external members, in accordance with the Declaration of Helsinki* to ensure the safety and scientific validity of the experiment. Likewise, a medical research experiment is reviewed in accordance with ethical guidelines by the Committee for the Ethics on the Applied Biomedical Engineering and Technology and the Committee for the Ethics on the Experiments with Human Derivative Samples. In addition, we have the Conflict-of-Interest Management Committee for Medical and Health Research Involving Human Subjects in place, which examines solely conflicts of interest in medical research. This committee reviewed five cases in FY 2020.

When an experiment is performed, its participants are given thorough oral and written explanations of the details of the experiment and of their right to revoke consent. In this way, we ensure that their human rights and dignity are protected.

* Subtitled "Ethical Principles for Medical Research Involving Human Subjects," this is a code of conduct regarding human subjects adopted by the 18th World Medical Association General Assembly in Helsinki. Medical researchers have established this rule to regulate themselves with regard to medical research involving human subjects.

Harassment Prevention

Harassment stains a person's personality and hurts the dignity of the person being harassed and causes emotional distress and disadvantage. Not only the person harassed but also those who learn of the presence of harassment may suffer from reduced motivation to work, and it may lead to adverse effects on the results of research. AIST has internal rules in place and provides training to make the workplace free of harassment.

●Harassment prevention measures

- AIST has in place rules for handling workplace harassment and sexual harassment and has defined procedures for the prevention of harassment.
- AIST provides counselors placed at AIST work sites with training on how to prevent harassment and provide counseling for harassment victims. We also held a seminar targeting all employees to re-recognize the need to prevent harassment.

●Counseling system

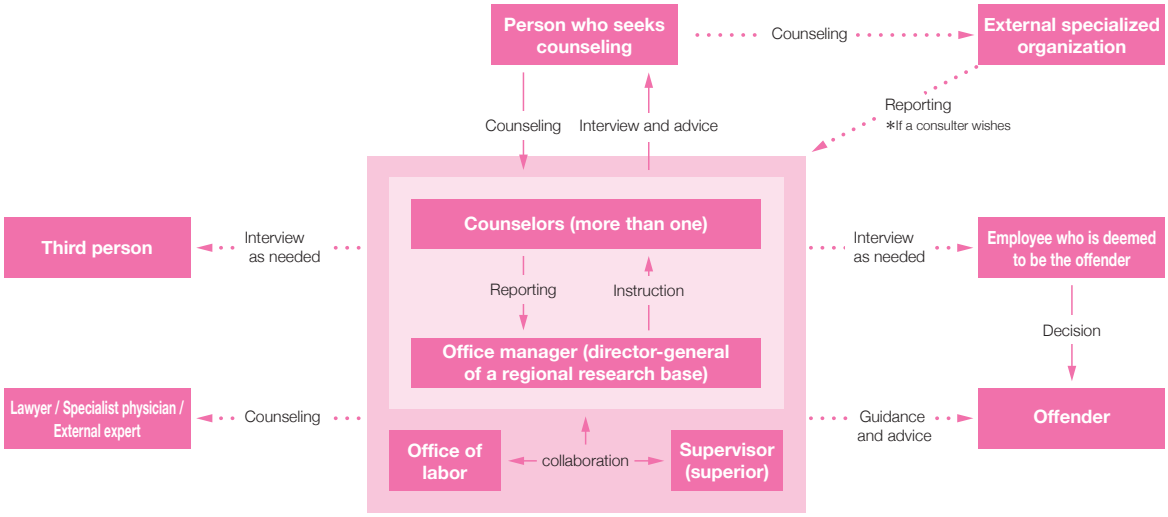
Each site has workplace harassment counselors. The counselors work to counsel, investigate, and mediate so that harassment victims are not distressed and suffer alone as a result of their experience. If the line of management or a counselor cannot address a harassment issue, it is possible to file for the recovery from the disadvantages suffered. In this case, the Compliance Promotion Committee reviews the issue and recommends the appropriate actions, which are then taken.

In addition, we create an environment that helps harassment victims to seek counseling. We also provide email and telephone counseling by industrial physicians or external organizations to protect people's privacy.

Training programs provided on harassment in FY 2020

Training program	Trainees	Objectives	Number of trainees in FY 2020
New Employee Training	New AIST employees	As part of training in the attitudes, basic knowledge, and skills required to perform their work, participants learn the basics of harassment issues and harassment prevention.	98
e-learning training for employees *including e-learning training for foreign researchers in English	Permanent employees, contract employees	As part of their learning of the basic organizational ethics and rules of AIST, participants learn the basics of harassment issues and harassment prevention.	7,030
Harassment Counselor and Sexual Harassment Counselor Training	Harassment counselors	Participants learn the harassment prevention knowledge and skills required by counselors. These include face-to-face counseling techniques based on lectures.	119 (viewing number)
Harassment Prevention Seminar	AIST employees who wish to attend the seminar	Participants learn the basics of harassment issues and harassment prevention.	459 (viewing number)

Flow of the counseling process



*Those who seek counseling can include people other than the employees involved (i.e. they can be the employee who is deemed to be the offender, the employee who is deemed to be the victim, or someone else, such as a colleague or supervisor).
*Counseling can be sought by means of a face-to-face meeting, telephone call, email, letter, or fax. (contact by email or telephone with external specialized organizations)
*Seeking counseling causes no disadvantage.
*Adequate consideration is given to the protection of privacy, and any information acquired in the course of counseling is kept strictly confidential.

Hiring Fixed-term Employees through Open Recruitment at AIST

The work conducted by AIST's headquarters organizations and operating units includes routine work such as purchasing, asset management, and employee benefit management which can be done more efficiently by engaging highly experienced employees.

A skilled contract employee and a temporary employee who have been working at AIST for a certain period of time can be candidates for employment by AIST under the fixed-term regional employment system (i.e. employing administrative staff who are not transferred from one region to another). AIST has hired 53 people in total, and these employees have been working at the headquarters organizations and operating units. We receive dozens of applications each year, and in FY 2021, we hired 8 people.

The employees can work for up to 2 years, yet they have a chance to be hired as permanent employees based on evaluations of their work performance. 8 employees have been rehired as permanent employees in FY 2021. AIST will continue to hire fixed-term regional employees to support research and development, innovation, and other activities.

Diversity

AIST aims to provide a working environment that embraces the values and ideas of employees with diverse attributes, including gender, age and nationality.

Activities of Intellectually or Developmentally Challenged Teams

AIST has set up Challenged Teams, made up of people with intellectual challenges and developmental challenges, at AIST Tsukuba, AIST Chubu and AIST Kansai. Each year, with reference to regional minimum wages, these people are employed on contracts at wages above the minimum wage for the region. They perform clerical support work, environment improvement work and the like with the support of instructors.

●AIST Tsukuba

The AIST Tsukuba Challenged Team, made up of 13 members and four instructors, assists with clerical work and improves the working environment. Upon request from departments of AIST Tsukuba, the members carry documents between offices, shred discarded printouts, clean and recycle binders, and clean lecture rooms and sidewalks. They make eco-friendly bags from old newspapers and small eco-friendly bags from geological maps, and distribute them at training sessions for new employees and at the AIST Tsukuba Open House event. At the end of the year, they hold a review meeting to reflect on their activities and set new goals. The team hopes to spread its activities and will try new tasks.

Sidewalk cleaning

At the end-of-the-year review meeting

●AIST Chubu

The AIST Chubu Challenged Team currently has five members and one instructor. After taking preventive measures against Covid 19, the team assists clerical work and engages in beautifying the environment. It regularly conducts cleaning and weeding the premises outdoors, activities indoors such as cleaning meeting rooms, collecting, sorting, and recycling used paper and cardboard and transporting copy paper. The team, upon request from departments, also do unscheduled work such as sorting stockpiles in the emergency supplies storehouse and setting up the examination room for medical examination.

Sorting stockpiles for emergency

Collecting old magazines

●AIST Kansai

The AIST Kansai Challenged Team presently comprises one member and one instructor, assisting clerical work and working to beautify the premises. It contributes to maintaining trees and vegetation there by clearing weeds with a weeder, cutting high dead branches with a tree trimmer, and doing other tasks using various machinery and tools. When it rains, the member chiefly cleans the windows, mops the floors, and shreds discarded documents, in the buildings. In addition, upon request from departments of AIST Kansai, the member helps out with various other tasks.

Weeding the premises

Measures to Promote Diversity in the Fifth Medium- to Long-Term Plan See pages 54–55 for more details ▶

Measures to promote diversity in the Fifth Medium- to Long-Term Plan (April 2020 to March 2025) were stipulated in March 2020. Activities in FY 2020 are shown in the table below.

Measure	Goal	Main outcomes in FY 2020
Achieving Work–life Balance	To promote measures to support work–life balance and create a work environment so that everyone working in AIST can work in a way that balances work with life and that moderates career interruptions resulting from life events.	• We are continuing to provide a teleworking system for working at home to support childcare, which was used by 22 employees (9 men and 13 women). • We expanded those eligible for teleworking as an emergency measure to prevent the spread of COVID-19. • We investigated the extension of the teleworking system as a new way of working.
	To embed attitudes unconstrained by established ideas of gender roles, to promote the provision of workplace environments that enable both men and women to conduct their childcare, and to widely adopt measures that support work–life balance.	• We held online work–life balance (WLB) lunch meetings (4 on childcare, 1 on nursing care, 1 on the support system for hiring supplemental staff). • We worked on providing information and spreading awareness in the Institute of systems of childcare leave, etc. • We were accredited under new standards for the Next Generation certification "Kurumin."
	To spread awareness in the Institute and improve the childcare and nursing care support systems as required to meet the needs of employees during maternity leave, during childcare leave, during nursing care leave, and after returning to work.	• We held online WLB seminars (148 participants) and subsequently streamed the seminars (538 views). • Seven people were supported by the support system for hiring supplemental staff (5 supported for childcare, 1 supported for nursing care, and 1 supported for childcare additionally). • We conducted a diversity promotion survey and learned that many staff want to know more about support systems and want easy access to advice.
Actively promoting female employees and expanding the employment of female research staff	To support the promotion of female managers, to step up measures to improve staff motivation, spread acceptance, and improve the workplace environment	• The proportion of female managers was 5.8% (22/380) at the end of March 2021. • We held a cross-industry social event (with two presentations from a researcher and a technology administrator) as part of MEXT's development support program for science personnel, "Initiative for realizing diverse research environments (collaboration type)."
	To proactively advertise to employ female research staff and to step up measures in accordance with the situation in each research domain	• We arranged informal meetings and lab tours with female researchers at AIST for female graduate students and postdocs (27 participants from universities around Japan) and held online events for female middle and high school students. • We participated in nine events at the invitation of universities and academic societies, giving introductions to research jobs and AIST. • 106 women applied for research posts in response to advertisements in FY 2020.
	To maintain the proportion of women in research posts at or above 18% over the five-year period	The proportion of women appointed to research posts (new entrants) in FY 2020 was 22.2% (18/81).
Recruiting and support for onboarding and work of foreign researchers	To raise foreign researchers' awareness of AIST by providing information to foreign researchers on a public English website to support the recruitment and integration of excellent foreign researchers	• Information provided on the public English website was updated and the general employer action plan was translated to English and publicized. • The proportion of foreign employees (foreign nationalities) recruited to research posts in FY 2020 was 22.2% (18/81).
	With AIST International Center (AIC) focusing on residence and living support services for foreign researchers, to understand the needs of regional research bases and, in cooperation with the appropriate departments, hold seminars in English on work in the Institute, etc.	• We launched an internal portal site explaining the Institute's administrative procedures in both Japanese and English. • We developed an app (starter kit) within the Institute to give guidance on various procedures to new appointees. • We trialed the introduction of machine translation to English for internal announcements from the system administration department. • AIC collaborated with relevant departments to give foreign researchers seminars in English (two, courses on Japanese, and information announcements for foreign staff (12 monthly newsletters). • 170 consultations on various subjects and 12 inquiries about the Ministry of Justice's points-based preferential immigration system for highly skilled foreign professionals.
Career development	To provide career counseling and lectures by experts, a mentor system, and consistent support from career path design to career development so that each researcher can take a positive approach to their career	• Lectures on diversity were included in internal training at different levels (new employee training and unit manager training). • One person took mentor training overseen by Ibaraki Prefecture. • Career development support training was given online (two sessions). Staff at regional research bases and staff in circumstances that make personal attendance difficult were able to participate. • Career counseling (92 sessions); due to the effects of COVID-19, face-to-face counseling was difficult and was suspended for some periods.
Comprehensive promotion of diversity	To prepare suitable workplace environments for people with disabilities, to promote the hiring of people with disabilities and comply with statutory employment rates, and to support people with disabilities to be active members of society	• The number of employees with disabilities was 133.4 out of 5337, achieving the statutory rate of 2.5%. • A study session on improving understanding of visual disabilities in office environments was held. • We installed collision prevention mirrors (in corridors) and chairs with armrests for people with disabilities (in break rooms). • Security tokens for smartphones and tablets were adapted for people with visual disabilities.
	To nurture awareness of diversity throughout the Institute to promote acceptance and understanding of people with diverse genders, ages, nationalities, etc.	We surveyed measures concerning sexual diversity (LGBT) in companies and universities, held a study session in the Institute, and prepared the ground for consideration of future measures.
	Guided by the Diversity Promotion Committee, to apply the PDCA cycle to promotion measures, consider necessary policies, and build awareness of diversity	• Online explanations of the helper employment support system were given in Japanese and English (18 people were identified for support in FY 2021). • A survey on diversity promotion was conducted (adding three items on career support). Awareness of appointments of female managers and familiarity and satisfaction with work–life balance support systems were compared with the previous year to ascertain the current situation.
	To contribute to the Diversity Support Office (DSO) as a key member organization and sustain cooperation with other organizations	• Together with the University of Tsukuba and IBM Japan, we continued activities in line with MEXT's "initiative for realizing diverse research environments (collaboration type)." • We continued to coordinate the activities of a diversity support network (DSO) of 20 research and education institutions in Japan, exchanging information such as case studies and improving internal systems.

TOPICS

"Kurumin" Accreditation: Certification for Companies Supporting Childcare

In January 2021, AIST received the "Kurumin" (new standard) certification for companies supporting childcare. This certification recognizes that we have met certain requirements such as drawing up and implementing an action plan to balance the work of staff with childcare in accordance with the Act on Advancement of Measures to Support Raising Next-generation Children (the Next Generation Act). This is the second time we have received the Kurumin certification since we attained it in October 2014 with a second edition of the action plan. Since then, AIST has worked to provide workplace conditions that enable a balance between work and childcare and has produced initiatives such as improving systems for childcare and spreading information on how to use the systems. The new standard also calls for the promotion of work–life balance, by reducing work hours, encouraging childcare participation by male staff, and so forth.

The current fifth edition of the action plan includes initiatives to make it easier for both men and women to take childcare leave, encourage the provision of conditions that make return to the workplace easier, and make long vacations possible in the summer and winter. In particular, to achieve work–life balance, we are proactively spreading information to staff to enable initial steps in changing ways of working and taking leave.

Safety and health

As would be expected in laboratories, AIST uses substances and equipment that may affect the human health and the environment, such as various chemical substances, high-pressure gases, radioisotopes, genetically modified organisms, nano-materials, laser equipment, and various experimental equipment. Accordingly, AIST creates a work environment in which all people working there can do so in a safe and healthy manner.

Occupational Health and Safety

See page 56 for more details ▶

●Safety and Health Committee meetings and site meetings of AIST

The Safety and Health Committee meetings attended by labor and management representatives are held monthly at each AIST site and research base to discuss health and safety issues. Representatives from each AIST department at the base discuss safety and health issues at other monthly site meetings. The results of the meetings are communicated to all employees through departmental safety and health meetings and the like.

●Establishment of Safety and Health Guidelines

Safety and Health Guidelines set out a code of safety conduct, including precautions when handling hazardous chemicals and high-pressure gas cylinders and performing experiments, in accordance with our Charter of Environment and Safety.

Serving as the basis for employee safety education and for laboratory work, these guidelines are reviewed and revised annually, in addition to amendments when needed. In FY 2020, the following revisions were made:

1. We made an industrial waste discharge manual and made mandatory to place designated labels on separated waste containers for proper discharge of industrial waste.
2. To prevent harmful incidences by poisonous and deleterious substances, the record retention period and checking method of specialized key management were reviewed and the roles of directors of units and managers of chemicals were clarified. Thus, the management system was strengthened.

●Emergency preparedness

AIST conducts disaster, fire, and other security drills so that we can promptly respond to emergencies such as disasters and accidents, thereby minimizing damage.

To ensure a means of communication with our regional research bases nationwide in the event of a disaster, we also conduct emergency communication drills using emergency radiotelephones installed at those bases. In addition, our research bases take part in the Japan Meteorological Agency's earthquake early warning drills that use its Earthquake Early Warning system. When participating therein, we simultaneously perform safety confirmation drills in preparation for a major disaster, using our safety confirmation system.* As part of preparedness for disasters such as earthquakes, we stockpile food, rescue equipment, and other emergency supplies, which are inspected and refreshed on a regular basis.

* In the event of a disaster, the safety confirmation system sends bulk safety confirmation emails to executives and employees. It automatically collects the results and displays them on the web.

●Preventing occupational accidents

In the event of a work-related accident, an investigation and analyses are conducted to determine the cause. The relevant work is put on hold until recurrence-prevention measures are implemented, and information on the accident is communicated to all employees to prevent similar accidents.

AIST holds a Safety Management Report Meeting every morning connecting Environment and Safety

Headquarters, AIST Tokyo Headquarters, regional research bases, and 19 sites at AIST Tsukuba by a web conference system to share information on accidents and near-miss incidents. The aim is to share details of recurrence prevention measures and thus improve safety and health.

FY 2020 saw a decrease in the number of total cases including accidental falls compared to FY 2019. However, there were 3 cases of exposure to chemicals and gas. To address this situation, we provide safety education to make sure that proper protective equipment is worn, prepare work procedure manuals and risk assessment for high-risk tasks, and enhance sensibility by conducting risk prediction activities to foster safety culture.

●Safety education and support for license acquisition

AIST accepts many researchers, engineers and students from businesses, universities and the like for cooperative research, technical training and so forth. With a view to preventing accidents, AIST runs a number of safety training programs and classes, both for employees and for visitors from other organizations. Safety education provided when employees are hired and when there is a change in work details is managed by an internal safety education management system, which allows participation history and program contents to be checked as needed. To enhance awareness of safety, a summary of information on incidents and safety and health management rules is streamed online every month, and all employees are required to watch. To broaden learning opportunities, an e-learning system is used in parts of the safety training for life science experiments.

Those engaged in animal experiments and recombinant DNA experiments take e-learning courses, and those engaged in experiments with human derivative samples, and applied biomedical engineering experiments, and ergonomic experiments take eAPRIN or ICRweb, educational programs offered by public institutions. AIST requires all those engaging in experiments to receive educational training before planning of the experiment and during execution of experiment each fiscal year, and thus they acquire necessary knowledge and way of thinking for drawing appropriate experiment plans and for conducting experiments.

AIST has made it compulsory for those responsible for hazardous chemicals in quantities exceeding a given amount to obtain a Hazardous Materials Engineer's License, and for those handling high-pressure gas recommends them to take high-pressure gas safety courses or to obtain a License for Manager for High-pressure Gas Safety. In this way, we are committed to improving safety management in our laboratories. Also, we actively support employees in acquiring licenses. For example, we host a course on the skills required for a Health Officer's License and a course on the skills required for a Chief Technician's License for Using Organic Solvents.

Health Management and Mental Health

See pages 56–57 for more details ▶

General and special medical examinations are performed in spring and autumn every year. We strive to increase the percentage of employees who undergo medical examinations by raising awareness that they are required to take these examinations, including health screening. As follow-up care after medical examinations, an industrial physician and industrial health staff provide health advice. We provide support to improve the performance of individual employees and AIST as a whole by detecting and preventing employees' health disorders and illnesses in their early stages.

To address mental health issues, we have developed a unified Mental Fitness Program in accordance with the directives and guidelines of the Ministry of Health, Labor, and Welfare. Four programs based on the Mental Fitness Program are implemented in a continuous and planned way. They focus on (1) self-care; (2) line care through implementation of education and training and seminars; (3) care by in-house industrial health staff and others through face-to-face counseling with an industrial physician and industrial health staff and support in returning to work; and (4) care by external resources through the use of external mental health organizations.

We use a stress check system (once a year) to encourage awareness of stress situations of staff and to promote workplace improvement to create a comfortable workplace. By doing this, we are making efforts to strengthen measures to prevent staff from suffering mental health disorder. For the entire AIST, the average stress score has been lower than the national average since the stress check was introduced.

●Outline of return to work program

Submission of medical certificate for absence from work ▶ **Start of leave of absence from work** ▶ **Care during absence and follow-up during preparation for return to work**
- Monthly meeting with an industrial physician
- Implementing return-to-work plan *

▶ **Return to work** ▶ **Follow-up after return to work**
- Meeting with an industrial physician twice a month (for 6 months)

*Depending on the length etc. of absence from work

Community Involvement

FREA and the Local Community: Supporting Reconstruction with Clusters of New Industries

Prompt, large-scale deployment of renewable energies such as solar and wind power is required as one of the keys to solving worldwide problems such as global warming. However, there are still numerous problems to be addressed with many forms of renewable energy, such as fluctuations over time and regional variations, and resulting difficulty of use and high costs. The Fukushima Renewable Energy Institute, AIST (FREA) is conducting activities with the missions of becoming a global innovation hub that solves these problems, hastens the large-scale deployment of renewable energy, produces original renewable energy technologies, and contributes to the regeneration of the region hardest hit by the 2011 Tohoku earthquake and tsunami disaster.

Accordingly, FREA is conducting activities to create new industries both by making use of research outcomes and by supporting industrialization and commercialization of technological seeds for renewable energy from businesses in the disaster region. For example, the research equipment and knowhow of FREA are being utilized to evaluate the capabilities of technologies and products being developed by businesses, and new products based on technology seeds from businesses are being cooperatively developed. So far, we have conducted support projects with more than 200 businesses. Industrialization and commercialization have resulted from over 60 of these projects, such as field testing of protective circuit equipment for preventing abnormal heating of solar cells, and geothermal energy storage evaluation technologies for properly evaluating resources and reducing development risks of hard-to-develop geothermal energy sources such as supercritical geothermal energy and sources in mountainous regions. Through these projects, we have created new employment for around 100 people and made great contributions to supporting regeneration.

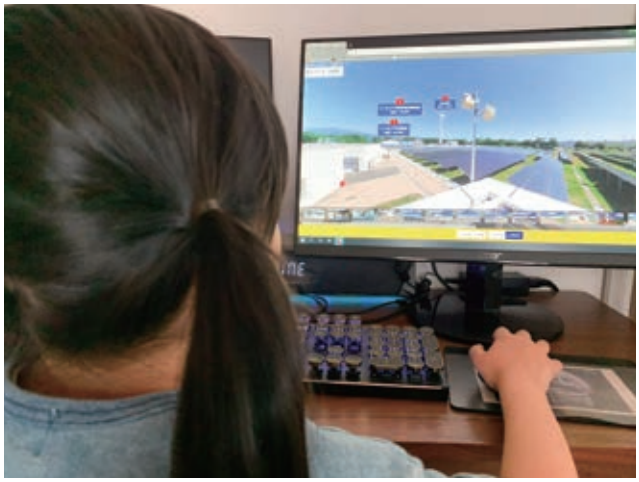
Each year since opening in 2014, FREA has held an open house event with a strong awareness of its links with the region, to promote knowledge and understanding of FREA's activities among a broad spectrum of the region's people. We have conducted activities to embed the event in the regional community by, for example, inviting local high schools, universities, and organizations set up exhibits, and with the cooperation of education committees, distributing publicity leaflets to elementary schools in the region. In 2020, as a measure against COVID-19, the open house event was only held online for the first time. We gave virtual tours and streamed videos of experiments, which were enjoyed by many people, particularly family groups.

As well as propagating the results of its research, in the future FREA will strive to distribute accessible information so that technologies and knowledge relating to renewable energy will reach more people.

●Permanent exhibit, the "FREA 360° virtual tour," opening up facilities that cannot be opened for normal visits

https://www.fukushima.aist.go.jp/v_tour/360/

Screenshot of the 360° virtual tour



An elementary school student taking the 360° virtual tour

Introducing "Association for PErsons concerning Technology": Open Innovation with Regional Industries

Introduction

At AIST Kyushu, the "Environmental measurement and sensing systems consortium," an AIST consortium mainly aimed at companies in the Kyushu region, was launched in 2005 with the goal of providing solutions to various problems affecting the sites of companies through cutting-edge measurement and diagnostic technologies. The consortium's efforts included various teaching activities and cooperative research projects. After two reorganizations of the consortium, the "Association for PErsons concerning Technology" (APET) was founded in September 2020 (with 38 corporate members and 75 individual members as of August 2021). The association aims to promote more multilateral collaboration with a range of organizations—including companies, public testing and research institutions, support agencies and regional universities—to manage solutions to diverse and complicated industrial and social problems, and aims to develop open innovation originating from sites in the region.

It will provide a venue for various kinds of networking through information exchanges and tours of universities, support agencies and the like in Kyushu and Okinawa, sharing information on AIST technology seeds with the corporate members and on other topics provided by corporate members. Through activities at this venue for discussion, the association seeks to clarify the issues affecting corporate members, provide hints of ideas for companies to develop new products, inspire new inter-company collaborations, and support the discovery of clues to solutions.

Hosting the kick-off lecture meeting

The association held a kick-off lecture meeting online on November 26, 2020. The many attendees were given an introduction to APET, an overview of projects at the AIST Sensing System Research Center in Kyushu, examples of projects at companies, and examples of collaboration from a laboratory at Saga University. The attendees provided suggestions for themed events and lectures, engaging online activities and such, and specific requests for future topics.

Specific activities

- Distributing information on technology seeds from AIST

The association plans to introduce technology seeds and collaboration examples from AIST throughout Japan at "delivery symposiums" (to be held online for now) about three times a year, to help corporate members learn about and make use of what AIST does to solve their problems (current plans are for symposiums in Kumamoto and Kagoshima).

- Agile webinars on topical issues

The association plans to hold several lecture meetings appropriate to the moment and the wishes of members. We are planning to introduce topics in agile webinars that focus on particular topics and to hold online discussion meetings.

- Introducing case studies of corporate members and introducing university laboratories

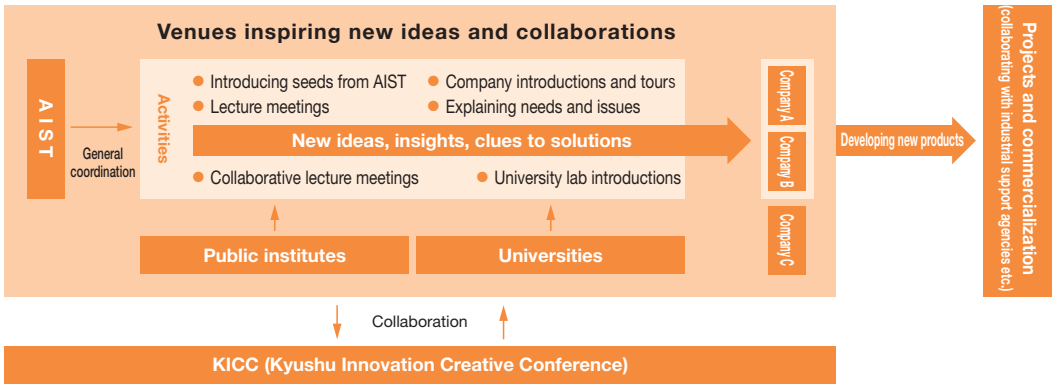
The association will provide a venue for exchanges of information and discussions between corporate members. Corporate members will provide case studies of company projects, descriptions of issues such as technology seeds and needs, and company introductions. University labs will provide introductions to technology seeds, tours, and case studies of collaboration with business.

Joining APET

For now, APET is mainly planning activities online as a measure against COVID-19. Even in these circumstances, we are providing a venue for all members to exchange their latest ideas and concerns, and we are conducting activities that may help solve problems and promote open innovation. We recommend anyone to join APET, we will be glad to meet new businesses and university labs, and we will enthusiastically use opportunities to spread our research outcomes and inspire social implementations.

APET: https://unit.aist.go.jp/kyushu/apet/index.html

Venues to support business collaborations with various organizations



Basic Information about AIST

Future Outlook

Under the banner "Create the Future, Collaborate Together," AIST is pursuing research activities to give the world technologies that can enable a sustainable society, address social problems, and generate economic development.

Policies of the Fifth Medium- to Long-term Plan

See pages 04-07 for more details. ▶

Introduction

Looking at the world today, we see a major change with the digital transformation spreading through all aspects of society thanks to technological developments and social implementations of the Internet of Things (IoT), big data, AI, and so forth. It is becoming possible to produce previously unseen new values and services that can link all people and things and share many kinds of knowledge and information; diverse new business models are appearing. Meanwhile, Japan is facing various social problems such as energy and environmental constraints, an aging and shrinking population, disaster prevention, and now COVID-19. Solutions to these problems are strongly needed. AIST commenced the Fifth Medium- to Long-term Plan (FY 2020–FY 2024) in April 2020 with a view to addressing social problems. In FY 2020, AIST further promoted strategic research and development and strategic research management to contribute to solving social problems as “solutions to social problems using the comprehensive strength of AIST.

In FY 2020, to "make use of the collective strength of AIST to solve social problems," we made progress in promoting strategic R&D to help solve social problems and promoting strategic research management.

To "improve bridging to contribute to stronger economic growth and industrial competitiveness," we made progress in promoting focused R&D to strengthen industrial competitiveness, using the Cooperative Research Laboratories and OIL as hubs for collaboration and synergy between multiple research institutions and businesses, promoting innovation in the regions, strengthening the creation and support of AIST technology transfer ventures, improving our marketing ability, enhancing strategic intellectual property management, and publicity activities.

To "develop infrastructure to support the innovation ecosystem," we made progress in creating even more technology seeds with a long-term perspective, further strengthening standardization activities, providing and encouraging more use of intellectual infrastructure, and nurturing personnel who can contribute to improved technology management.

For "core, pioneering institute management maximizing the outcomes of R&D," we have made progress in our role as a Designated National Research and Development Institute in improving and accumulating technological intelligence, contributing to national strategies, driving national R&D projects, and promoting international cooperative research.

Issues that have come to the fore in pursuing these activities include, for example, the following.

In order to produce research outcomes at a world-leading level, unleashing the collective strength of AIST under the leadership of the president is important. Organizational governance must be made more efficient. Management must strike a balance with limited resources to drive solutions to social problems and bridging research while not leaving basic research understaffed to ensure that basic research strength is not weakened over the long term. The review of organizational governance structures conducted in April 2021 is one measure to tackle these issues.

Basic policy for the Fifth Medium- to Long-term Plan

In the Fifth Plan, AIST has taken up the mission of producing world-beating innovation that solves social problems and contributes to stronger economic growth and industrial competitiveness. We will make particular efforts focused on the following three themes.

Ⅰ. R&D that spearheads innovation for solutions to social problems

Ⅱ. Strengthening the innovation ecosystem through improved bridging

Ⅲ. Developing infrastructure to support the innovation ecosystem

To maximize the outcomes of these efforts, we are working on pioneering laboratory management as a Designated National Research and Development Institute, enhancing and accumulating technological intelligence, and contributing to national strategies.

I. R&D that spearheads innovation for solutions to social problems

●Promoting strategic R&D that contributes to solving social problems

AIST is expected to produce breakthrough innovations that address social problems such as energy and environmental constraints, declining birthrate and aging population, and natural disaster prevention and to contribute to sustainable economic growth and stronger industrial competitiveness. In response to these expectations, AIST aims to build a sustainable society—featuring zero emissions, a resource circulation economy, and health and longevity—and to meet the sustainable development goals (SDGs) through our R&D initiatives and activities.

Particularly to achieve the SDGs, we have specified three social problems that should be addressed: response to energy and environmental constraints; measures for declining birthrate and aging population; and contribution to resilient country and prevention of disaster. The whole institute will work on strategic research projects to contribute to solutions to these social problems. Furthermore, we will continue to take measures to combat COVID 19. Synergistic initiatives beyond the scope of existing research departments will be needed for these solutions. As a system for all parts of the institute to work on research, we are setting up integrated research centers and integrated research laboratories.

Specifically, as response to energy and environmental constraints, we develop basic technology for sharp reduction of greenhouse gas, advanced utilization technology of resources and system evaluation technology for a resource circulating society, environmental evaluation, restoration, and management technology for environmental conservation and harmony of development and utilization.

As measures for declining birthrate and aging population, we develop technology that contributes to improvement of labor productivity and skill development and transfer in all industries, next-generation healthcare services that use advanced technology that fits into daily life, and develop high-quality, highly functional, high-precision medical care and diagnostic technology that improves the quality of life.

As contribution to resilient country and prevention of disaster, we develop technology for innovative integrity inspection and prolonging of life of infrastructure for a sustainable safe and secure society. As measures against COVID 19, we will do research and development that links to measures against infectious diseases and formulation of action guidelines.

1 Developing fundamental technology for sharp reduction of greenhouse gas

Setting the Global Zero Emission Research Center as a hub, we promote fundamental research on innovative environmental technologies to achieve greenhouse gas reduction targets. By implementing demonstration research such as massive introduction of renewable energy, we are working to achieve a zero-emission society.

2 Developing advanced resource utilization technologies and system evaluation technologies for resource circulation economy

With Resource Circulation Technology Research Laboratory as a core laboratory, we aim to move beyond a resource consumption society and build a resource circulation society. We develop recycling technology of functional materials, resource recovery technology of carbon dioxide and nitrogen oxides originating from functional materials production, and their evaluation technology.

3 Developing the technologies to evaluate, restore and manage the environment to balance utilization of natural resources and environmental conservation

With the Research Laboratory on Environmentally-conscious Developments and Technologies (E-code) as a core hub, we develop and combine relevant technologies to evaluate and monitor environmental impacts as well as to repair and manage the environment. We aim to improve the quality of human life bringing human activities such as development and utilization of natural resources that support society and industry into harmony with environmental conservation.

4 Developing technologies for improving labor productivity and facilitating skill development and transfer in all industrial fields

A decrease in labor population due to decreasing birthrate and aging population is one of the key challenges in Japan. Industrial Cyber-Physical Systems Research Center and collaborating research units in AIST aim to provide solutions to this issue by integrating AI, robot, and sensor technologies so that machines can coordinate with humans. These technologies will improve quality of work, create new customer values foreseen along with the industrial trend, and facilitate skill development and transfer.

5 Developing technologies to contribute to next-generation healthcare that blends cutting-edge technologies into daily life

With the Advanced Healthcare Service Research Laboratory as a hub, we will develop technologies that contribute to the creation of innovative and new healthcare services. These technologies will enable early detection of diseases by utilizing data on monitoring the physical and mental state of individuals and big data on health care. The technologies will also promote behavioral changes that lead to good health, thereby extending healthy life expectancy.

6 Medical treatment and diagnosis technology with high quality, high performance and high precision to improve QoL.

New-generation Medical Treatment and Diagnosis Research Laboratory develops a diagnostic technology to realize an active-aging society, medical-device treatment technology with biomedical materials, and a new technology to enhance and maintain active mental and physical condition from medical intervention to convalescent rehabilitation.

7 Developing novel infrastructure integrity diagnostics technologies and operating life-extending technologies for a sustainable, secure, and safe society

With the Sustainable Infrastructure Research Laboratory as a hub, we will develop innovative technologies for infrastructure integrity diagnostics and technologies for extending infrastructure operating lifespans. Through demonstration testing in collaboration with industry, academia, and government, we will quickly bring the developed technologies to practical applications.

8 Research and development that leads to preventive measures and formation of action guidelines against infectious diseases

Regarding measures against COVID 19 which is an urgent social issue, we develop technology for virus detection with high speed and high accuracy. We also contribute to evaluation of preventive measures and formation of guidelines in collaboration with various organizations using various measurement technologies which contribute to risk assessment of infection at large-scale events.

Ⅱ. Strengthening the innovation ecosystem through improved bridging

●Promoting focused development that leads to stronger industrial competitiveness

To further enhance the bridging function that was improved during the Fourth Plan, AIST will conduct research that is likely to form more connections with business in cooperative research and that accurately meets industrial needs at advanced levels.

●Stronger functioning as a platform for collaboration and synergies

Using the Cooperative Research Laboratories and OILs as enhanced hubs for the bridging function linking AIST's technological seeds to commercialization, we will strengthen and expand our function as a platform between organizations to encourage collaborations and synergies between many organizations, including collaborations with ministries and government agencies.

●Promoting innovation in the regions

AIST will work to understand the needs of major local businesses and small and medium enterprises, and to promote innovation that invigorates regional economic activity by closely collaborating with local bureaus of economy, trade and industry, public testing and research institutions, and universities.

Ⅲ. Developing infrastructure to support the innovation ecosystem

●Creating even more technology seeds with a long term perspective

To create more key technology seeds and breakthrough technology seeds, AIST will strive to focus even more on long-term, challenging research that is unlikely to produce results in the short term.

●Further improvement of standardization activities

Through the Standardization Promotion Center, AIST will actively work on cross-disciplinary standardization activities that go beyond the conventional scopes of industrial fields, and will improve standardization activities as a whole across AIST.

●Nurturing personnel who can contribute to improved technology management

To create innovation in private companies, it is important to nurture innovation personnel—staff who will contribute to improved technology management in those companies—and to enhance their talents and encourage their activities. Therefore, AIST intends to continuously improve and expand personnel development projects, such as the AIST Innovation School and AIST Design School, and deliver their graduates to society.

Appropriate and trustworthy organizational governance

AIST ensures appropriate management of all operations to make full use of AIST's capabilities and achieve AIST's missions.

Promotion of Compliance

To raise employee awareness of compliance and take our organizational culture to the next level, AIST undertakes the following measures to strengthen compliance:

Compliance initiatives

1. Every week, a Compliance Promotion Committee meeting is held to gather risk information and determine how to address it. Risk information is also shared at regular in-house meetings to prevent recurrence.
2. AIST has set a Compliance Promotion Week from 2018 and has extended it to a month setting December as the Compliance Promotion Month to strongly raise awareness of compliance of each executive and staff and reliability of AIST. In particular, the President's message was issued, special training for executives and management officials as well as stratified training were provided, a slogan was set, posters and notices were displayed, and we proactively engaged in activities based on action plans drawn by each research domain.
3. In addition to e-learning courses for all staff, we provide compliance education as part of training for newly hired employees and management training for unit directors and research group leaders, with content adjusted to each group of participants.
4. In an effort to instill compliance, we post monthly compliance posters titled "Compladayori," created under a different theme for each month. This is aimed at increasing employee awareness of compliance and urging them to be vigilant at work, in particular.

●Addressing research misconduct

1. In the event that research misconduct is alleged to have occurred, AIST handles the allegations rigorously in accordance with the Research Misconduct Rules and other guidelines.

2. In order to become a research and development organization trusted by society, a Handbook on the Code of Conduct for Researchers was made and distributed to all the staff that succinctly summarizes into "5 minds" the ethics and points of attention needed in conducting research.

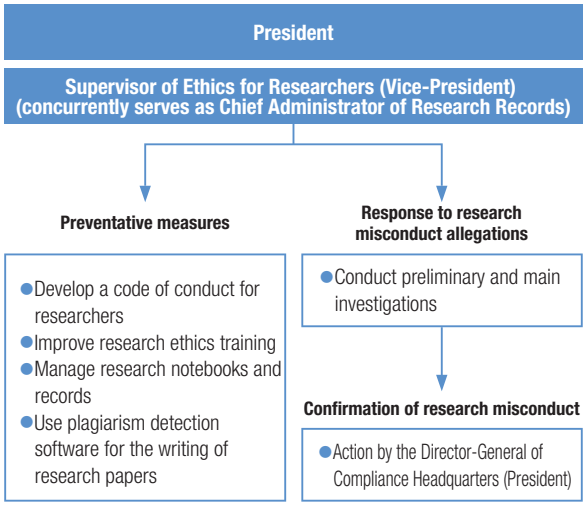
3. We encourage employees to use the online plagiarism detection tool, which was introduced to help prevent inadvertent self-plagiarism and other forms of research misconduct. The number of times used was 483 in FY 2015, the first year it was introduced, and in FY 2020, the number increased 3.4 times to1,621.

●Compliance partnerships with other entities

1. The Expert Committee on Compliance was established in December 2017 in the Association for National Research and Development Agencies with the primary aim of enhancing the risk management of agencies and now there are 27 member agencies. AIST played a central role as its chair and secretariat.

2. In FY 2020, AIST, as the secretariat, held Expert Committee on Compliance meetings in July and March, where the member agencies shared compliance information and discussed challenges and other matters. Furthermore, a Compliance Promotion Month was set by all members of the expert committee, a slogan was decided, identical posters were posted, and executive and official training was conducted.

●Response to research misconduct at AIST



●Research information management

As an institution conducting scientific and technological R&D financed by public research funds, AIST has been strongly called upon to take steps to prevent research misconduct—such as fabrication, falsification, and plagiarism—by the guidelines issued by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry.

AIST has considered concrete measures to prevent research misconduct and ensure the integrity and transparency in research. As a result, we have introduced a variety of measures, which include obligating researchers to record research activities, setting rules of records management and of a supervisor confirmation process, and building a system that centrally manages these data (research notebook recording system).

In FY 2020, for the thorough execution of appropriate maintenance and management of research information, we revised, in part, rules concerning research record management and prohibit research notebooks and copies to be taken out, and realized a way for outside agencies to request for disclosure of research notebooks. We also issued a guideline and showed ways to manage and preserve research information that was the base of research outcomes. This was done so that researchers are able to undertake research in a secure environment.

AIST will continue doing its utmost to ensure the integrity and transparency in research and will make effort to prevent research misconduct.

Disclosure of Information and Protection of Personal Information

●Disclosure of information

To increase the transparency of AIST's activities and fulfil its accountability requirements, AIST proactively discloses information on its website and by other means in accordance with the Act on Access to Information Held by Incorporated Administrative Agencies (implemented October 1, 2002).

●Protection of personal information

In accordance with the Act on the Protection of Personal Information Held by Incorporated Administrative Agencies, etc. (implemented April 1, 2005), AIST has established a privacy policy and Rules on the Protection of Personal Information at AIST, to protect the individual's rights and interests while ensuring that activities at AIST are conducted properly and smoothly.

Every year, self-inspections by e-learning for personal information protection and information security are conducted, to raise awareness of the proper management of personal information relating to executives and staff and of information security compliance.

●Information disclosure desk and personal information protection desk

Requests for information disclosure in accordance with the Act on Access to Information Held by Administrative Organs and the Act on the Protection of Personal Information Held by Administrative Organs can be made through these desks and the website of AIST Tsukuba and other regional research bases. Each desk also provides help on the procedures for disclosure and personal information protection. Only requests for information disclosure can be made through the website.

Internal Audits

At AIST, the Audit Office is deemed an independent organ that reports directly to the president. In collaboration with the auditor and the accounting auditor, the office endeavors to achieve (1) effective and efficient work, (2) observance of laws and ordinances governing AIST operations, (3) preservation of assets, and (4) reliable financial and other reports. Toward these ends, the office monitors whether individual operations function properly and efficiently and, based on the findings, recommends improvements and other corrective actions. These internal audits are performed to support the auditees, not only by detecting and pointing out problems in work processes (i.e., problem finding), but also by suggesting effective improvements based on mutual understanding that is built through thorough discussion on the problems (i.e., problem solving).

●In FY 2020, audits were performed concerning the following topics:

- As specific themes that urgently need auditing as well as cross-sectional themes, for administrative headquarters, and research units, comprehensive audits of research operations in general was conducted. While the audits confirmed that these operations were generally being carried out properly, issues in terms of compliance, effectiveness, and efficiency of some of the operations were identified. The auditees concerned were advised to swiftly make suggested improvements and the improvements were confirmed.
- As information security audit and personal information management audit, audits were conducted on implementation status of various rules, and the audits confirmed that these matters were generally being handled properly.

●**Collaboration in audits**

	Internal audit ← Collaboration → Auditor audit ← Collaboration → Accounting auditor audit		
Scope of audit	●Operational audit ●Accounting audit ●Compliance audit	●Operational audit ●Accounting audit	●Accounting audit
Points of audit	●Activities as a whole ●Appropriateness of risk management and development and operation of internal control systems ●Improvement of work process efficiency	●Activities as a whole ●Decision-making by the President ●Creation and operation of internal control systems ●Appropriateness of financial statements	●Appropriateness of financial statements (effectiveness of internal control systems)

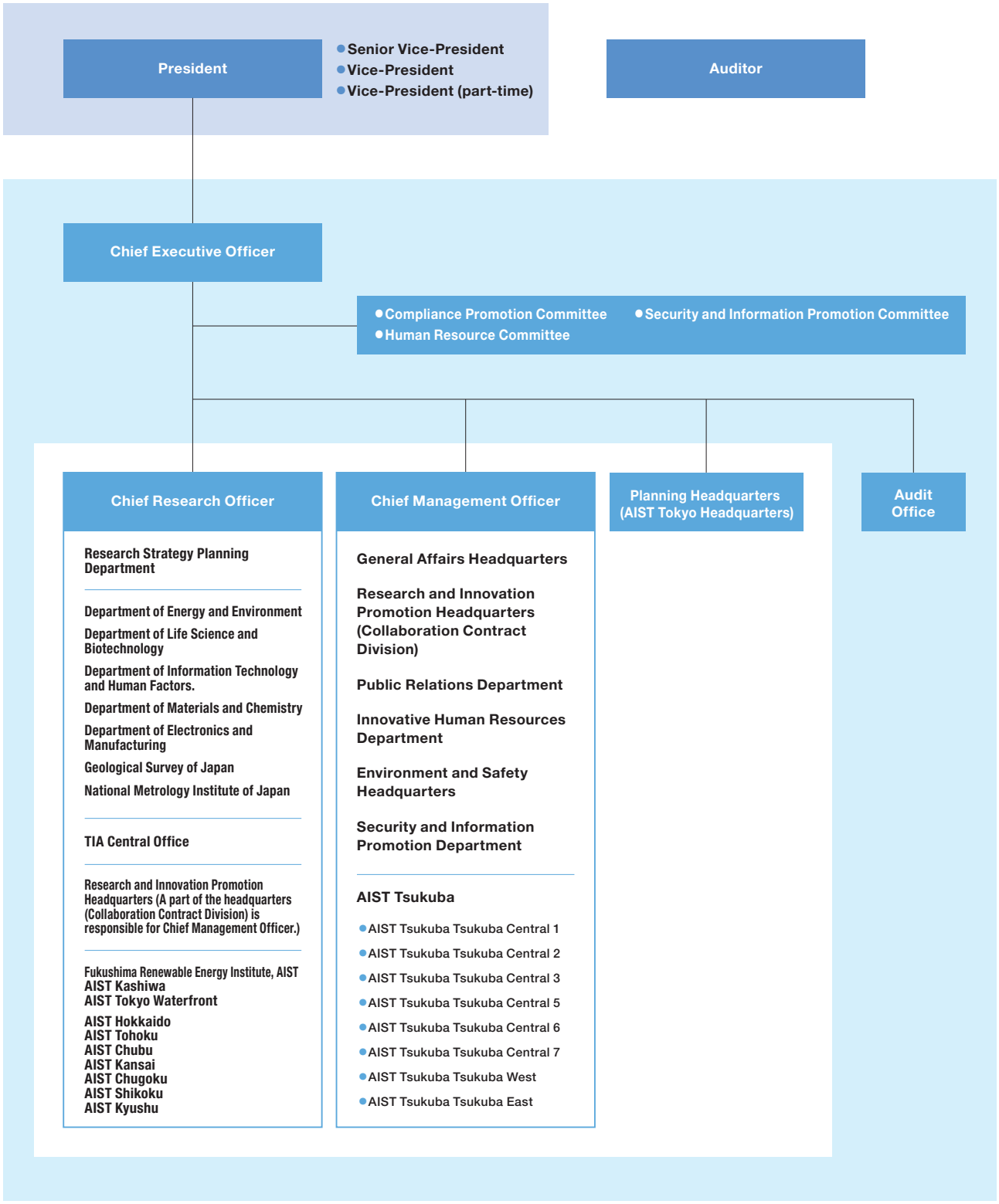
Fair Operating Practices

We conduct appropriate work management based on the law.

Item	Purpose	Action in FY2020
Management of Conflict-of-Interest	Management of conflict-of-interest is conducted based on the rules for conflict-of-interest management.	In order not to give the impression to society that individual profits from other parties in industry–academia–government collaborations are put before duty by executives or research responsibility, a conflict-of-interest management system is in place. •3,402 executives and employees who needed to declare their own status of conflict-of-interest all submitted their self-assessments. •6 employees who had particular concern for conflict-of-interest were interviewed by outside counselors to look into their activities. Additionally, after the Conflict-of-Interest Management Committee consisting of outside experts deliberated, they were notified of points of attention regarding promotion of industry–academia–government collaborations. •In order not to give the impression that we are putting profits before public responsibility, from FY 2020, we operate a management system for conflict-of-interest on a full scale. 39 corporate bodies with which we have close collaborative relations were targeted, and the Committee deliberated on our collaborative activities and procurement records. No problem was found.
Information Security	When conducting medical research involving human subjects, conflicts of interest must be managed in compliance with Ethical Guidelines for Medical and Health Research Involving Human Subjects, in particular to protect subjects and enhance research transparency.	Concerning 5 cases in which executives and employees who intended to conduct medical research declared having conflict-of-interest, examination was conducted by the Conflict-of-Interest Management Committee for Clinical Research, whose members include outside experts. Based on this, the leaders of experiments were notified of how to correspond to persons to be studied, and precautions to be taken in presenting results.
	In order to ensure high-level information security, AIST is strengthening the information network and the information security management system.	●Information security measures •Segmentation of internal network by organizational units •Response to information security incidents by the Computer Security Incident Response Team (CSIRT) ●Information security training •Improving information security awareness by information security training ●Information security audit •Information security audits for all units and departments are primarily conducted by the information security department
Implement-ation of Security Export Control	To maintain peace and security within the international community, AIST has tight security export controls in place in accordance with AIST's Rules on Security Export Control (internal rules and regulations), formulated based on the Foreign Exchange and Foreign Trade Act, thereby preventing AIST's technology from being used for the development of weapons of mass destruction.	Through (1) dissemination of the latest information on legislative amendments within AIST; (2) export control training for AIST staff; (3) export control instruction to individual staff members; (4) classification and transaction screening; and (5) internal audits, efforts are being made to raise awareness of security export control at staff level, and by maintenance of departmental systems, we are implementing appropriate export controls.
Promoting Rational Procurement	Under the AIST Rational Procurement Policy (in compliance with the May 25, 2015 decision of the Minister for Internal Affairs and Communications), we streamline procurement operations autonomously on an ongoing basis while ensuring fairness and transparency, using a plan-do-check-act cycle in light of the characteristics of our duties and operations.	Each year, we formulate an AIST Rational Procurement Policy, and conduct ex-post facto inspections of individual contracts by a Contract Oversight Committee, whose members include outside experts. We answered to questions from members and obtained their agreement. Once a fiscal year ends, we conduct a self-assessment of how our rational procurement policy for the fiscal year has been implemented using the set indicators, and the results are publicized. As part of the CSR procurement and pursuant to the Act on Promotion of Government's Procurement of Goods Supplied by Facilities for Persons with Disabilities to Work, every year AIST also discloses its policy for promoting the procurement of goods from those facilities and its procurement results. As outcome of efforts in line with the policy, we were able to achieve a goal that exceeded the results of the previous year. Furthermore, AIST has introduced a procurement method that evaluates suppliers based on how they promote work–life balance, with the aim of realizing public procurement contributing to women' s active participation in the workforce.
Implementing Market Testing	In accordance with the Basic Policies on Public Service Reform, AIST Tsukuba conducts facility management under procurement contracts.	Continued from FY 2019, the following 7 services were conducted ((1) to (6) up to FY 2020, (7) planned up to FY 2022): (1) maintenance and management of AIST Tsukuba facilities, (2) management of trees and vegetation on AIST Tsukuba premises, (3) safeguarding of AIST Tsukuba, (4) cleaning of AIST Tsukuba buildings, (5) operation and management of the Research Collaboration Center, the Science Square Tsukuba, and the Geological Museum, (6) driving, maintenance, and management of AIST Tsukuba vehicles, and (7) operation and management and user assistance of the information network system. According to questionnaires on facility management of AIST Tsukuba, the satisfaction level of users was over 98 %.

Basic Information about AIST

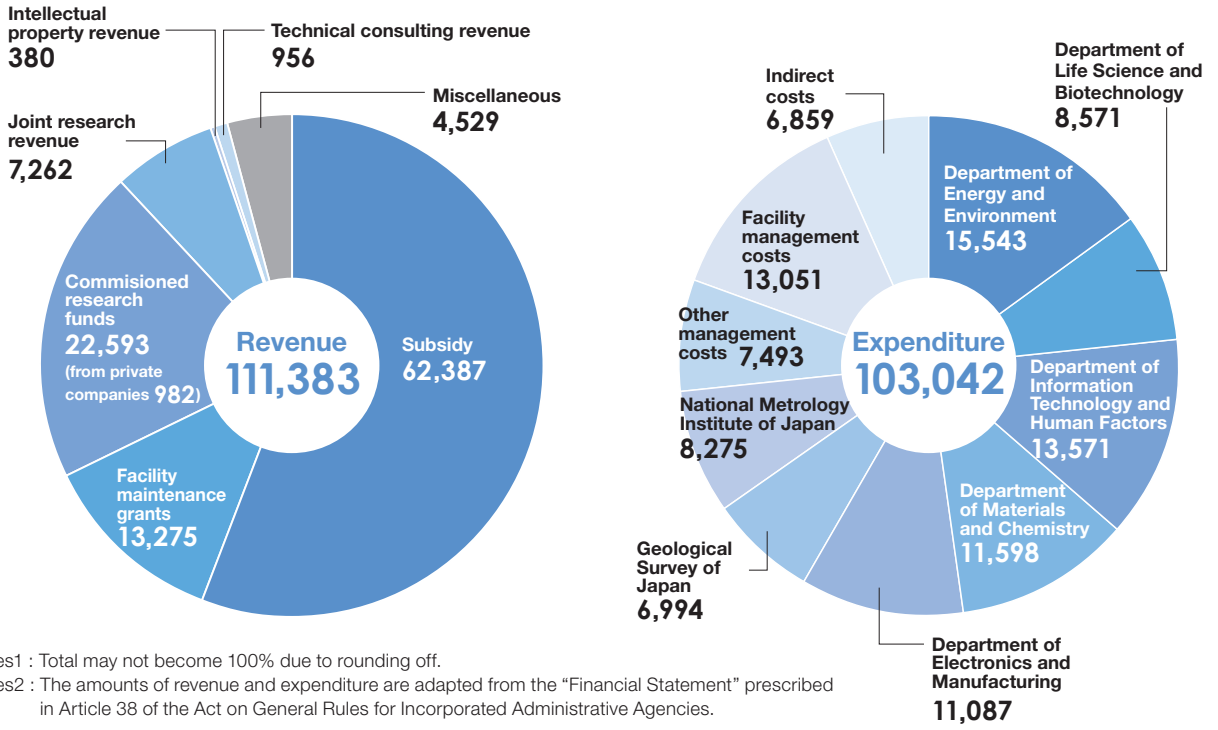
Organization Profile



As of September 2021

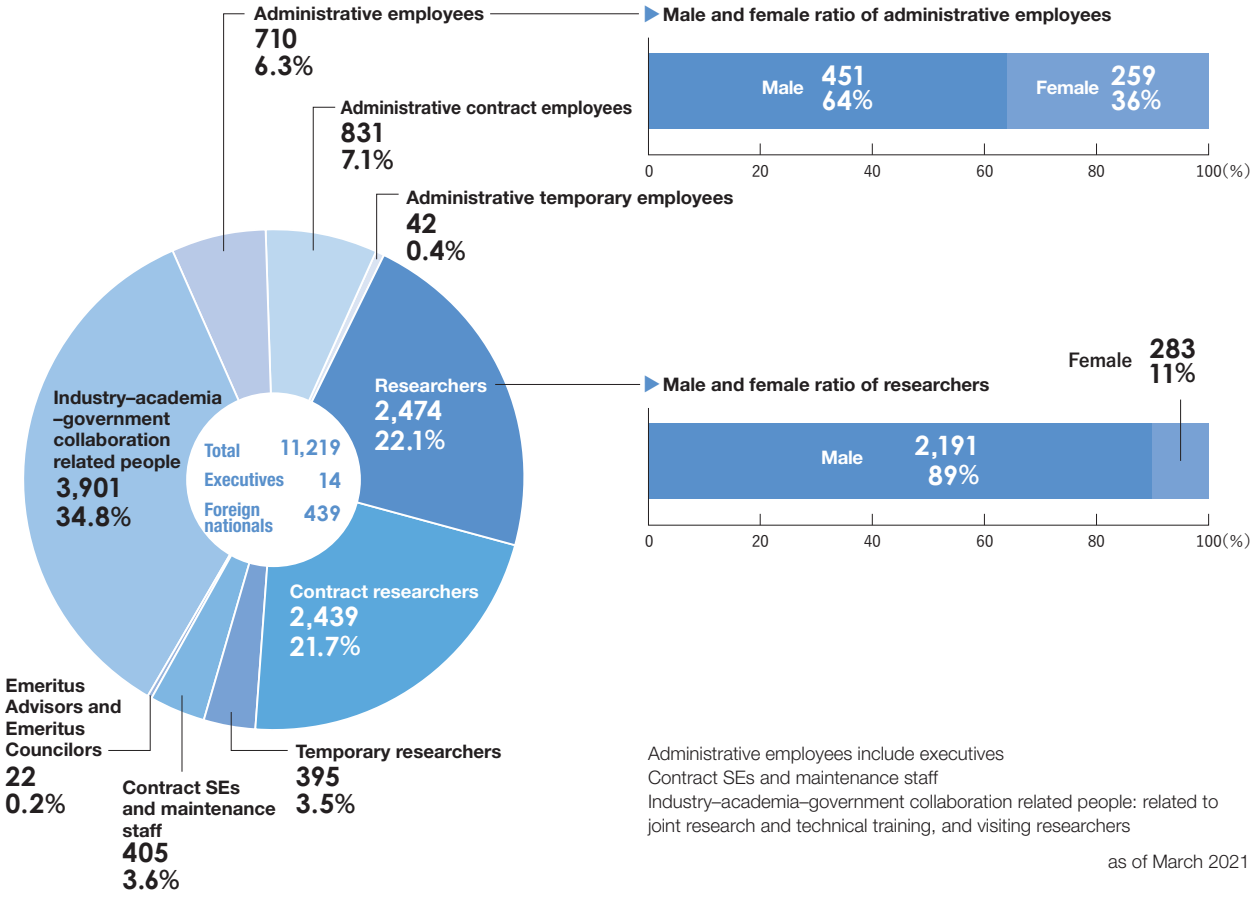
Revenue and Expenditure

Financial results for FY 2020 (unit: million yen)



Notes1 : Total may not become 100% due to rounding off.
Notes2 : The amounts of revenue and expenditure are adapted from the "Financial Statement" prescribed in Article 38 of the Act on General Rules for Incorporated Administrative Agencies.

Staff



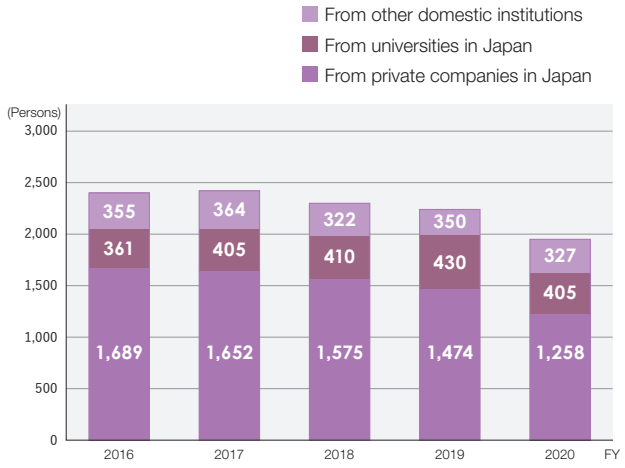
Administrative employees include executives
Contract SEs and maintenance staff
Industry–academia–government collaboration related people: related to joint research and technical training, and visiting researchers

as of March 2021

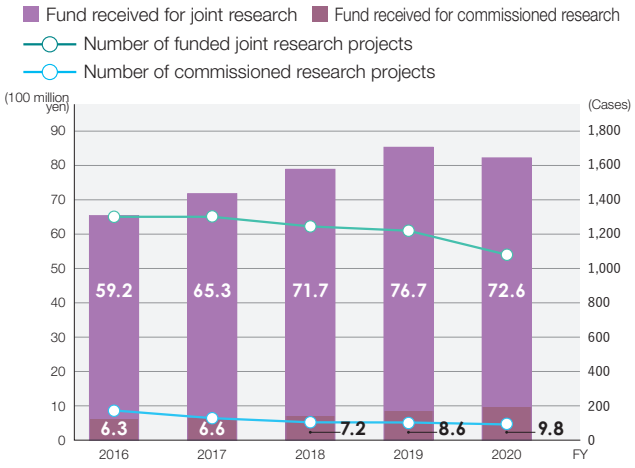
Reference Data

Data about promotion of research and development

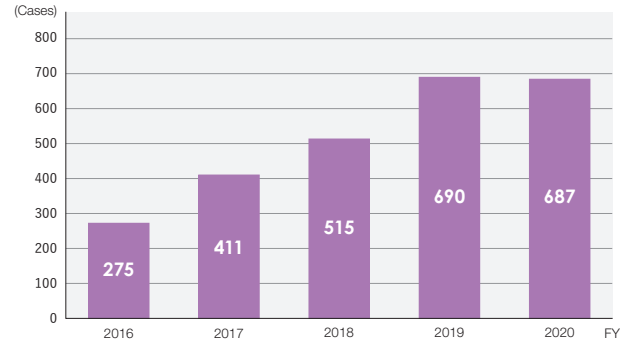
Acceptance of external researchers for joint research



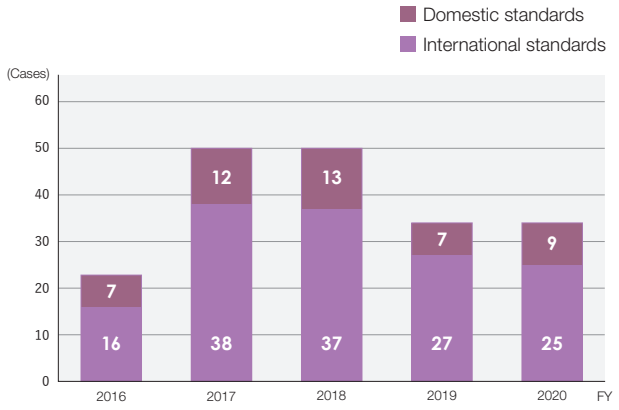
Joint and commissioned research with companies



Number of technical consulting

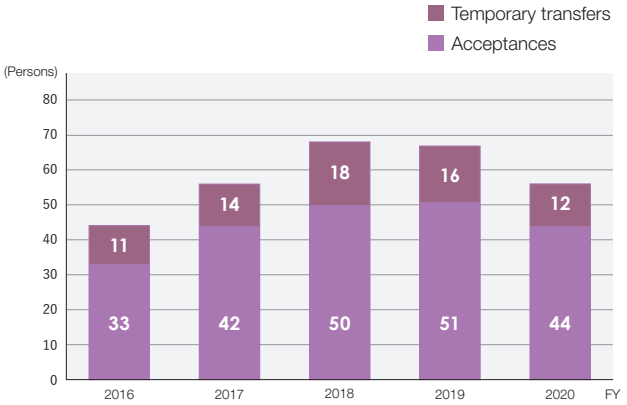


Number of proposed standards



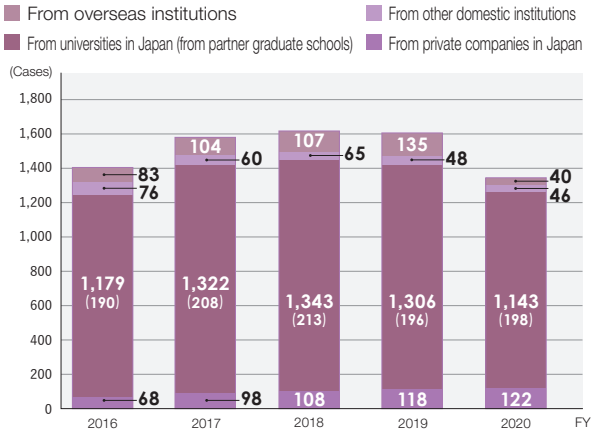
Contribution of AIST staff to international standardization activities

Number of cross-appointment program users

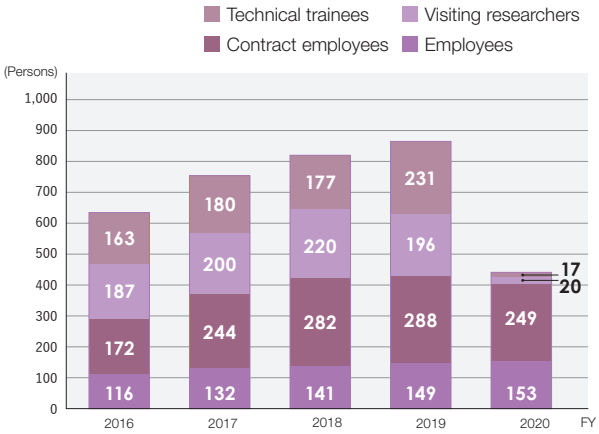


*This figure is not the number of projects as of April 1, 2021, but includes projects that were completed in the middle of FY 2020.

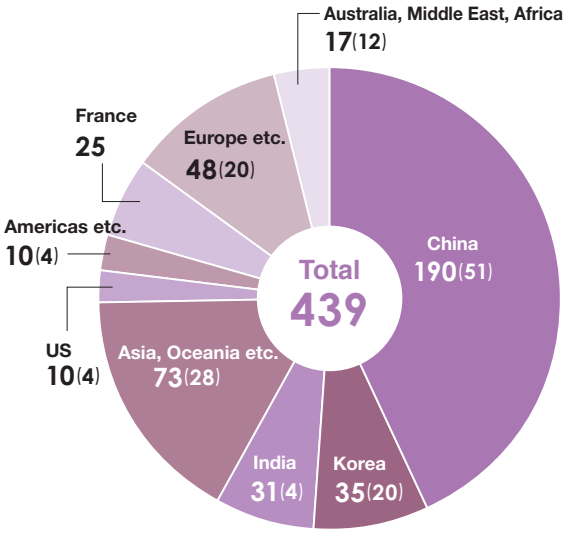
Number of trainees on technical training



Number of foreign researchers



Number of foreign researchers by country and region in FY 2020



*Numbers in parentheses are those with employee status.

Data relating to human resources

Number of people who used the various leave programs

(Persons)

	FY2016		FY2017		FY2018		FY2019		FY2020	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Leave to care for sick children	110	192	124	224	139	217	122	219	89	147
Special childcare leave	32	11	27	14	42	22	39	21	30	13
Extended childcare leave*	4	27	2	38	9	48	17	67	13	56
Nursing care leave	51	37	69	45	72	57	75	59	48	40
Extended nursing care leave*	1	0	2	4	0	8	1	9	1	0

*Number of employees starting the leave within the fiscal year

Number of employees who used child daycare services

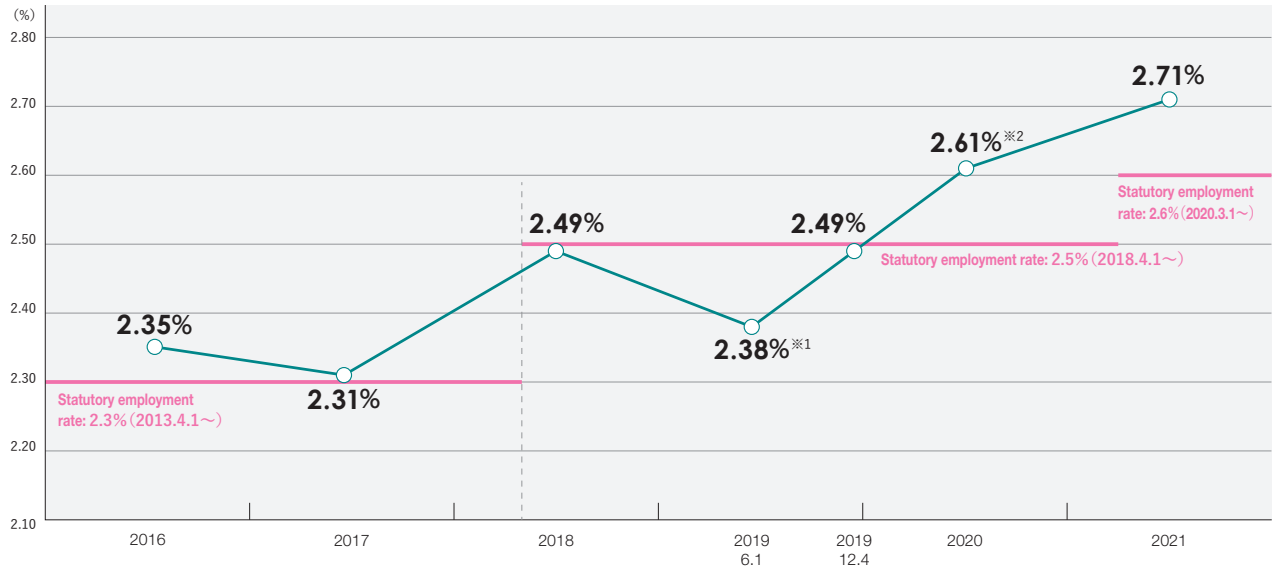
(Persons)

	FY2016		FY2017		FY2018		FY2019		FY2020	
	Permanent employees	Contract employees	Permanent employees	Contract employees	Permanent employees	Contract employees	Permanent employees	Contract employees	Permanent employees	Contract employees
AIST Tsukuba	1,135	1,016	1,872	1,069	1,681	897	834	1,047	473	73
AIST Chubu	7	33	5	112	15	87	93	59	18	11
AIST Kansai	190	10	229	5	136	21	134	45	4	1
Private child daycare facilities and babysitters	7	1	32	26	41	12	43	4	24	0

*total number

Change in employment rates for people with disabilities

% of June 1 of each year

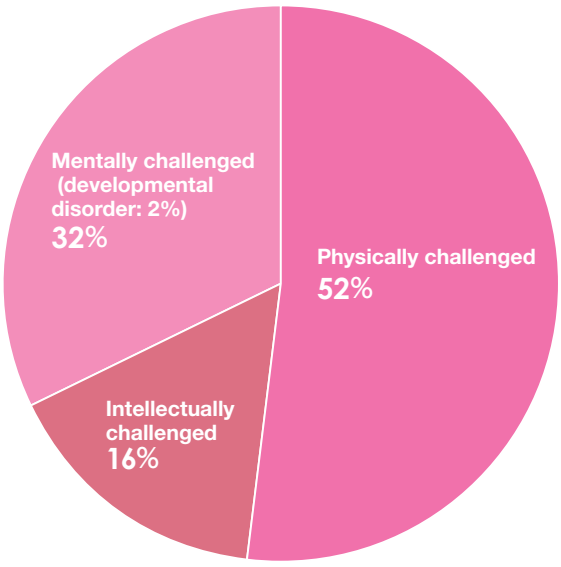


*1 Corrections were made after reinvestigation.
*2 As of December 4, 2019, the actual employment rate was 2.49%, but the number of legally employed persons (136 persons) calculated from the legally mandated employment rate of 2.50% has been met.
Therefore, the statutory employment rate has been achieved.

Percentage of people with disabilities remaining at work

	FY2016	FY2017	FY2018	FY2019	FY2020
Number of people at the beginning of the fiscal year	87	88	105	111	110
Number of people who left AIST within the fiscal year	10	11	8	9	4
Employee turnover rate	11.49%	12.50%	7.62%	8.11%	3.64%
Employee retention rate	88.51%	87.50%	92.38%	91.89%	96.36%

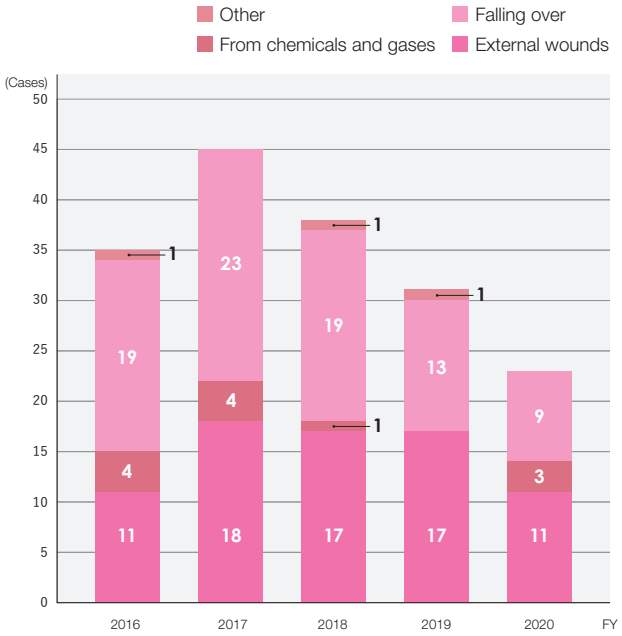
Employment rate by disability type



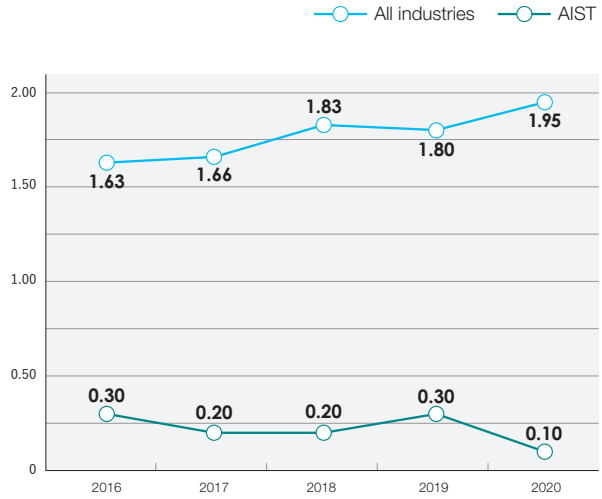
as of June 1, 2021

Health and safety data + Health management data

Trends in the number of occupational accidents



Frequency rate of accidents resulting in absences from work



Calculation method
AIST: (number of applications for compensation for absence from work due to industrial accidents/total number of working hours) x 10^6
All industries: (number of deaths and injuries due to occupational accidents/total number of working hours) x 10^6
*The occupational injury rate for all industries is calculated by limiting the number of casualties to those who lost at least one day of work or lost part of their body or its function due to industrial accidents.

Main education and training programs and workshops held in FY 2020

Program	No. of sessions	No. of participants
Course on skills required for a Health Officer's License	2	43
Course on skills required for a Chief Technician's License for Using Organic Solvents	1	22
Course on skills required for a Chief Technician's License for Using Specified Chemical Substances	1	21
High-pressure gas safety course (for those handling high-pressure gases for the first time)	4	351
High-pressure gas safety course (for those handling high-pressure gases on an ongoing basis)	4	1,419
General safety workshop (for all those responsible for hazardous chemicals, etc.)	4	2,427
Education and training for recombinant DNA experiments (e-learning participants)	1	1,058
Education and training for animal experiments (e-learning participants)	1	394
Education and training on human ethics in life science experiments (e-learning participants) Lecture on Clinical Trials Act	1	230
Specific safety training course (radiation)	10	384
Specific safety training course (X-ray) (for new X-ray researchers)	77	198
Course on compliance with laws and regulations on radioactive materials (for managers)	1	18

Number and percentage of permanent and contract employees who underwent periodic medical examinations (including health screening), 2016–2020

Top: percentage of examinees Bottom: no. of examinees/ total no. of eligible employees

	2016	2017	2018	2019	2020
(1) Employees (excluding (2)) *1	99.7%	99.8%	99.9%	99.8%	99.7%
	3,022／3,031	3,061／3,067	3,065／3,068	2,986／2,992	3,021／3,030
(2) Contract employees *2	99.9%	99.8%	99.9%	99.7%	99.9%
	2,319／2,322	2,436／2,440	2,455／2,456	2,569／2,577	2,399／2,401

*1 Excluding those on extended childcare leave and sick leave and those on long leave due to overseas relocation *2 Social insurance policy holders only

Number of permanent and contract employees (including temporary employees) who underwent special medical examinations in FY 2020

	Spring			Autumn		
Special medical examination	Permanent employees	Contract employees	Total	Permanent employees	Contract employees	Total
Medical examination for organic solvent poisoning prevention	723／723	700／700	1,423／1,423	758／758	765／765	1,523／1,523
Medical examination for specified-chemical poisoning	434／434	367／367	801／801	457／457	403／403	860／860
Medical examination for ionizing radiation exposure	340／340	102／102	442／442	356／356	103／103	459／459
Medical examination for lead poisoning	9／9	10／10	19／19	10／10	10／10	20／20
Medical examination for laser injury	326／326	132／132	458／458	25／25	17／17	42／42
Medical examination for pneumoconiosis	10／10	27／27	37／37	0／0	1／1	1／1
Medical examination for asbestos exposure	4／4	3／3	7／7	4／4	3／3	7／7

*no. of examinees/ total no. of applicable employees

Number of employees with significant findings from AIST's medical examinations, and number of employees who received face-to-face counseling

(1) Number of employees with significant findings, and their percentages of the total

FY	2016	2017	2018	2019	2020
With significant findings (D-diagnosis)	117	134	152	140	159
	2.5%	2.2%	3.5%	3.1%	3.7%
With significant findings (E-diagnosis)	970	907	822	817	872
	20.5%	14.6%	19.1%	18.3%	20.6%

(2) Number of employees who received counseling, and their percentages to employees with significant findings

FY	2016	2017	2018	2019	2020
With significant findings (D-diagnosis)	98	110	123	121	130
	83.8%	82.0%	80.9%	86.4%	81.8%
With significant findings (E-diagnosis)	862	791	718	726	779
	88.9%	87.2%	87.3%	88.9%	89.3%

Definition of criteria: A: no anomalies; B: mild abnormalities but no interference with daily life; C: follow-up examination required; D: health advice required; E: treatment required; F: counseling required (applicable only to special medical examinations)

number

Number of face-to-face health consultations in FY 2016-2020

(Cases)

		2016	2017	2018	2019	2020
Industrial physician	Physical	1,651	1,451	1,573	1,439	921
	Mental	594	540	551	573	525
Industrial health staff		3,345	3,356	3,850	5,496*	5,599
Total		**5,590**	**5,347**	**5,974**	**7,508**	**7,045**

*From FY 2019, the number includes consultations for employees who received health screening at outside medical facilities and overworked employees (based on reform of working practices).

Flu shots (at AIST)

(Persons)

FY	2016	2017	2018	2019	2020
AIST Tsukuba/Tokyo	1,927	1,876	1,201	2,000	1,962
Regional research bases	538	664	566	578	640
Grand total	**2,465**	**2,540**	**1,767**	**2,578**	**2,602**

Other activities of health management

(Persons)

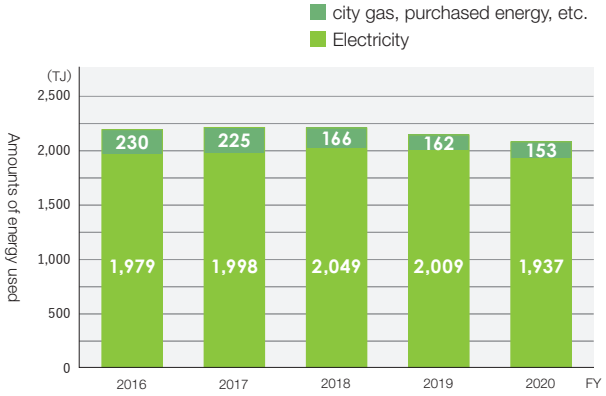
FY	2016	2017	2018	2019	2020		2016	2017	2018	2019	2020
Exercises to refresh	219	246	192	198	*	Mental health seminars	133	79	115	55	146
Walking lessons	-	377	175	82	*	Workshops (training)	407	187	227	183	239
Emergency first-aid workshops	154	80	138	145	*	Anger management workshops	-	-	-	119	43

*Due to Covid-19, the event was not held. (Exercises to refresh were conducted via video streaming.)

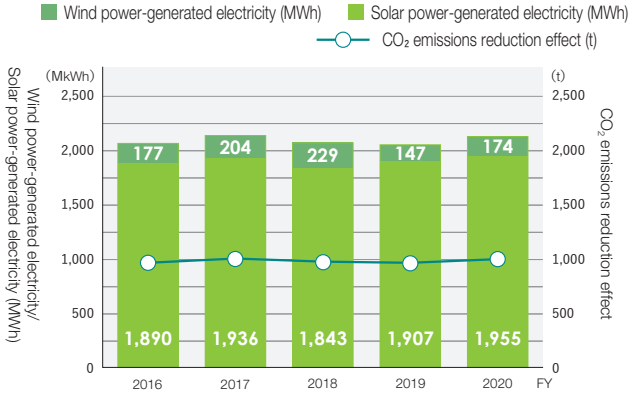
Environmental Reporting Data

Energy

Changes in amounts of energy used



Progress in renewable energy generation and CO_2 emissions reduction



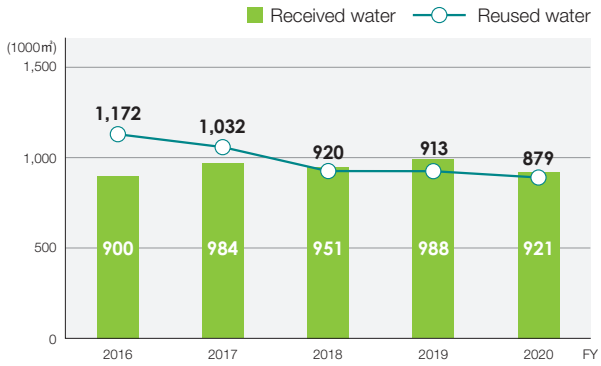
Water resources

Breakdown of water received

Unit: 1000㎥

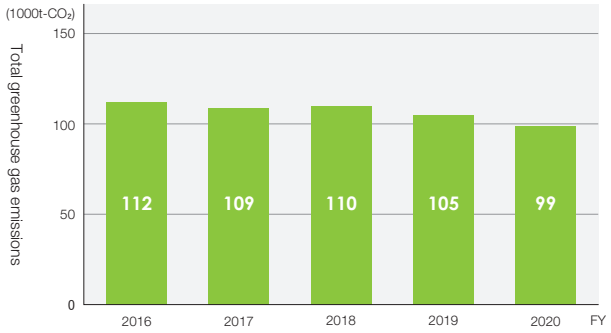
FY	2016	2017	2018	2019	2020
Potable water	881	968	937	974	913
Groundwater	19	16	14	14	8
Industrial water	0	0	0	0	0
Total	900	984	951	988	921

Changes in amounts of water received and reused



Atmospheric emissions

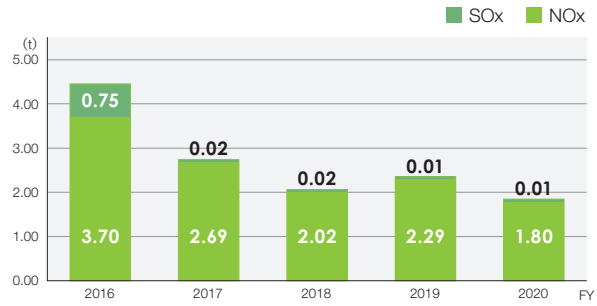
Changes in CO_2 emissions by year



Estimated leakage of CFCs (FY 2020)

Type	R-number	Estimated t-CO_2e released by R-number	Estimated t -CO_2 released by type
HCFC	R22	43.44	43.44
HFC	R32	3.3075	229.3373
	R134a	41.7088	
	R407C	109.917	
	R410A	74.404	
Mixed	Mixed refrigerant	0	0
Total			272.7773

Changes in atmospheric environmental loads

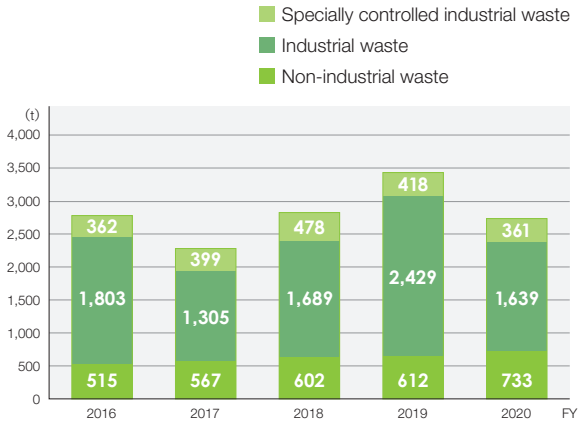


Waste

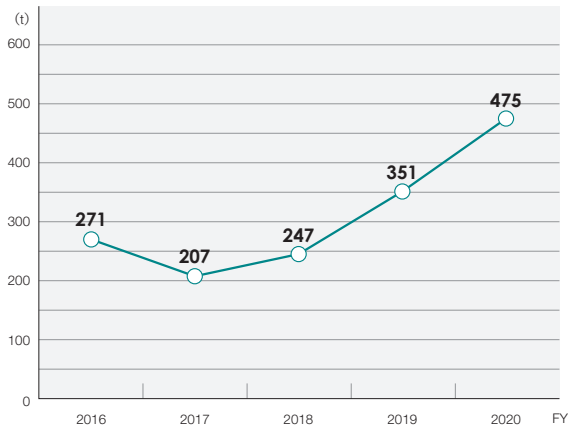
Breakdown of generated waste (FY 2020)

Waste type	Amount disposed of (t)	Amount landfilled (t)	Percentage of waste landfilled (%)
Non-industrial waste	732.70	118.16	16.1
Industrial waste	1,639.44	338.24	20.6
Plastic waste	507.14	31.98	6.3
Metal scrap	198.40	6.01	3.0
Sludge	319.31	226.03	70.8
Glass/concrete/ceramic waste	69.40	16.61	23.9
Slag	30.48	0.00	0.0
Other	514.71	57.62	11.2
Specially controlled industrial waste	361.22	18.19	5.0
Flammable waste oil	19.86	1.71	8.6
Strong acids	264.10	8.14	3.1
Infectious waste	17.87	7.28	40.8
Waste oil (hazardous)	3.37	0.02	0.6
Sludge (hazardous)	9.27	0.02	0.3
Acid waste (hazardous)	4.38	0.06	1.3
Other	42.36	0.96	2.3
Total	2,733	475	17.4

Changes in amounts of disposed waste



Changes in amounts of landfill waste



Storage and disposal of PCB-containing items and PCB waste

Waste type	Quantity stored at the end of FY 2019	Quantity added in FY 2020	Quantity disposed of in FY 2020	Quantity stored at the end of FY 2020
Capacitors	1,715	339	466	1,588
Electrical ballasts	1,225	2	542	685
Transformers	2	0	0	2

Waste type	Quantity stored at the end of FY 2019	Quantity added in FY 2020	Quantity disposed of in FY 2020	Quantity stored at the end of FY 2020
Oils/paints (L)	106ℓ	0ℓ	106ℓ	0ℓ
Other contaminated materials	Stored as research chemicals, etc.	Use of waste cloth used for analysis	—	Stored as research chemicals, etc.

Water quality

●Monitoring of groundwater at AIST Kansai

Sampling month	Measurement of arsenic and arsenic compounds (standard: ≤ 0.01 mg/L)	Sampling month	Measurement of arsenic and arsenic compounds (standard: ≤ 0.01 mg/L)
April 2020	0.004	October 2020	0.017
May 2020	0.006	November 2020	0.021
June 2020	0.019	December 2020	0.013
July 2020	0.010	January 2021	0.013
August 2020	0.006	February 2021	0.007
September 2020	0.025	March 2021	0.009

Appropriate Management of Chemical Substances (FY 2020)

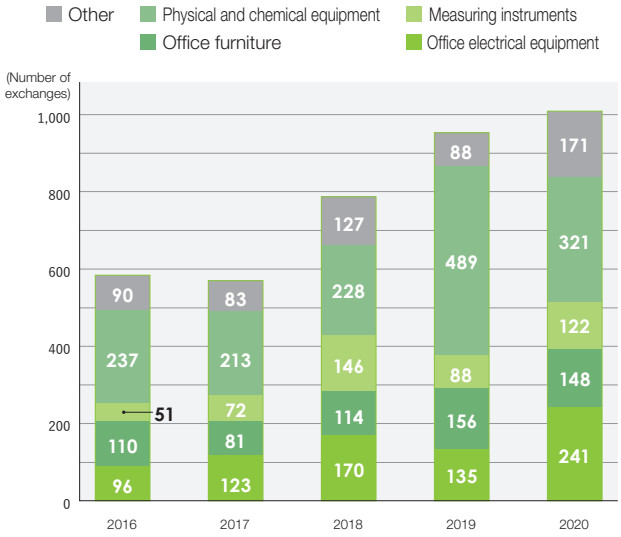
●Amount of chemicals reported under the Chemical Control Program

Research site	Substance	Amount used	Amount released	Amount transferred	
			Air	Sewer	Waste
Fukushima Renewable Energy Institute, AIST	Ammonia (kg)	190	0	0	11
	Hydrogen peroxide (kg)	350	0	0	350
	Sulfuric acid (kg)	0	0	0	320
	Hydrogen fluoride and its water-soluble salts (kg)	270	0	0	270
AIST Tsukuba Central 5	Chloroform (kg)	1,100	110	0	1,000
	n-hexane (kg)	2,100	460	0	1,700
AIST Tsukuba West	Ferric chloride (kg)	71,000	0	0	0
	N,N-dimethyl acetamide (kg)	1,600	0	0	1.4
	Hydrogrn fluoride and aqueous salts thereof (kg)	3,300	0	330	410
AIST Tokyo Waterfront (Bio-IT integrated technology facility)	Acetone (kg)	140	14	0	126
	Chloroform (kg)	153	7	0	146
	Ethyl acetate (kg)	200	16	0	184
	Methanol (kg)	320	13	0	307
AIST Kansai	VOC (kg)	1,500	430	0	1,000

AIST Tsukuba Central 5, AIST Tsukuba West：PRTR Act
AIST Tokyo Waterfront (Bio-IT integrated technology facility): Ordinances relating to the health and safety of citizens and the environment
AIST Kansai: Ordinances relating to preserving the living environment of Osaka Prefecture

Reuse of equipment etc.

●Reuse within AIST



Environmental accident drills

●Environmental accident drills in FY 2016–2020

FY	2016	2017	2018	2019	2020
Number of drills	18	17	18	19	19

Green Procurement, Etc.

Purchase Results of Eco-friendly Goods and Services

Area	Item		Target	Total quantity purchased	Purchase of specified purchase items	Target attainment
Paper	Photocopier paper		100%	14,472.6kg	14,472.6kg	100%
	Forms		100%	5.6kg	5.6kg	100%
	Coated paper for inkjet color printers		100%	92.5kg	92.5kg	100%
	Toilet rolls		100%	2,430.7kg	2,430.66kg	100%
	Tissue paper		100%	11,668.2kg	11,668.2kg	100%
Stationery	Mechanical pencils		100%	271	271	100%
	Mechanical pencil leads		100%	173	173	100%
	Ballpoint pens		100%	7,456	7,456	100%
	Marker pens		100%	9,434	9,434	100%
	Media cases		100%	915	522	57%
	Glue (including glue sticks and glue pouches)		100%	1,684	1,684	100%
	Adhesive tape		100%	597	597	100%
	Files		100%	64,061	64,061	100%
Office furniture, etc.	Chairs		100%	487	487	100%
	Desks		100%	365	365	100%
Copying devices		Purchased	100%	23	23	100%
	Photocopiers, etc. *	Leased/rented (new)	100%	90	90	100%
		Leased/rented (extension)	-	153	153	-
		Purchased	100%	118	118	100%
	Scanners	Leased/rented (new)	100%	0	0	100%
		Leased/rented (extension)	-	0	0	-
	Toner cartridges		100%	4,776	4,776	100%
	Ink cartridges		100%	2,278	2,278	100%
Office equipment		Purchased	100%	45	45	100%
	Paper shredders	Leased/rented (new)	-	0	0	-
		Leased/rented (extension)	-	0	0	-
Vehicles, etc.		Purchased	100%	0	0	100%
	Non-general official vehicles	Leased/rented (new)	100%	4	4	100%
		Leased/rented (extension)	-	0	0	-
Fire extinguishers	Fire extinguishers		100%	31	31	100%
Services	Passenger transportation		100%	701件	701件	100%

*: Photocopiers, combination units, digital photocopiers with expandable functions

Number of green contracts (FY 2020)

Type of green contract	Number of cases
Automobile purchase	5
Contract for power supply	13
Industrial waste	17

Third Party Opinion

This third party opinion is not simply produced from the final version of the report; exchanges of views in the process of creating the report are crucial. For this year's report, I identified two points on which I submitted requests and asked for improvements, and I offered comments on the first draft. The comments were fed back to the relevant offices and considered earnestly, and I received responses. The responses included examples where the content was changed, reasons where the content was not changed, and policies for the future. I believe this contributed significantly to continuing improvement of the report.

Changes such as the UN adopting the SDGs in 2015, stock exchange-listed companies in Japan becoming subject to the Corporate Governance Code, and the GPIF (Government Pension Investment Fund) committing to PRI (Principles for Responsible Investment) have driven a transformation of ESG (environmental, social and corporate governance) management in Japanese companies. In the report, we read how this wave of change has broken over AIST and set off reforms of organizational governance aimed at fulfilling the AIST mission.

The first of these reforms is the adoption of Management Policies for Research. I think this is the first time the term "management policies" has appeared in this report and I recognize that these policies are vital for maximizing the value of the Institute. The second reform is the review of organizational governance systems. The main pillars of this review are fewer internal vice presidents, more external vice presidents, and the separation of oversight from execution. All of these are in accordance with the principles of the Corporate Governance Code and bring hopes of improvements in governance. In the future, I hope that board effectiveness will be assessed, as it is in many companies, and that summaries of the results will be presented along with the assessment process and what is assessed.

The third aspect is the adoption of the "AIST Vision." Many companies facing economic crisis, the pandemic, climate change and so forth have rewritten their visions or statements of purpose. At the landmark of 20 years since the launch of the organization, I understand that this vision has been adopted with the aim of solving social problems. With the establishment of AIST Vision, as "more staff than ever before ... join the conversation," we can anticipate that the vision will become deeply ingrained. However, the President says in his message "For individual intentions to lead to improved value of the organization as a whole, it is important to raise engagement between the organization and the staff working in it." Staff engagement represents agreement with the direction of the Institute and staff voluntarily wanting to support it; enhancing engagement does seem to be very important. In the future, I would like the extent to which individual employees can contribute to achieving the vision through their work to be measured by engagement surveys and for scores to be published.

The keyword that leaves a particular impression in this report is "social implementation." In the two years of the COVID-19 pandemic, with inadequate online administrative services, the slow appearance of Japan-made vaccines and so forth, the current weakness of social application in quickly bringing the benefits of new technology to all citizens has been remarkable to observe. Social implementation has been mentioned in the report previously, but this year, it is clearly stated as part of "our mission," and is mentioned more often than before in the section on Management Policies for Research and in the Opening Dialogue and the Research Reports. We can only hope that cutting-edge technologies and innovation leading to social implementation will renew Japan's competitiveness.

Finally, I would like to talk about the presentation of environmental and social information. Until now, this information has typically been limited to describing states of environmental burden reductions and environmental impact initiatives. These days, however, sustainability is the big challenge. Information on future intentions should be added to previous presentations, such as how these efforts will contribute to the value of the Institute and to its environmental value and social value in the infrastructure of society. With this in mind, I would like to see new consideration of how the information is arranged. In addition, I would suggest amending the subtitle of the report from "Social and Environmental Report" to "Sustainability Report" or "Comprehensive Report."

Workers Club for Eco-harmonic Renewable Society (NPO)

Director **YAMAGUCHI Tamio**

Workers Club for Eco-harmonic Renewable Society (Junkan Workers Club): A citizens group that investigates, with a global perspective, the form of a society in harmony with the natural ecosystems that will be passed on to the next generation. The goal of the club is to study, support and put into practice measures leading to a sustainable mode of society for regional citizens, businesses, and governments. At CSR workshops within the club, the group studies and proposes appropriate forms of CSR.
URL：https://junkanken.com/

On the publication of the AIST Report 2021

AIST has been publishing environmental reports since 2004, as the AIST Report: Social and Environmental Report in accordance with ISO 26000 since 2010. The scope of the report has widened from AIST Tsukuba to cover research bases across the country, and reports on initiatives relating to the environment, workplace health and safety, and corporate social responsibility have been added.

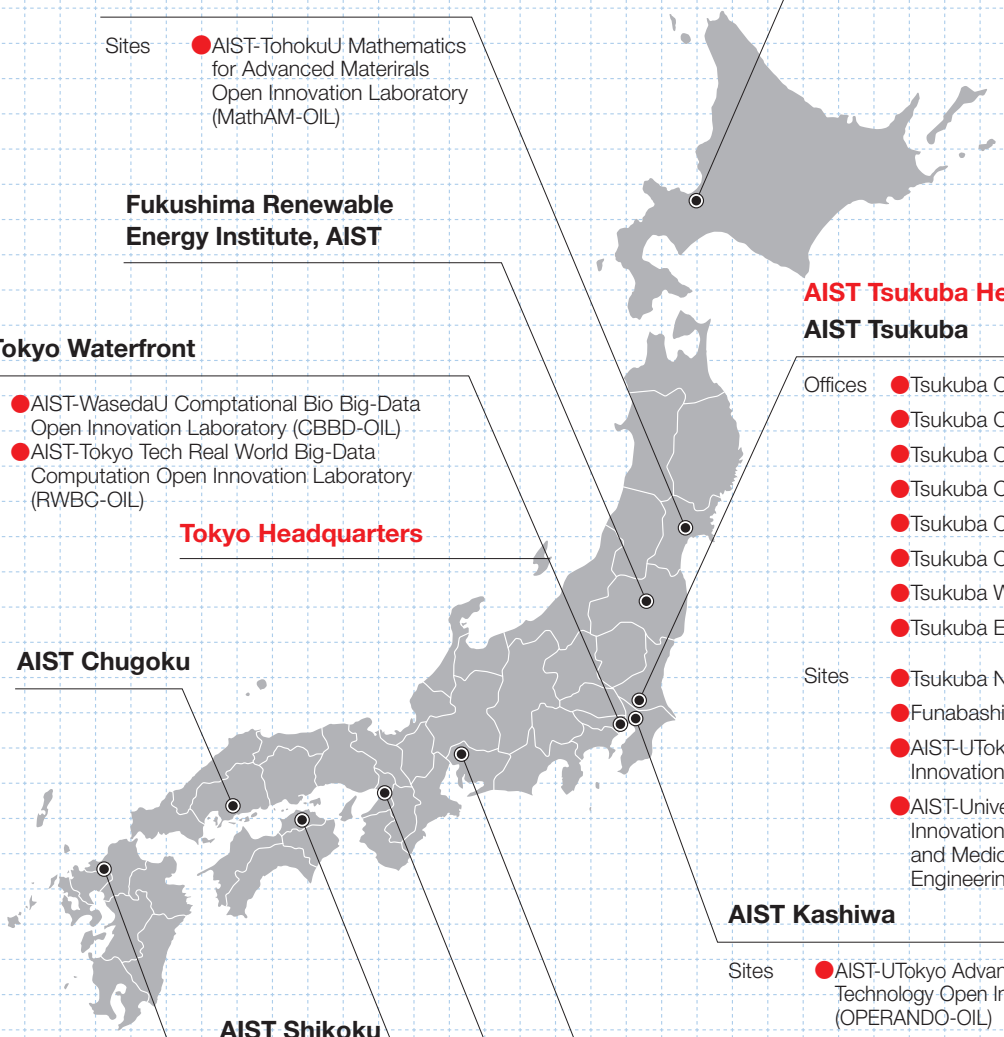
In this year's AIST report, in the Top Message delivered by President and Chief Executive Officer ISHIMURA Kazuhiko, he presents efforts on the 20th anniversary of AIST's founding to give AIST real value as the heart of a national innovation ecosystem and to solve social problems. He also introduces Management Policies for Research, the review of organizational governance systems and the AIST Vision as initiatives to achieve the AIST Mission of "producing world-beating innovation, solving social problems, and contributing to stronger economic growth and industrial competitiveness." In the interview given by External Vice-President YANAGI Hiroyuki, Chairman of Yamaha Motor Co., he tells us about his hopes for AIST's efforts as a public research institute. In the Opening Dialogue, University of Tokyo Professor Emeritus KISHI Teruo and President Ishimura exchange their thoughts on a range of issues including the future of science, technology and industry and the development of personnel. In the Research Reports, results and projects at the Global Zero Emissions Research Center founded in January 2020 are introduced. In Third Party Opinion, YAMAGUCHI Tamio of the NPO Junkan Workers Club provides invaluable thoughts and guidance.

As AIST's staff work in unity to solve social problems with "Create the Future, Collaborate Together." (AIST Vision, adopted June 2021) in their hearts, it is our duty and our mission to present AIST's activities to the many stakeholders who want to hear about them in a form that is easy to understand. With this report, we are striving to build relationships of deeper trust with society.

Vice-President and Director, Public Relations Department **KATO Kazumi**

Research Bases

as of Sept., 2021



AIST Hokkaido

Sites
- AIST Sapporo Odori Site

AIST Tohoku

Sites
- AIST-TohokuU Mathematics for Advanced Materirals Open Innovation Laboratory (MathAM-OIL)

Fukushima Renewable Energy Institute, AIST

AIST Tsukuba Headquarters

AIST Tsukuba

Offices
- Tsukuba Central 1
- Tsukuba Central 2
- Tsukuba Central 3
- Tsukuba Central 5
- Tsukuba Central 6
- Tsukuba Central 7
- Tsukuba West
- Tsukuba East

Sites
- Tsukuba North
- Funabashi Site
- AIST-UTokyo AI Chip Design Open Innovation Laboratory (AIDL)
- AIST-University of Tsukuba Open Innovation Laboratory for Food and Medicinal Resource Engineering (FoodMed-OIL)

AIST Tokyo Waterfront

Sites
- AIST-WasedaU Comptational Bio Big-Data Open Innovation Laboratory (CBBD-OIL)
- AIST-Tokyo Tech Real World Big-Data Computation Open Innovation Laboratory (RWBC-OIL)

Tokyo Headquarters

AIST Chugoku

AIST Kashiwa

Sites
- AIST-UTokyo Advanced Operando-Measurement Technology Open Innovation Laboratory (OPERANDO-OIL)

AIST Shikoku

AIST Chubu

Sites
- Nagoya Ekimae Site
- Ishikawa Site
- AIST-NU GaN Advanced Device Open Innovation Laboratory (GaN-OIL)

AIST Kyushu

Sites
- Fukuoka Site

AIST Kansai

Sites
- Fukui Site
- AIST-Osaka University Advanced Photonics and Biosensing Open Innovation Laboratory (PhotoBIO-OIL)
- AIST-Kyoto University Chemical Energy Materirals Open Innovation Laboratory (ChEM-OIL)

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