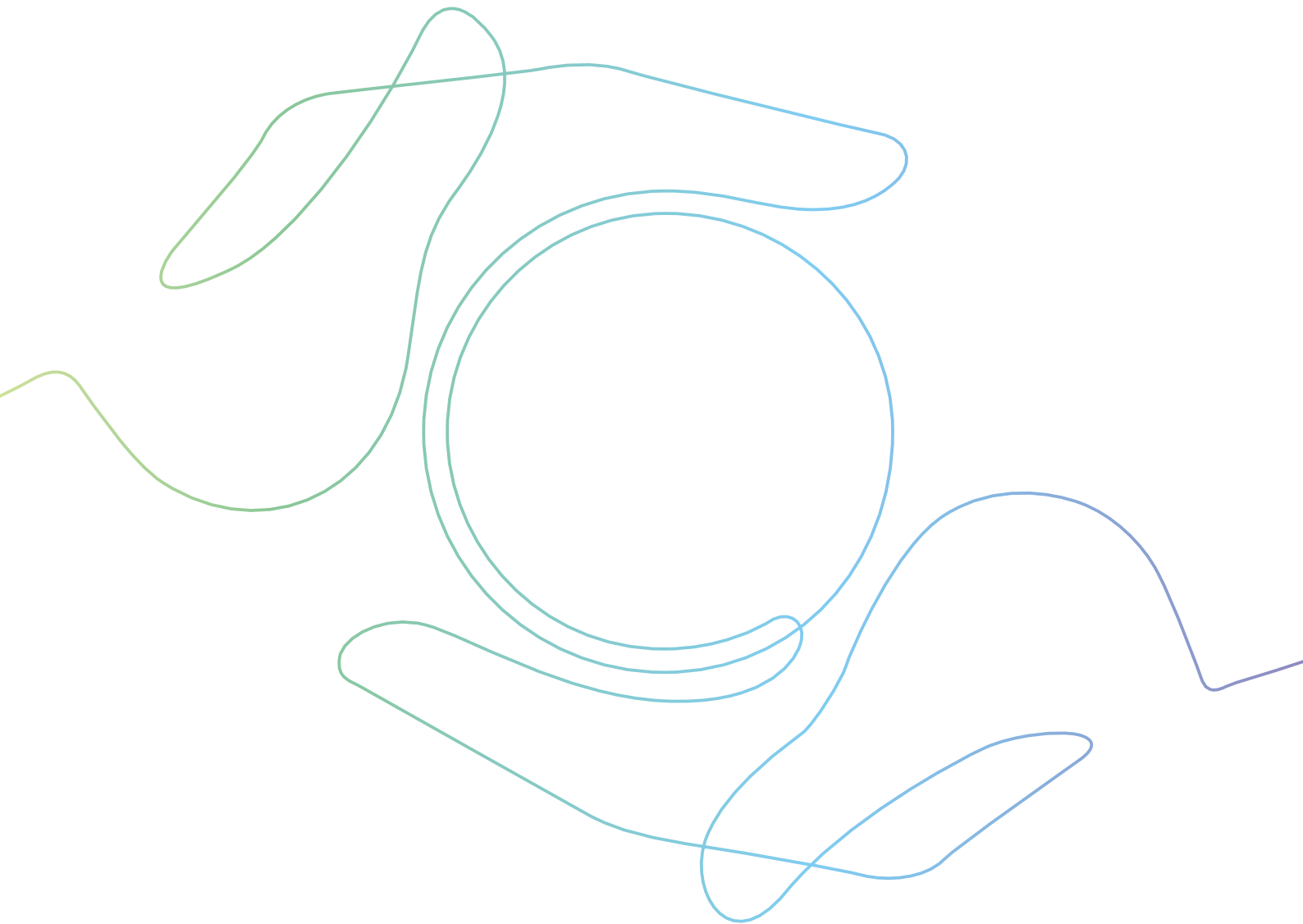# A I S T

R e p o r t

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Full Research in Society, for Society

Social and Environmental Report

AIST

Full Research in Society, for Society

National Institute of Advanced Industrial Science and Technology (AIST), An Independent Administrative Institution

The common goal of humankind is to realize a society in which every person can enjoy a comfortable life. Science and technology can lead the way to such a society. The mission entrusted to AIST and its staff, as members of the scientific community, is to develop science and technology that complements society and the environment.

We, the staff members of AIST, recognize our mission and responsibility to society. We work towards the realization of such a society through research and development in industrial science and technology.

Accurate Assessment of Social Trends

We endeavor to ascertain social trends and needs at every level of society from local communities to the international stage, to identify key issues promptly, and to propose scientific and technological solutions in collaboration with other organizations.

Creation of Knowledge and Technology

We value each person's autonomy and creativity and display our collective strength through collaboration and synergy, creating new knowledge and innovative technology based on advanced research efforts.

Application of Research Findings

We contribute to Japan's industrial development by applying our research findings to academic pursuits, intellectual infrastructure development, technology transfer, and policy proposals. We endeavor to enhance and disseminate science and technology through human resources development and the open sharing of information.

Responsible Conduct

We are actively involved in improving our own abilities and our working environment in order to perform our duties more effectively. We respect both the letter and the spirit of the law and maintain a strict sense of ethics in all our affairs.

Charter of the Environmental 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 Guideline, 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.

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 2019 Social and Environmental Report provides easily comprehensible introductions to leading-edge research activities for solving social issues, including a special article on aiming for the realization of a smart society with Kashiwa City, efforts for reconstruction with Fukushima Prefecture, field testing at Tsukuba City for implementation of near-future technology in society, and cooperation with Mie Prefecture to protect the future of children. AIST Report also describes AIST's work on technology transfers to effectively provide the fruits of AIST's technological research to industry. Through this content, we hope that our many stakeholders will understand AIST's diverse activities and that a deeper relationship of trust will be built between AIST and society.

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

☐ **Activities covered by the report**
  Research activities at all AIST research bases

☐ **Period covered by the report**
  April 2018 to March 2019

☐ **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 2020 (Japanese edition)

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To Create Both Social Value and Economic Value

A public research institute showing the way for science and technology

This year, Japan experienced another sweltering summer; many places suffered damage from "guerilla rainstorms" and other heavy localized rains. Extreme weather, which used to be recognized as unusual is no longer unusual, is manifesting more and more in many parts of the world. One cause of this is said to be global warming; the need to implement mitigation measures at the global level grows year by year.

In the 20th century, the industrial development enabled by the progress of science and technology made people's lives more convenient and enjoyable, and also brought many economic benefits. However, the "negative legacies" of science and technology have been steadily growing and have rapidly become more apparent from the end of the 20th to the beginning of the 21st century. Now that it is clear these negative legacies have reached levels that cannot be ignored, ameliorating and eliminating negative legacies is a very important matter both for national and local governments and for companies and individuals. The matter is particularly urgent for the enterprises at the center of economic activities and for the research institutes that support their technology.

The United Nations adopted the Sustainable Development Goals (SDGs) in 2015, setting 17 goals and 169 targets for building a sustainable society. Since the adoption of the SDGs, popular interest in the sustainable society has grown rapidly and many companies have started initiatives to use the attainment of SDGs as a business target. Previously, business activities have been evaluated and examined with the focus on creating economic value. Creating economic value remains important and will continue to do so. However, companies, which are actively involved in protecting people's living environments and natural resources and in contributing to sustainability, are highly evaluated by society. Creating social value, which was previously understood to be the role of national governments and public bodies, is now both expected and demanded of companies.

Stunning progress is being achieved in new technologies, such as artificial intelligence (AI), robotics and the Internet of things (IoT); this progress is greatly affecting existing technologies and is changing people's lives. Practical self-driving technologies for cars that would have been thought the stuff of dreams a few years ago are now within reach and devices equipped with AI are appearing in our homes. A business revolution to deploy AI and IoT in locations such as factories and retail stores has begun. On the other hand, the increasing sophistication and complexity of technology has developed technological black boxes which are difficult to follow. It is no longer straightforward for a single company or a single research institute to independently develop a new technology and commercialize it with sufficient understanding of the risks that lie in the background. At the same time, in the context of intense international competition, the speed with which technologies are developed and commercialized is becoming more and more important.

The National Institute of Advanced Industrial Science and Technology (AIST), in accordance with its name, is promoting world-class research through research activities across the whole range of industrial technologies, at the same time pursuing fundamental and basic research in areas that are difficult for businesses to address. As one of Japan's leading "multiple open platform" research institutes, we are cooperating

in partnership with companies, universities and other research institutes to deliver the many fruits of our research to society. Producing innovations from science and technology and creating next-generation industries are major objectives for AIST. AIST also has an important role to play as a public research institute in tackling the problems of society with science and technology and enabling people to live safe and secure lives.

This report outlines these efforts by AIST. It also describes major research activities, new collaborations with other organizations, and our efforts in many institutional matters: governance and welfare programs; staff training initiatives; support for a proper work–life balance; the promotion of diversity by means such as support for progressive participation of female staff and foreign researchers, and more employment of people with disabilities. Our efforts in strengthening compliance, environmental safety management, and the establishment of fair business practices such as reasonable procurement are also discussed. 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, winning trust from society, and improving the effectiveness of its research.

We are now asking companies, universities and research institutes "Will you embark on the future with AIST?" This message expresses our wishes to work together on producing innovations from science and technology and to jointly create sustainable social structures. We hope that you will understand our work and we look forward to receiving your continued support.

National Institute of Advanced Industrial Science and Technology (AIST)

CHUBACHI Ryoji, President

Opening Interview

– Kashiwa City and AIST Kashiwa –

AIST Kashiwa is a new research base that started full-scale operations in April 2019. Set in Kashiwanoha, a town that is pursuing futuristic urban development through public–private–academic collaborations, AIST Kashiwa has embarked on social applications research for new service businesses centered on human augmentation technologies. It is involving local citizens and enterprises in field testing of technologies that will be useful for people and towns, and is ambitiously working to derive innovations from solutions to society's problems. The four participants in this interview discussed their expectations of AIST as a partner for the Kashiwa City government on how AIST can contribute to the area, and the path to future collaborations.

Using the Whole Town of Kashiwanoha as a Research Site to Facilitate Social Applications of Human Augmentation Technologies

Kashiwanoha, a stage for collaboration

Iida: The dominant feature of Kashiwanoha is the progress of next-generation urban development through collaborations between the public, private and academic sectors. Urban Design Center Kashiwa-no-ha (UDCK) is an urban development base performing the functions of a think tank, which is working to implement the Kashiwa-no-ha International Campus Town Initiative Note1 and pursuing futuristic urban development. The opening of AIST Kashiwa is an undoubted boost, in bringing a powerful collaboration partner to the area.

Nanjo: In contrast to central Kashiwa (the area around Kashiwa Station), which had already taken shape as a city center district, the urban development of Kashiwanoha started from zero. Previously, urban development has been in the form of a government body preparing infrastructure and then companies, schools and so forth arriving individually. However, the urban development of Kashiwanoha is in an entirely new style, in which a government body prepares a stage for development and then various actors such as developers, researchers and citizens come together to create the finished product.

Director,
Human Augmentation
Research Center
**MOCHIMARU
Masaaki**

Director-general,
AIST Kashiwa
**HIROSHIMA
Hiroshi**

Manager,
Planning Department,
Kashiwa City
**IIDA
Terukazu**

Director,
City Department,
Kashiwa City
**NANJO
Yosuke**

Note1 Kashiwa-no-ha International Campus Town Initiative

The aim of the Kashiwa-no-ha International Campus Town Initiative is for the whole town to be a green, high-quality area similar to a university campus and to be a venue for intellectual exchanges (knowledge sharing).

In order to achieve this, an innovative urban development framework has been created in which the public sector, responsible for public services needed by the local community, the private sector, responsible for raising the vitality and attractiveness of the area, and the academic sector, responsible for high-level activities based on specialist knowledge and technologies, collaborate beyond the scope of a conventional framework. The initiative is building an "international academic research city" in which new knowledge, industries and culture are created. The city will be a sustainable and autonomous "next-generation environmental city" that exists in an excellent natural environment and provides healthy, high-quality living and working environments. From intellectual exchanges in public–private–academic collaborations, eight objectives have been identified as the philosophy of the initiative.

1	A garden city in harmony with the environment
2	Nurturing a creative industrial space
3	A space for international academia, education, and culture
4	A sustainable transportation system
5	A Kashiwanoha lifestyle that cultivates good health
6	Area management through public–private–academic partnerships
7	High-quality urban space design
8	An Innovation Field city

Hiroshima: AIST Kashiwa is a research base whose principal focus is human augmentation technologies. We aim to combine AI technologies with manufacturing technologies and to collect and make use of original field data. Kashiwanoha contains all the elements of a town in a compact area, including a train station, housing, schools, parks, hospitals, a large shopping mall, hotels, and offices, providing an environment that facilitates field testing for research into human augmentation technologies.

Mochimaru: The term human augmentation refers to systems that are put in close proximity with people to enhance their human capabilities. More specifically, the target of our research is systems that make use of information technology and robotics technology. When I first arrived in Kashiwanoha, I had the idea that I would use the town itself as a research site. The R&D associated with services that affect people intimately cannot be concluded in the lab but needs a venue for field testing. Kashiwanoha is suitable for this, having 20,000 residents and, as indicated by director-general Hiroshima, being a city with facilities for comfortable living. Another important feature is that the land zoning is straightforward and easy to understand. This means that we can start working as soon as landowners give us the nod. For these reasons, since coming here we have not been stuck in the lab but out testing services in the town with citizens and companies.

Iida: As you say, the advantage of Kashiwanoha is that whatever you decide to do, you can get to work on it quickly. In the immediate future, the biggest question for us is how to attract companies. To achieve sustainable local government as the population declines due to low birthrate and increased lifespans, urban development that strikes a balance between maintaining population and encouraging companies to locate here will be crucial.

Mochimaru: Indeed, you cannot be completely sustainable as a local government unless companies bring headquarters functions here as well as research departments. AIST will also have to bear this in mind in our efforts.

Demonstrations of design thinking in society

Hiroshima: One particular initiative of AIST Kashiwa is the AIST Design School (see page 44), which is training personnel who can drive social innovation. We must not just develop technology and then think about what to use it for; we must set goals and think up pathways to achieving them. The Design School program trains researchers to cultivate the opposite mindset from the conventional focus on technological seeds. Another

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Introducing Research **AIST Kashiwa**

We have set up a facility that, by utilizing AI and sensing technologies, can combine the real world (physical space) with virtual worlds (cyberspace) to research new technologies that will improve the quality of people's activities. We hope to address society's problems with the novel technology of human augmentation, which enhances human capabilities through information technology, wearable devices and such. We are running a large-scale AI cloud computing system ("ABCI") and a staff training program (AIST Design School). In addition, we are utilizing a range of testing environments and measurement environments within the research base to evaluate humans and devices and advance our R&D.

Comprehensive measurement and intervention facilities

An environment is provided that not only measures the motion characteristics of humans but also enables detailed measurements and interventions, which will enable augmentations of motion and sensory capabilities by such interventions.

Organic thin-film transistor array-printing fabrication line

This is a facility for manufacturing and evaluating flexible devices to be used for sensing health conditions and activities of humans. This fully integrated manufacturing facility, unusual anywhere in the world, is capable of fabricating thin-film transistor arrays through just printing and coating processes.

Service field simulator Ver. 3

This is virtual reality (VR) equipment for measuring and modeling activities and bio-information of humans. An eight-wall upright display and an omnidirectional treadmill enable concurrent movements in all directions in a VR environment.

characteristic of AIST Kashiwa is working on social applications: for projects at the Design School in 2018, with the cooperation of UDCK, interactions with the children and high school students of Kashiwanoha were arranged.

Mochimaru: In design thinking, the most important thing is to practice thinking outside the boundaries. For example, you can proceed from the question "what if this human capability could be improved by human augmentation technology" to creating a narrative of the technologies required to achieve the improvement, how it relates to business and what cooperation is needed from citizens, then performing R&D, and conducting social demonstrations involving companies and citizens.

Iida: In Kashiwanoha, we have instigated a variety of partnerships, preparing the infrastructure for collaborations.

Mochimaru: What AIST particularly hopes for is collaborations with small and medium enterprises and venture companies. In the way that a stone wall is not made only of large stones, business partners that fit into the gaps between large companies are always necessary. Because 31VENTURES (a venture co-creation project by Mitsui Fudosan Co., Ltd.) and Todai Kashiwa Venture Plaza are located in Kashiwanoha, diverse collaborations may emerge and the town should be attractive for enterprises.

Iida: 31VENTURES KOIL is a co-working space and office facility for venture companies, among the largest in Japan, which is operated by Mitsui Fudosan near Kashiwanoha Campus Station. It has been used by many people and has already seen the launch of a number of new businesses. Nearby, Tokatsu Techno Plaza is an incubation facility set up by the Chiba Prefectural Government.

The Innovation Field and perspective for citizens

Iida: Innovation Field Kashiwanoha was launched in February 2019 with Mitsui Fudosan, UDCK and Kashiwa City as its core members. It is a demonstration platform for public–private–academic collaborations, which centrally administers field testing projects using the town as a theatre. It is working with AIST to create a positioning environment with high-precision markers incorporating tags, and is promoting a number of other projects such as a study into reducing waiting times in hospitals by measuring flows of people and a project to utilize electrical potential measurements in plants for cultivation and agriculture.

Mochimaru: The positioning environment with high-precision markers that you just mentioned is a system in which sticker-type markers are stuck up in various places around the town. When a person or robot photographs one of these markers with a smartphone or a camera, the system can identify their position. AIST is working with Innovation Field Kashiwanoha to create this kind of IT infrastructure and use it to provide services to citizens in cooperation with companies and universities. However, it is very important that the provided services can be continued. If services are often cancelled after field tests have ended, the citizens will lose interest.

Creating a positioning environment with high-precision markers

The objective of this system is to enable precise global positioning by the use of high-precision markers. In the course of the field testing, it is hoped that the system will be applied to and developed for a range of position information services, such as navigation for mobile robots.

Hiroshima: We must make rules so that data and operations are passed on to another enterprise when we finish a service.

Mochimaru: That's right. If we can create a framework in which a small or medium enterprise takes over the data and operations when a large company ends a service, I think many small and medium enterprises will put themselves forward.

Nanjo: It will be good if the data collected in Kashiwanoha are not used only by businesses but can be paid back to citizens by making life in the town more pleasant. We can administer the town better by making use of various kinds of data and technologies such as IoT. It would be great if the whole town can offer hospitality, making people feel welcome

Mochimaru: This relates to building a civic culture in which people feel trust and provide their data willingly. There is a concept called "the information bank": citizens deposit their data, which is used and paid back to them with added value. Proceeding step by step in this manner would be ideal.

How to confront and deal with data

Hiroshima: AIST Kashiwa has built a large-scale AI cloud computing system called the AI Bridging Cloud Infrastructure (ABCI; see page 51). ABCI is designed for machine learning on the ultrahigh-speed computing infrastructure developed by AIST, which is the fastest in Japan. ABCI set world speed records for deep learning in November 2018 and April 2019. It is a system that, by bridging the three elements A (algorithms), B (big data) and C (computing), may hasten social applications of AI. It provides a framework that can be used by many people and is openly operated.

Iida: The government is another player possessing big data. A number of actors including AIST have cooperated in partnership to establish the Kashiwa-no-ha Smart City Consortium Note2, which deploys new technologies such as AI and IoT with public data and private data in order to address the town's challenges and realize a smart city. The consortium has planned and proposed a model smart city project for the Kashiwanoha Campus district, and this project was selected as a precursory model project in May 2019 by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). When we have decided how to make use of public data and how to link up with private data, we will be ready to take the next step. To give an example, we have an initiative to prevent road subsidence. The plan is to install small devices capable of scanning the road surface in municipal government cars. Cavities below road surfaces will be automatically detected while the cars are travelling around the town in their usual daily work, and preventive maintenance will be administered by making use of sewer pipe deterioration data and performing AI analysis.

Mochimaru: The smart city model project also has

Note2 Kashiwa-no-ha Smart City Consortium

Kashiwa City, Mitsui Fudosan and UDCK provide management for the Kashiwa-no-ha Smart City Consortium, and AIST is also participating. The consortium was set up with the objective of bringing private companies and associations together with government bodies to cooperate in partnership on driving the creation of Kashiwa-no-ha Smart City.
The smart city model project focusing on the Kashiwanoha Campus district that was planned and proposed by this consortium has been selected as a precursory model project for smart city model projects contributing to the realization of "Society 5.0", an MLIT initiative.
It is easy for people, things and information to come together in the urban area centered on Kashiwanoha Campus Station. The consortium is building a platform to leverage the characteristics of this area and link private data with public data. The objective is to form a compact smart city centered on the station through "data driven" public–private–academic collaborations that deploy new technologies such as AI and IoT.

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another purpose. This is to check what unintended side effects the social applications of technology are producing and to modify technologies and systems accordingly. What I mean by side effects is, for example, the risk of becoming a target for terrorism if information on hidden infrastructure such as a map of water pipes below the ground is made public. Similarly, even though human augmentation technologies are developed in order to enhance people's lives, they may have adverse effects in society depending on how they are used. Because it is not possible for developers to foresee all such effects, it is better to conduct field tests in a limited area and, if worrying signs appear, apply feedback to the technology and rules.

Iida: The Kashiwa City government is carefully studying future uses and management of data and preparing the necessary systems. Director-general Hiroshima has described the ABCI to us. As technologies such as AI and IoT evolve, I feel that government bodies will be asked how data should be administered. For us as a government body, it seems that big data and advanced technologies will be useful for disaster response. I hope that we will be able to develop a smart aid system with measures to help people who cannot get home, guidance to temporary evacuation sites, distribution of relief supplies and so forth.

Mochimaru: Research addresses both questions arising from experiments and questions arising from social issues. It is very important that we can promptly hear about the issues affecting local governments and embark on specific research efforts.

Hiroshima: For researchers, a question like "what methods are available to deal with this social problem" is easy to answer, but clearly understanding what problems there are in society is not possible. It is valuable to hear voices from the front line face-to-face, like today.

Iida: For Kashiwa City, AIST is a good discussion partner and we have very high hopes of the cutting-edge knowledge and technology that AIST brings to be a driving force for urban development through public–private–academic collaborations. We can very sincerely say that we are glad AIST has come to Kashiwanoha.

Nanjo: Even without an official gathering place, it is truly ideal if researchers and company employees can naturally meet in the town and new ideas emerge from informal conversations. I hope to see urban development in which people want to go outside and opportunities for interaction are increased.

A "front lobby" for AIST that fits in with the town

Hiroshima: AIST Kashiwa will serve as the point of contact for involving AIST as a whole with sensing, information communication, and other technologies that are required for social demonstrations at Kashiwanoha.

Mochimaru: I think of AIST Kashiwa as something like a front lobby opening AIST to the community. Not all problems can be solved by the 30 researchers in the front lobby, but solutions can be found with the 2300 AIST researchers behind them. AIST Kashiwa will help to make connections between solutions to social issues and the creation of new industries.

Iida: I would like to provide encouragement to employees of the city who have to face various social problems to take the first step and "consider talking to AIST."

Nanjo: I hope that the symbiosis between the technological strength and research products of AIST and the potential of Kashiwanoha will make Kashiwanoha as a whole the best town it can be.

Hiroshima: What the two of you have said today has given me a real sense of how much you expect from AIST. You have conveyed a positive attitude from Kashiwa City.

Mochimaru: I hope that we at AIST will fit into Kashiwa City and function as a good "front lobby" deepening exchanges with the citizens. We are looking forward to working with you.

■ On the Opening of AIST Kashiwa

Kashiwanoha is a town with unique characteristics, deploying next-generation urban development through public–private–academic collaborations.

I recall that this urban development started from an empty site. By taking advice from a range of parties and aiming high for the goal of a world-class cutting-edge model city and sharing ideas with the public, private, and academic sectors, we have been able to work together to create this town.

In little more than ten years, we have seen amazing development of a new city that, as well as commercial buildings, hospitals, large residential buildings, and so forth, has attracted many academic research institutes. However, this is still only half the journey and we must continue with further development.

AIST has brought its cutting-edge knowledge and technologies and links with business by opening a research base in Kashiwanoha. We have great hopes that it will provide a driving force to accelerate the urban development.

For future urban development in Kashiwanoha, we hope that everyone in business will take the attitude that things that are impossible in other towns are possible in this town. It is also important that all citizens will feel glad that they chose this town and came to live here.

With the help of AIST, I hope that we can collaborate closely to make "a world-class cutting-edge model city" a concrete reality and that AIST will be glad to have opened a research base in Kashiwanoha.

Mayor, Kashiwa City
AKIYAMA Hiroyasu

01 Organizational Governance

> Aiming to create an honest and transparent organization based on the principle of developing a sustainable society

■ AIST R&D in the Fourth Medium- to Long-Term Plan

Basic Policy for the Fourth Medium- to Long-Term Plan

This year was the last of the Fourth Medium- to Long-Term Plan period that began in 2015. Activities in the fourth plan are based on the following basic policy to conduct world-class research and transfer the fruits of the research in accordance with the institutional image that we aspire to: "Through world-leading research taking account of the needs of society and industry, and transfers of the fruits of this research, contributing to the sustainable development of society with a focus on innovation and winning the trust of society."

■ Identifying strategic issues with consideration for the needs of society and industry

Through technology marketing activities, we are accurately identifying the needs of society and the needs of industry, strategically setting research topics, and flexibly modifying and creating research execution systems. For example, in order to conduct R&D that more closely relates to the strategies of business, we have set up 12 collaborative laboratories in AIST branded with the names of companies, and are progressing with research in cooperation with these companies.

■ Driving innovation in the regions

At our regional research bases, we are identifying important research topics in consideration of characteristics such as clusters of industries in those regions, conducting world-class R&D, forming relationships with public research organizations, learning about the needs of small and medium-sized enterprises, transferring technologies from AIST as a whole, and supporting local industries. We are currently working in 104 collaborations (such as contract research) with regional businesses.

■ Research system that can win strong trust from the nation's people

To continuously progress in research activities that can win the trust of business and society, and to ensure trustworthy research results and transparent operations, we are working to strengthen safety management and operations management systems, understand sources of risk and prevent problems from arising, and improve governance in the conduct of our operations. For example, we are reviewing our research notebook management system and working on more thorough management of research results.

■ Driving open innovation to combine know-how from Japan and other countries

We are actively working to bring many excellent technology seeds and personnel to AIST from universities in Japan and abroad and from public research organizations and businesses in Japan's regions, thereby improving AIST's research potential and driving open innovation as the heart (hub) of an innovation system for Japan. For example, we have appointed 187 innovation coordinators around the country, who are gathering the seeds of new technologies and cultivating human resources.

■ Training and welcoming people who will create innovation

With personnel systems that can make use of staff of different categories and ages and the introduction of systems to accurately evaluate their contributions to the institute, we are training and bringing in people who will create innovation. For example, we are inviting excellent researchers under the cross-appointment system (69 appointments in FY 2018) and the research assistant system (338 in FY 2018).

■ Seven Domains of AIST

1. Department of Energy and Environment

■ To resolve energy and environmental problems

AIST has been working towards green innovation to resolve globally expanding energy and environmental problems through such technologies as follows: the use of new energies including renewable energies, energy saving technologies, high-efficiency energy storage, efficient use of resources, and evaluation/reduction of environmental risks.

2. Department of Life Science and Biotechnology

■ Realizing a healthy, active, aged society and creating a sustainable society

Anyone wants a long life in good health, and hopes to build a sustainable society by reducing environmental loads. To achieve such a society, we are contributing to life innovation by developing new technologies to evaluate health and to promote drug discovery, as well as to maintain, improve, and recover health according to individual conditions. We are also contributing to green innovation by developing technologies to reduce environmental loads using bioprocesses.

3. Department of Information Technology and Human Factors

■ Addressing social issues by interdisciplinary use and advancement of information technology to bring mutual prosperity to human life

Digital Data is becoming a critical part of life in modern society. To achieve a safe, comfortable, and prosperous future society, real-time access to and intelligent integration of data in both the cyber and physical spaces of society are key. Application of information technology to widely diverse fields in society can solve common problems. Furthermore, new value created by the integration of data provides new possibilities for communities and can transform society. We are contributing to the development of a sound society by specifically addressing the mutual interaction of informatics and ergonomics.

4. Department of Materials and Chemistry

■ Contributing to enhancement of industrial competitiveness by synergistic interaction between materials and chemical technologies

We are developing technologies to enhance added value of functional chemicals, and to realize practical use of new materials, with strengthening value chains of materials through synergistic interaction between materials and chemical technologies in mind. Thus, we are aiming to contribute to the primary materials and chemical industries.

5. Department of Electronics and Manufacturing

■ Enhancing industrial competitiveness through innovative technologies that lead varying manufacturing

We are contributing to enhancing industrial competitiveness by developing advanced electronic and optical device technologies that enable both performance enhancement and significant energy savings of IT equipment, and innovative manufacturing technologies that enable energy savings, resource savings, and low cost. Moreover, we are building a highly efficient production system by combining innovative manufacturing technologies and sensing technologies based on the advanced devices.

6. Geological Survey of Japan

■ Understanding of the Earth and coexistence with the Earth

Geological information is essential for a country like Japan, located at a tectonically active area, to ensure a safe and secure society. We gather, compile, and provide geological information under the name of the Geological Survey of Japan (GSJ) and promote its wider use. We also develop technologies to overcome various difficulties in global environment protection, exploration of minerals and energy resources, and natural disaster mitigation, and coordinate international cooperation as a national representative.

7. National Metrology Institute of Japan

■ Development, dissemination, and use promotion of the measurement standards and development of the standards related to measurement technologies

As the national metrology institute (NMI), NMIJ focuses on development and dissemination of the measurement standards, promotion of effective utilization of the measurement standards, development of measurement technologies related to the measurement standards, legal metrology services and training of experts. NMIJ also maintains engineering, physical, material and chemical measurement standards while developing measurement and analytical instruments. Coordinating international activities on metrology standards is another important mission as a national representative.

■ AIST Organization Chart (as of June 1, 2019)

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President ———— Management Steering        Auditor
                Committee
   |
 Board
   |
   |———— Compliance Promotion Committee
         Research and Operation Steering Committee
         Human Resource Committee
         Security and Information Promotion Committee
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Department of Energy and Environment

- Research Institute of Energy Frontier
- Research Institute of Electrochemical Energy
- Research Institute for Energy Conservation
- Environmental Management Research Institute
- Research Institute of Science for Safety and Sustainability
- Research Center for Photovoltaics
- Renewable Energy Research Center
- Advanced Power Electronics Research Center

Department of Life Science and Biotechnology

- Biotechnology Research Institute for Drug Discovery
- Biomedical Research Institute
- Health Research Institute
- Bioproduction Research Institute
- Molecular Profiling Research Center for Drug Discovery

Department of Information Technology and Human Factors

- Information Technology Research Institute
- Human Informatics Research Institute
- Intelligent Systems Research Institute
- Automotive Human Factors Research Center
- Robot Innovation Research Center
- Artificial Intelligence Research Center
- Cyber Physical Security Research Center
- Human Augmentation Research Center

Department of Materials and Chemistry

- Research Institute for Sustainable Chemistry
- Research Institute for Chemical Process Technology
- Nanomaterials Research Institute
- Inorganic Functional Materials Research Institute
- Structural Materials Research Institute
- Interdisciplinary Research Center for Catalytic Chemistry
- CNT-Application Research Center
- Research Center for Computational Design of Advanced Functional Materials
- Magnetic Powder Metallurgy Research Center

Department of Electronics and Manufacturing

- Nanoelectronics Research Institute
- Electronics and Photonics Research Institute
- Advanced Manufacturing Research Institute
- Spintronics Research Center
- Sensing System Research Center
- Advanced Coating Technology Reserch Center
- Research Center for Ubiquitous MEMS and Micro Engineering

Geological Survey of Japan

- Research Institute of Earthquake and Volcano Geology
- Research Institute for Geo-Resources and Environment
- Research Institute of Geology and Geoinformation
- Geoinformation Service Center

National Metrology Institute of Japan

- Research Institute for Engineering Measurement
- Research Institute for Physical Measurement
- Research Institute for Material and Chemical Measurement
- Research Institute for Measurement and Analytical Instrumentation
- Center for Quality Management of Metrology

Compliance Headquarters

Audit Office

Evaluation Department

Planning Headquarters

Research and Innovation Promotion Headquarters

Environment and Safety Headquarters

Information Security Department

General Affairs Headquarters

TIA Central Office

AIST Tokyo Headquarters

AIST Tsukuba

Fukushima Renewable Energy Institute, AIST

AIST Kashiwa

AIST Tokyo Waterfront

AIST Hokkaido
AIST Tohoku
AIST Chubu
AIST Kansai
AIST Chugoku
AIST Shikoku
AIST Kyushu

■ Revenue and Expenditure

➡ **Financial results for FY 2018 (unit: million yen)**

Revenue 112,405

- Intellectual property revenue 489
- Technical consulting revenue 750
- Miscellaneous 4,814
- Joint research revenue 7,167
- Commisioned research funds 19,405 （from private companies 718）
- Facility maintenance grants 16,930
- Subsidy 62,850

Expenditure 114,619

- Indirect costs 9,111
- Facility management costs 8,511
- Other management costs 7,725
- National Metrology Institute of Japan 8,317
- Geological Survey of Japan 8,080
- Department of Electronics and Manufacturing 15,330
- Department of Materials and Chemistry 11,733
- Department of Information technology and Human Factors 20,249
- Department of Life Science and Biotechnology 8,658
- Department of Energy and Environment 16,905
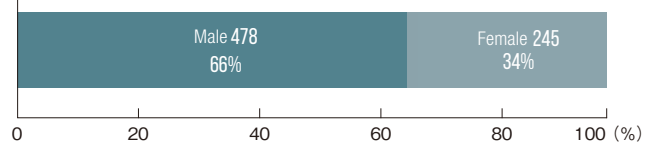
Notes1 : Total may not become 100% due to rounding off.
Notes2 : The amounts of revenue and expenditure are adapted from the "Financial Statement" prescribed in Article 38 of the Act on General Rules for Incorporated Administrative Agencies.
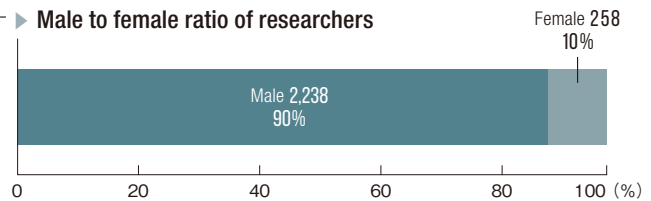
■ Staff (as of March 1, 2019)

Total 10,975 Executives 14 Foreing natinals 820

- Administrative employees 723 6.6 %
- Administrative contract employees 812 7.4 %
- Administrative temporary employees 37 0.3%
- Researchers 2,496 22.7 %
- Contract researchers 2,405 21.9 %
- Temporary researchers 362 3.3 %
- Contract SE and maintainance staff 294 2.7 %
- Emeritus Advisors and Emeritus Councilors 27 0.2 %
- Industry-academia-goverment collaboration related people 3,819 34.8 %

▶ **Male to female ratio of administrative employees**

| Male 478 66% | Female 245 34% |

0   20   40   60   80   100 (%)

▶ **Male to female ratio of researchers**

| Male 2,238 90% | Female 258 10% |

0   20   40   60   80   100 (%)

■ Promotion of Compliance

The Compliance Headquarters conducts AIST compliance activities and addresses research misconduct.

Compliance initiatives

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

(1) Every week, the Compliance Headquarters hosts a Compliance Promotion Committee meeting, primarily to report to the president on the risk information gathered from front-line employees and determine how to address it. Risk information is also shared at regular in-house meetings.

(2) AIST has set a Compliance Promotion Week from 2018 to further raise awareness of compliance of each executive and staff and reliability of AIST. In particular, we put up posters, provide stratified training, and draw action plans for each research discipline.

(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

➜ Response to research misconduct at AIST

President (concurrently serves as Director General of Compliance Headquarters)
Supervisor of Ethics for Researchers (Vice-President) (concurrently serves as Chief Administrator of Research Records)

Preventative measures

- Develop a code of conduct for researchers
- Improve research ethics training
- Manage research notebooks and records
- Use plagiarism detection software for the writing of research papers

Response to research misconduct allegations

- Conduct preliminary and main investigations

Confirmation of research misconduct

- Action by the Director-General of Compliance Headquarters (President)

accordance with the Research Misconduct Rules and other guidelines.

(2) As part of on-site training at research units and management training for unit directors and research group leaders, the participants learn about research ethics, including compliance with the Code of Conduct for Researchers and how to prevent research misconduct.

(3) We have improved our research record-keeping practices and upgraded the system centrally managing research records, primarily to prevent falsification and ensure the authenticity of records even more effectively.

(4) 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. Its use has been increasing year by year, the number of times used being 483 in FY 2015, 725 in FY 2016, 900 in FY 2017, and 1,228 in FY 2018.

Compliance partnerships with other entities

(1) In December 2017, the Association for National Research and Development Agencies created an Expert Committee on Compliance with the primary aim of enhancing the risk management of the 27 member agencies. AIST plays a central role as its chair and secretariat.

(2) In FY 2018, AIST, as the secretariat, held Expert Committee on Compliance meetings in July, October, and February, where the member agencies shared compliance information and discussed challenges and other matters. Furthermore, it was proposed that the Compliance Promotion Week be implemented by all member agencies, and identical posters were posted and executive training was conducted.
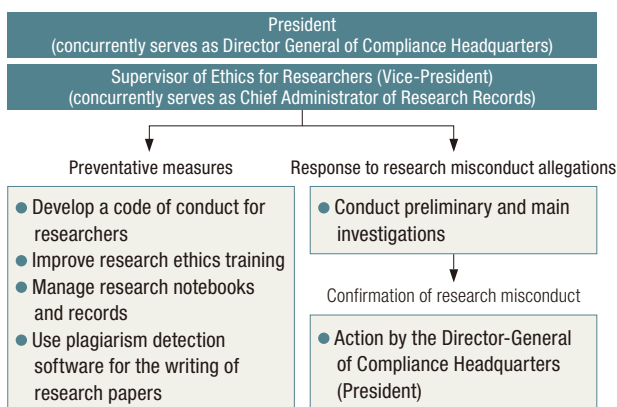
Research record-keeping practices

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 2017 we improved our research record-keeping program, primarily by replacing the type of recording media from paper to electronic, and determining the timing of the supervisor confirmation according to research progress. Likewise, the research notebook recording system was upgraded to accommodate these changes while enhancing security. These improvements were made from the perspective of raising operational effectiveness and efficiency.

AIST will continue doing its utmost to ensure the integrity and transparency in research so that the people of Japan can place greater trust in science.

■ 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 Independent Administrative Agencies (implemented October 1, 2002).

Protection of personal information

In accordance with the Act on the Protection of Personal Information Held by Independent 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.

Year-to-year numbers of requests for disclosure of information and personal information

FY	Information disclosure	Personal information
2015	5	1
2016	3	0
2017	7	0
2018	6	0

■ Emergency Communication Tree

AIST has created an internal emergency communication tree in order to respond swiftly to crises in Japan or abroad, such as terrorist attacks, hurricanes, floods, and serious risks that materialize on weekends or holidays.

■ 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 2018, audits were performed concerning the following topics:

• As cross-sectional themes, information security and personal information management themes were combined to undergo a single audit with the aim of reducing the auditee's burden while increasing audit effectiveness. The audit confirmed that these matters were generally being handled properly.

• As a theme focusing on research units and Open Innovation Laboratories (OILs)★, a comprehensive audit of research operations as a whole was conducted. While the audit confirmed that these operations were generally being carried out properly, it identified issues in terms of the compliance, effectiveness, and efficiency of some of the operations. The auditees concerned were advised to swiftly rectify the issues with improvements suggested. Follow-up audits were also performed to assess how the improvements suggested in previous internal audits had been implemented, and found that the improvements were being implemented properly.

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★ In FY 2018, audits were performed of 8 OILs established in FY 2017.

➔ **Collaboration in audits**

	Internal audit	Auditor audit	Accounting auditor audit
	Collaboration	Collaboration	
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)

Director,
Renewable Energy Research Center

FURUTANI Hirohide

Senior Policy Administrator of Renewable Energy
Promotion Sector
(Policy Administrator of Business Promotion Section)
Commerce, Industry & Labour Department, Fukushima
Prefectural Government

YAMADERA Kenichi

Fukushima Prefecture: Aiming for a Pioneering Region of World-Leading Renewable Energy

The FREA (Fukushima Renewable Energy Institute, AIST) propagates new renewable energy technologies from Fukushima Prefecture. One of its primary missions is to support reconstruction in close collaboration with Prefectural Government of Fukushima. Part of this, a Seeds Support Program for businesses in areas affected by the 2011 disaster is achieving many successes, including commercialization of new technologies. We talked about what we have achieved in Fukushima Prefecture and what future we will create.

Using the power of local enterprises for the reconstruction

Furutani: We opened FREA in 2014 as part of the national government's Basic Policy for Reconstruction After the Great East Japan Earthquake. FREA's missions are to promote R&D of global cutting-edge renewable energy and to contribute to the reconstruction in the disaster region. We have been cooperating with the prefectural government from the preparation stage for the establishment of FREA.

Yamadera: AIST's support, firmly grounded in the region, has become a great force for reconstruction. The philosophy for reconstruction that we have adopted in this prefecture is "building sustainable communities, not reliant on nuclear power, that can continue to grow safely without fear." Aiming to become a pioneering region for renewable energy, we have increased installation of renewable energy and worked on nurturing and clustering the related industries that underpin renewable energy.

Furutani: Since FY 2013, AIST has been running the Seeds Support Program for businesses in disaster-affected areas. By leveraging AIST's knowhow and research facilities, this program provides the technical support

needed for the commercialization of seeds developed by businesses in three prefectures most affected by the disaster (Fukushima, Miyagi and Iwate). Up to FY 2018, the program has provided support in 124 cases.

Yamadera: Ninety-three of those have been in Fukushima Prefecture. This has been a boost for local businesses seeking to commercialize their ideas.

Major outcomes of the Seeds Support Program

Furutani: Since the start of the Seeds Support Program, 19 cases have achieved commercialization. One example is the development of large-diameter bolts for wind power generation (Tohoku Bolt Mfg Co., Ltd.). Another success brought to market is the fault diagnosis equipment for bypass circuits (Nippon Kernel System Co., Ltd.) that used FREA's demonstration field to test the soundness of solar cells. A number of businesses have achieved commercialization of technologies for utilizing geothermal heat, including Geosystem Corporation Co., Ltd.; JGD Nippon Chikasui Kaihatsu K.K.; Shinkyo Tisui K.K.; and Sunpot Co., Ltd. Fukushima Prefecture has attained leadership status in Japan for geothermal heat technology.

Since FY 2018, we have set up a new consortium for seeds support. Renewable energy involves integrated technologies from the development and production of individual components to whole-system management. When new ideas from enterprises are put together, one plus one can make three or even four.

Yamadera: Because this commercialization is tied to the industrial recovery of Fukushima Prefecture as a whole, the benefits to the reconstruction provided by the Seeds Support Program are immeasurable. In April 2017, the Fukushima Prefectural Government established EnergyAgency.FUKUSHIMA to be a vehicle for raising renewable energy industries in Fukushima to the top level in Japan. By combining AIST's strength in technological support, EnergyAgency.FUKUSHIMA's strength in supporting commercialization, and the Fukushima Prefectural Government's strength in policy support, we hope to nurture technologies, products, and business models that can be said to be "Made in Fukushima."

Shaping the future with The Fukushima Plan for a New Energy Society

Yamadera: The Fukushima Prefectural Government is implementing the Fukushima Plan for a New Energy Society as a platform for building a model of a new energy society. This plan has three pillars. The first is expanding the installations of renewable energy; we are proceeding with large-scale wind power projects in the Abukuma Highlands and coastal areas. The second is creating a model for building a hydrogen-based society; we are constructing the Fukushima Hydrogen Energy Research Field in Namie Town. The third is creating smart communities; we are working with national

governmental supporting systems and other organizations on the efficient use of energy in five municipalities: Shinchi Town, Soma City, Namie Town, Naraha Town and Katsurao Village.

Furutani: The Fukushima Plan for a New Energy Society is a national-level project using the whole prefecture as a demonstration field; so, of course AIST is playing a part too. For example, in relation to the assessment and O&M (operation and maintenance) of wind power, we are helping talent training of staff in local businesses and are providing programs for students at local universities.

AIST was one of the early starters to work on related technologies for utilizing hydrogen-based energy. Hydrogen produced from renewable energy sources in Fukushima by AIST is already being supplied to many locations.

Yamadera: The prefectural government has high hopes of AIST's research in the hydrogen field.

Furutani: The national government is interested not only in how hydrogen is produced from renewable energy sources but also in how effectively hydrogen is utilized in this prefecture. We are considering both national and prefectural perspectives and working on R&D to push the revitalization of Fukushima Prefecture in the best directions.

Industrial reconstruction with the world watching

Furutani: For the introduction of renewable energy, Fukushima Prefecture has set the ambitious goal of producing the equivalent of 100% of the prefecture's energy demand from renewable energy sources by the year 2040.

Yamadera: Renewable energy accounted for 21.9% of the prefecture's energy demand in 2011 and this had reached 31.8% by 2018, which corresponds to 77.1% of the prefecture's electricity consumption. The installation of renewable energy is proceeding strongly.

Furutani: From the view point of present Japanese standards, those numbers are amazing. Many hurdles must still be overcome to reach 100%. I anticipate that world-leading technologies will originate from Fukushima Prefecture.

Yamadera: We look forward to AIST's continuing help so that Fukushima Prefecture can be honestly called "a pioneering region for renewable energy" with recovery from the Great East Japan Earthquake and the nuclear disaster, and industrial revitalization watched with keen interest by the world.

Furutani: This conversation has given me a real sense of the huge scale of what is expected from AIST and renewed my determination that AIST should pursue research activities that can meet these expectations.

Extensive Field Testing in Robot City Tsukuba: Developing Mobility Robots to Assist Safe, Reliable Travel in the Aging Society

Senior Researcher,
Smart Mobility Research Team,
Robot Innovation Research Center

YOKOZUKA Masashi

Team leader,
Smart Mobility Research Team,
Robot Innovation Research Center

BANNO Atsuhiko

A range of personal mobility devices are being introduced as "the legs of the future," which will facilitate trouble-free movement through towns. AIST is developing autonomous driving technologies and incorporating them in wheelchairs to be used for the transport of senior citizens and people with disabilities. In a collaboration with Tsukuba City to make the city a demonstration field for mobility robots, we are conducting the first extensive field testing in Japan and making advances in R&D that will help greatly with applications of near-future technologies.

Developing autonomous driving technology for wheelchairs

Traffic accidents involving senior citizens, and increasing numbers of mobility-impaired people for whom travel is beset by difficulties, are problems for society. Personal mobility devices are attracting attention as vehicles that enable safe, comfortable travel and are kind to the environment. AIST has been working on the development of mobility robots that utilize high-level robot technologies for a long time.

One of these is a self-driving wheelchair called "Marcus." Banno Atsuhiko summarizes the features of Marcus: "We have developed functions for creating three-dimensional environment maps of large areas, for identifying the vehicle's position, and for detecting obstacles and amending paths of travel. We have incorporated these functions into a conventional wheelchair. These technologies are highly versatile, enabling seamless autonomous driving both indoors and outdoors."

Field testing that facilitates regulatory easing for practical use

In 2011, Tsukuba City was designated the first mobility robot testing zone in Japan, enabling field testing on public roads. Since then, many businesses and universities have conducted field testing in Tsukuba, verifying the social consequences and safety of mobility robots. In recognition of the results, regulations have been eased. Since 2015, driving of mobility robots on public roads has been allowed in many areas of Japan, provided certain conditions are satisfied.

Yokozuka Masashi recollects that "In field tests of Marcus on public roads, things that we could not have imagined in testing in the lab continually came up. We took the results and improved the software bit by bit. The most difficult thing was that Marcus would lose track of its own location in all kinds of circumstances. We realized that we would have to keep conducting meticulous field tests and making improvements before we could open the door to practical use."

Banno adds "Tsukuba City set up a committee with members from industry, academia and government to direct the field testing. Affirmed in the 'policy for social applications of near-future technologies' from the Cabinet Office in 2018 as a local government body with demonstration fields, it is making active use of them and regulatory easing towards practical use is progressing steadily. This would not have happened without our collaboration on R&D with Tsukuba City." Field tests of Marcus are still continuing.

Industry–academia–government collaboration for autonomous driving of senior cars

The team is currently working on autonomous driving technologies for senior cars (electric wheelchairs with handlebars for use by senior citizens). Under traffic laws, a senior car is equivalent to a pedestrian and does not require a driving license. The objective of senior cars is safe, reliable, independent movement for senior citizens and other people, for example, using multiple senior cars between the home and a bus stop, inside a shopping mall, inside a hospital, and so forth. In a collaborative project between Panasonic Corporation, Suzuki Motor Corporation, the University of Tokyo, and AIST, AIST is mainly responsible for outdoor autonomous driving technology.

Specifically, sensors and software developed by AIST are being incorporated into senior cars that are manufactured and sold by Suzuki. Having clarified the legal position of autonomous driving in Tsukuba City under the policy for social applications of near-future technologies, in April 2019 the team conducted Japan's first field tests of self-driving electric wheelchairs on public roads. In August, in the area around Tsukuba Station, the team started autonomous driving on public roads in conditions closer to actual daily life, including boarding and leaving elevators.

Prospects for implementing a sharing system

Banno and Yokozuka hope in future to implement a sharing system for self-driving wheelchairs in the city. "For example, an empty wheelchair will bring itself to a person's home and the person can ride it to the hospital. When the person leaves the wheelchair at the destination, the wheelchair drives itself back to a docking location. When this kind of scenario is envisaged, unattended autonomous driving is an extremely important aspect of the service. However, under current laws a senior car is not equivalent to a pedestrian when driving itself while empty; further regulatory easing is required. Moreover, there are many challenges in optimizing systems for management of sharing systems and in developing communication systems and other technological aspects."

Building a pleasant society with robot technology

To finish, they portray an image of the future from their perspective as researchers and describe their philosophy in the development of mobility robots.

Yokozuka portrays a future in which applications have progressed: "Nowadays, cars and other vehicles that aid travel are indispensable for people. I hope that 10 or 15 years from now, autonomous driving technology for mobility robots will be a part of our lives as unremarkable as breathing."

According to Banno, "As Japan becomes the most aged society in the world, we should be leading the world in mobility support technologies for people who can be described as mobility-impaired. I think the technologies we have developed will contribute to creating a pleasant society." This idea is at the heart of AIST's support for research into mobility robots. The aim is for cutting-edge technologies to be introduced into all kinds of industry and other activities in society to enable a human-centered society, "Society 5.0," in which all people can have a good quality of life.

Probabilistic Modeling Research Team,
Artificial Intelligence Research Center

TAKAOKA Kota

A Groundbreaking Challenge for Mie Prefectural Government and AIST: Introducing AI Technology to Child Guidance Centers to Help Save Children from Abuse

Because data on child abuse is highly privileged personal information, it has been difficult to employ information and communications technology in child guidance centers. Now, in a collaboration between Mie Prefectural Government and AIST, child guidance centers are combining collected data with cutting-edge AI technology. We have developed a groundbreaking child abuse prevention support system and conducted field tests, the first in Japan. The AI assesses child abuse risks and provides scientific support for decision-making in child guidance centers.

Applying experience of fieldwork to R&D

Child abuse is a serious social problem that continues to grow. The heartbreak of young lives being lost is not disappearing and the number of reports to child guidance centers, the front line in the battle against child abuse, continues to rise. The number of cases being handled by each child welfare officer has ballooned to around 50 times what it was in 1990.

Takaoka Kota is qualified as a clinical psychologist and has nearly four years experience as a non-regular employee in child guidance centers. He has worked on fighting child abuse through both practice in the field and academic research, including practical work and research in multi-agency collaborations between healthcare, welfare and judicial bodies, development of systems that use information and communications technology (ICT), and education and outreach activities with the NPO Child First Lab. He links his personal experiences of the harsh situations faced by children, their families, and field workers to the development of a child abuse prevention support system that makes use of AI technology. The big shift in child guidance centers from paper-based

information-sharing to digital data and the application of AI technology is a revolutionary challenge.

Improving work efficiency and the quality of judgments

Takaoka and the team have developed a system that aids decision-making by child guidance center officers. An officer on a home visit enters certain kinds of information such as how a child looks and conditions in the home into an app ("Assistance of Intelligence for Child Abuse and Neglect") on a tablet terminal. In real time, the system estimates a degree of severity of abuse, a likelihood of recurrence, whether temporary protective care is necessary, a number of days needed for treatment, and so forth.

Takaoka has been working to develop solutions to two problems. "One is improving the efficiency of work. As far as possible, we should eliminate unnecessary work and share information quickly. The other is improving the quality of judgments. We can avoid missing abuse by combining judgments based on experience with judgments based on data. Knowledge based on experience can be lost when officers move for redeployment and the like. However, because the AI studies the more successful cases, knowledge can be passed down."

Preserving security and maintaining accountability

The system that has been developed comprises an app for dedicated tablets, a cloud database, and a data analysis AI.

"The system can use work records from the field as research data without modification and incorporates global cutting-edge technology. One of its features is strong information security measures. We have created a specialized system for linking data directly into the cloud; no data at all is kept on the tablets. Even if a tablet is lost, information leaks are prevented.

"The AI employs machine learning technology, which improves the accuracy of predictions, and probabilistic modeling technology*, which is useful for presenting the reasons for predictions. Child guidance centers always have to be accountable for their actions. The probabilistic modeling technology is very important because it makes it possible to trace how a decision has been arrived at."

Mie Prefecture and the first field tests in Japan

Field testing of the system started in Mie Prefecture in July 2019. Twenty tablets were provided to two child guidance centers. Later, the opinions of the officers who used the tablets will be collected and further improvements will be added.

"Cooperation between local governments and AIST is crucial for research into child abuse. Because child guidance centers have the legal right to enter people's homes, they can gather particularly sensitive personal information. Legally, this information can only be shared for use in academic research by bodies such as national research institutions. We have had to deal with many security constraints to conduct this R&D and field testing."

The field testing has produced a big response, with many local governments expressing interest. Several local governments have already advanced to cooperative research with AIST. However, because the databases and support resources that are used vary from area to area, the information from each separate local government must be analyzed and standardized. Where there is no data, practical use of the technology is not possible. Therefore, cooperation with local governments will be key to future progress.

To make a society in which children can be happy

We asked Takaoka how he hopes the system he has developed will be useful in the future. "One aspect is effective multi-agency cooperation. The AI judges risks, draws the attention of child guidance centers to high-risk cases, and passes less severe cases to local government offices, health centers, nursery schools, and so forth. In studies from other countries, it has been reported that children who are being abused show declining academic performance and more frequent tardiness. In the future, I think we will link up data from schools, kindergartens, and nursery schools and detect abuse risks from the early stages.

"Another aspect is using the accumulated data for evidence-based policymaking. The fight against child abuse is being hampered by staff shortages and inadequate budgets. It is an issue that the government should treat as an urgent priority."

Looking at international development beyond Japan, there is hope that the system will contribute to Target 16.2 of the Sustainable Development Goals: "End abuse, exploitation, trafficking and all forms of violence against and torture of children."

Takaoka adds "By organizing and analyzing data, we can use the results to constantly improve knowledge that can be used in the field. This research provides an important ecosystem in which specialists in front-line work, research, training, and technical development can cooperate as teams to continuously update the whole system with a vision of making a society that is safe for children." Our efforts to build a safe and comfortable society in which children can be happy will continue.

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★ Probabilistic modeling: A technology that automatically creates statistical models incorporating uncertainty and variability from provided data.

02 Promotion of Research and Development

AIST promotes research activities "in society, for society" with awareness of the role of industrial science and technology.

■ Establishment of Cyber Physical System Research Annex

In December 2018, AIST opened a new research facility, Cyber Physical System Research Annex at AIST Tokyo Waterfront, to play a part in R&D fusing AI technologies and robot technologies.

In applying AI technologies to real-world environments, it is necessary to gather data on conditions in those real-world environments with various IoT technologies and to use those data as learning data for AI. However, required learning data are different depending on the real-world environments being interacted with. Therefore, simulated environments are necessary to enable research into questions such as which AI technology to employ in a real-world environment, what data need to be collected to apply the AI technology, and which IoT technologies are most suitable for the application.

Cyber Physical System Research Annex will provide four kinds of simulated workplace: a factory for manufacturing; a semiconductor fabrication facility for manufacturing variable-quantity multiple device types; a convenience store for sales and distribution; and a drug discovery and bio-testing facility. Cyber Physical System Research Annex will provide each of these workplaces with equipment (machining equipment, robots, and so on) and workers, prepare environments in which physical data similar to real-world workplaces can be gathered, and develop technologies to build cyber physical systems that can represent these physical-world environments in cyberspace environments.

Cyber Physical System Research Annex is advancing human–machine collaboration AI technologies that will utilize these simulated environments and cyber physical systems, fuse AI technology and robot technology, facilitate collaboration between people and different kinds of machines, and support human activities. Hence, environment information and work information will be converted to data, which will be processed by AI technologies. This will improve efficiency in industrial sites as the working population declines and address the problems of collaborations between humans and robots.

The exterior of Cyber Physical System Research Annex

Simulated factory environment (processing area)

Simulated factory environment (assembly area)

Simulated shop environment

■ Establishment of the Consortium for Human-Centric Manufacturing Innovation

AIST; Oki Electric Industry Co., Ltd.; NS Solutions Corp.; and Mitsubishi Electric Corp. have established the new Consortium for Human-Centric Manufacturing Innovation (HCMI Consortium) with the aim of developing and deploying innovative manufacturing methods centered on people.

In recent years, Japan's manufacturing industries have faced a transformation from low-cost mass production systems to multi-product variable-quantity production systems. With this transformation, it is important to make use of humans, who can respond flexibly to diverse tasks at production sites. However, with the falling birthrate and aging population, the working age population is shrinking. To assure sufficient personnel for workplaces, policies under which diverse personnel can be employed in diverse working styles must be established urgently.

In hope of addressing this issue, we have established the HCMI Consortium with the goal of developing and deploying innovative manufacturing methods based on a human-centric philosophy. Through the activities of the consortium, we aim to establish new production methods

that enable flexible and efficient production centered on humans in collaboration with machines; methods for efficiently transferring the skills, experience, and insights of craftsmen; and environments and management techniques that focus on Quality of Working (QoW) and allow people to exploit their capabilities in accordance with their talents and physical conditions. In this way, we aim to create systems in which diverse personnel can grow in the course of their work.

As a base for these activities, we are setting up a "manufacturing innovation base" (provisional name) where participating organizations can conduct R&D, testing, and evaluations. At first we will use part of the simulated factory in Cyber Physical System Research Annex at AIST Tokyo Waterfront; we are planning to set up further model bases in other regions. With these bases as centers of operations, the HCMI consortium will support R&D, testing, and evaluation to develop innovative human-centric manufacturing methods; spread knowledge of the methods; and support commercialization of the outcomes.

■ Participation in Technology Research Associations

AIST has become a member of Technology Research Associations, the members of which provide researchers, research funds, and equipment and carry out joint research and development of technologies used in industry. AIST contributes to the associations' projects from planning and performing research to utilizing research outcomes.

Particularly by providing our "members" and "places" to 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.

AIST "members" participate in the associations projects as researchers, project leaders or board members. We also provide our facilities as places to researchers from industries and universities participating in the associations for carrying out intensive research.

■ Participation in Technology Research Associations in FY 2018

- AIST participated in 18 associations.
- Intensive research projects were performed at AIST (12 associations marked with the letter "A" in the table).
- AIST researchers served as project leaders and managed the entire projects (6 associations marked with the letter "B" in the table).
- AIST managers served as directors (15 associations marked with the letter "C" in the table).
- AIST provided technical guidance and support, as well as know-how of equipment operation.

➡ Technology Research Associations in which AIST participated (FY 2018)

1	Photovoltaic Power Generation Technology Research Association (PVTEC)	A	B	C
2	Lithium Ion Battery Technology and Evaluation Center (LIBTEC)	A		C
3	Fuel Cell Cutting-Edge Research Center Technology Research Association (FC-Cubic)	A		C
4	International Standard Innovation Technology Research Association (IS-INOTEK)			C
5	Photonics Electronics Technology Research Association (PETRA)	A		C
6	Chemical Materials Evaluation and Research Base (CEREBA)	A		C
7	Japan Advanced Printed Electronics Technology Research Association (JAPERA)	A		C
8	Technology Research Association for Next Generation Natural Products Chemistry	A	B	C
9	NMEMS Technology Research Organization Technology Research Association (NMEMS)	A	B	C
10	Control System Security Center (CSSC)			C
11	Technology Research Association of Magnetic Materials for High-Efficiency Motors (MagHEM)	A	B	C
12	International Research Institute for Nuclear Decommissioning (IRID)			C
13	Manufacturing Technology Research Association of Biologics (MAB))	A		
14	Thermal Management Materials and Technology Research Association (TherMAT)		B	C
15	Innovative Structural Materials Association (ISMA)			
16	The Research Association of Automotive Internal Combustion Engines (AICE)			
17	Technology Research Association for Future Additive Manufacturing (TRAFAM)	A	B	C
18	Geological Carbon dioxide Storage Technology Research Association (CCS)	A		C

■ Deployment of Innovation Coordinators

AIST is strengthening its function of transferring technology to society by deploying 187 (as of June 2019) innovation coordinators responsible for liaising with external bodies such as companies and universities. In order to quickly and accurately understand diverse needs according to the characteristics of different industries, AIST assigns the innovation coordinators to various research domains and is also improving the organization of cross-sector marketing activities spanning different domains and regional research bases. As a result, the Research and Innovation Promotion Headquarters, research domains, and research units in AIST are working together to promote collaboration with partners.

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

■ Opportunities for Industry–Academia–Government Collaboration and Researcher Invitation

AIST supports R&D and product development of private companies by conducting joint research, commissioned research, and testing and calibration as well as by providing technology consulting, technical advices, and research materials. In addition, AIST explores potential applications of new technologies in collaboration with companies and universities—for example, through the operation of AIST Consortiums—with the aim of developing new markets.

Active invitation of external researchers

■ Acceptance of external researchers for joint research Number of researchers accepted in FY 2018: 2,307

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.

■ Joint research program involving transfer of human resources Number of researchers transferred to AIST under this program in FY 2018: 2

Under this joint research program, researchers from our joint research partner institutions are temporarily stationed at AIST. (The partner institution bears the cost equivalent to the amount of the personnel expenses in the form of research expenses.) Researchers from both our partner institutions and AIST can thus deepen their research collaboration and accelerate their R&D, taking full advantage of our research infrastructure and human resources.

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.
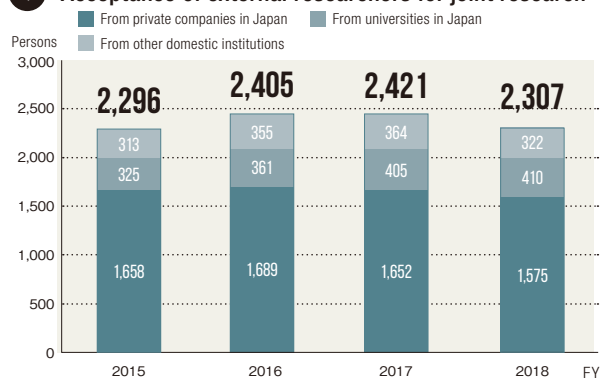
Joint and commissioned research projects conducted in past years

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 service, 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 2018, 515 cases were implemented.

➡ Joint and commissioned research with companies

➡ Acceptance of external researchers for joint research
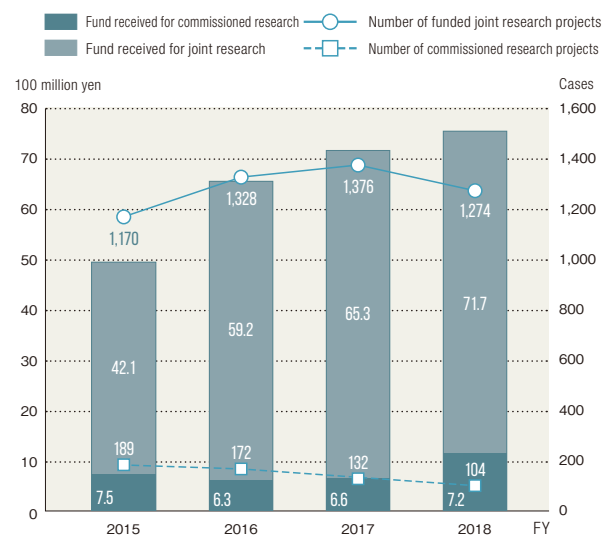
➡ Number of technical consulting
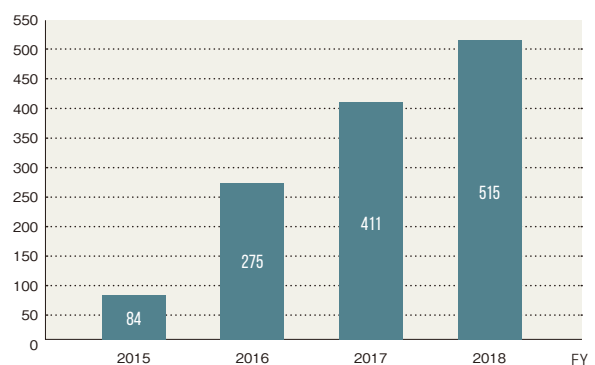
■ Promoting International Standardization

AIST promotes standardization activities, utilizing its R&D achievements. Our employees play key roles in international standard-setting bodies, most notably the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). In the committees of these bodies, 56 AIST employees are serving as chairs, secretaries, or convenors while 422 participating as experts.

FY 2018 saw the issuance of the Japanese Industrial Standards (JIS) of the methylene blue absorption test of bentonite, and of ISO standards concerning characterization methods of nano materials by field flow fractionation. That year, AIST proposed a total of 50 domestic and international standards.

AIST has held the Symposium on Strategies for International Standardization each year since FY 2011, with the aim of enhancing standardization efforts by sharing the importance and challenges of standardization and certification with relevant parties in industry and government. In FY 2018, AIST cohosted this symposium with NEDO under the theme of "Service Standards and Certification Opens the Way to Rich Japan—Society Brought Together by Safety, Security, and Reliability."

→ Contribution of AIST staff to international standardization activities

Legend: Experts ■ — Chairs, secretaries, convenors ○

Persons

FY	Experts	Chairs, secretaries, convenors
2015	282	48
2016	317	48
2017	385	54
2018	422	56
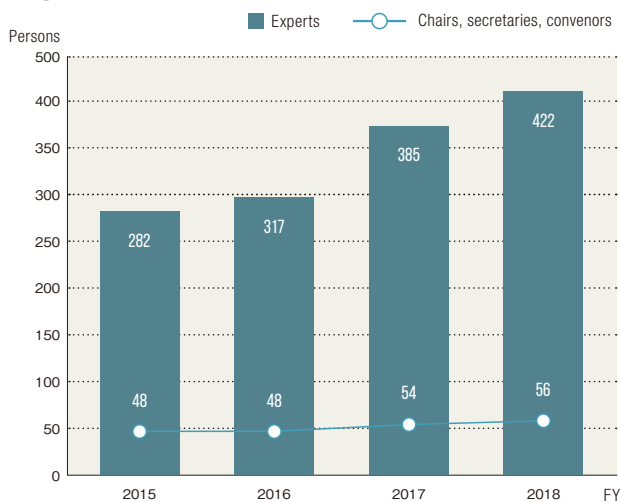
→ Number of proposed standards

Legend: ■ International standards ■ National standards

Cases

FY	International standards	National standards	Total
2015	24	9	33
2016	16	7	23
2017	38	12	50
2018	37	13	50
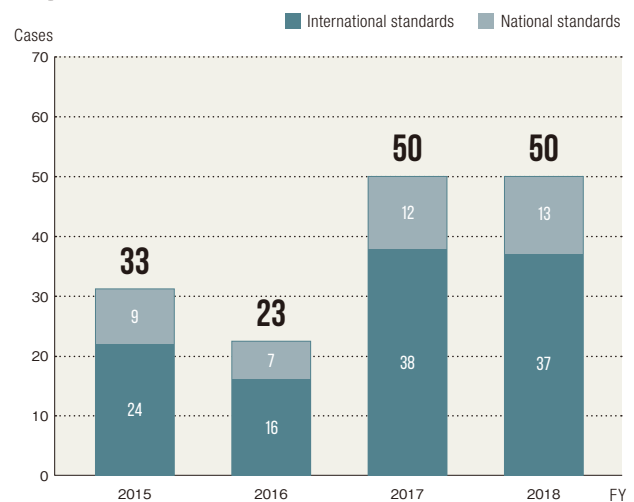
■ Increasing Global Presence

AIST has been increasing its global presence, not only by conducting world-leading research but also by enhancing cooperation, and exchanging personnel organization-wide, with overseas research institutes. In an effort to enhance such cooperation, AIST together with RIKEN organized the Seventh Global Summit of Research Institute Leaders in October 2018. The purpose of this summit is to provide those leaders with an opportunity to discuss face-to-face the future of science and technology, the roles of individual institutes, and collaboration among them. The seventh summit was attended by leaders representing 22 world-renowned research institutes of 11 countries, who engaged in vigorous discussion on the theme, "Science Interacting with Society: Tasks for Global Research Institutes." As the representative of AIST, President CHUBACHI Ryoji made opening remarks, in which he stated that scientists' efforts toward building a sustainable society are expected by society.

The 7th Global Summit of Research Institute Leaders

■ Strengthening International Collaboration to Address Global Issues

AIST has been building an international research network by concluding MOUs on comprehensive research collaboration with 29 research institutes worldwide. These MOUs have enabled us to conduct joint research and personnel exchanges with the partner institutes as we work toward addressing global issues. In August 2018, we hosted a workshop with Fraunhofer-Gesellschaft (FhG) with whom we have been pursuing close cooperation focusing on energy, environment, electronics, and manufacturing since we concluded an MOU on comprehensive research collaboration in 2012. During the workshop, there were presentations on efforts taken by both institutes and exchange of ideas on the importance of data construction and data handling methods.

In December 2018, we held a workshop in Taiwan with the Industrial Technology Research Institute of Taiwan (ITRI). We have held six 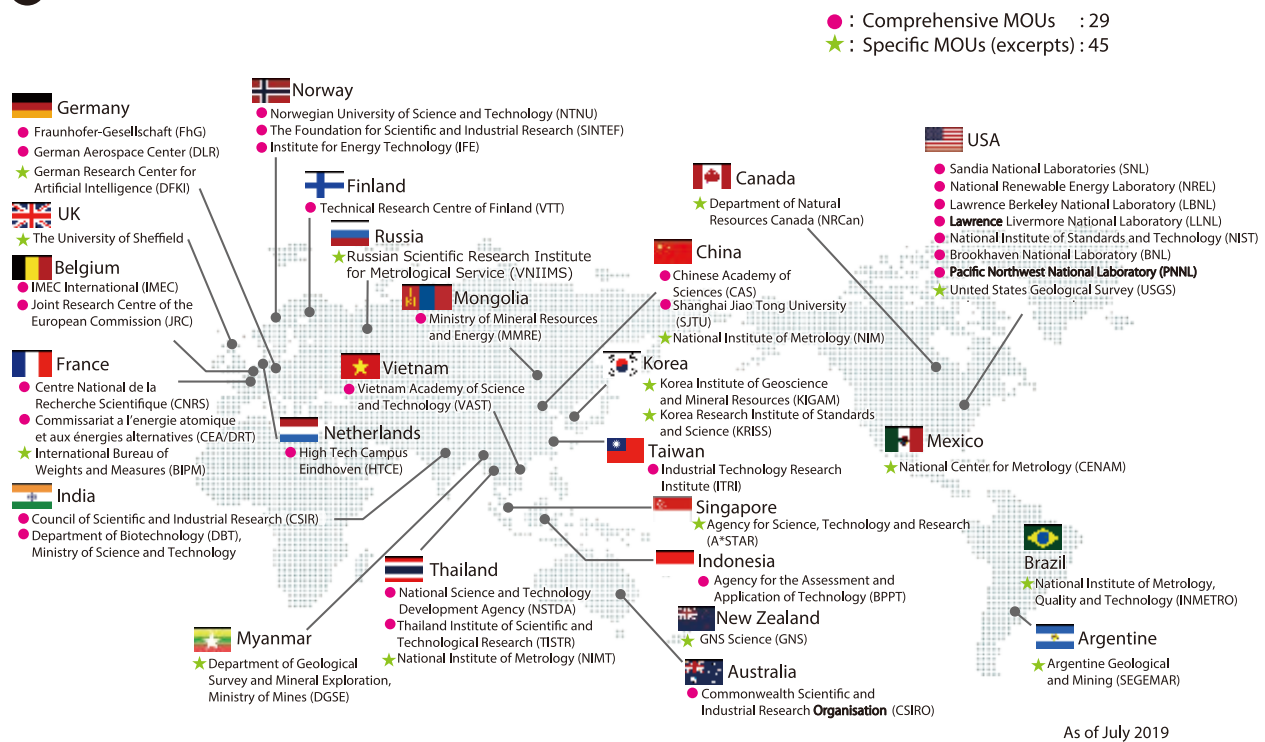joint symposiums with ITRI in the past. This workshop was attended not only by researchers but also by a number of Innovation Coordinators. The workshop was rich in content including exchange of opinions on startups.

Workshop of FhG and AIST (August 2018)

→ List of MOUs

● : Comprehensive MOUs : 29
★ : Specific MOUs (excerpts) : 45

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

UK
★ The University of Sheffield

Belgium
● IMEC International (IMEC)
● Joint Research Centre of the European Commission (JRC)

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

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

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

Finland
● Technical Research Centre of Finland (VTT)

Russia
★ Russian Scientific Research Institute for Metrological Service (VNIIMS)

Mongolia
● Ministry of Mineral Resources and Energy (MMRE)

Vietnam
● Vietnam Academy of Science and Technology (VAST)

Netherlands
● High Tech Campus Eindhoven (HTCE)

Thailand
● National Science and Technology Development Agency (NSTDA)
● Thailand Institute of Scientific and Technological Research (TISTR)
★ National Institute of Metrology (NIMT)

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

Canada
★ Department of Natural Resources Canada (NRCan)

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

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

Taiwan
● Industrial Technology Research Institute (ITRI)

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

Indonesia
● Agency for the Assessment and Application of Technology (BPPT)

New Zealand
● GNS Science (GNS)

Australia
● Commonwealth Scientific and Industrial Research Organisation (CSIRO)

USA
● Sandia National Laboratories (SNL)
● National Renewable Energy Laboratory (NREL)
● Lawrence Berkeley National Laboratory (LBNL)
● Lawrence Livermore National Laboratory (LLNL)
● National Institute of Standards and Technology (NIST)
● Brookhaven National Laboratory (BNL)
● Pacific Northwest National Laboratory (PNNL)
● United States Geological Survey (USGS)

Mexico
★ National Center for Metrology (CENAM)

Brazil
★ National Institute of Metrology, Quality and Technology (INMETRO)

Argentine
★ Argentine Geological and Mining (SEGEMAR)
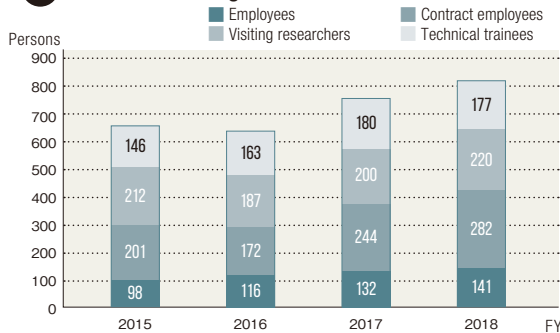
As of July 2019

■ Invitation to Foreign Researchers

To enhance cooperation with overseas research institutions and to develop an international network of researchers, we actively accept researchers from universities and research institutions outside Japan. In FY 2018, a total of 820 foreign researchers engaged in research at AIST.
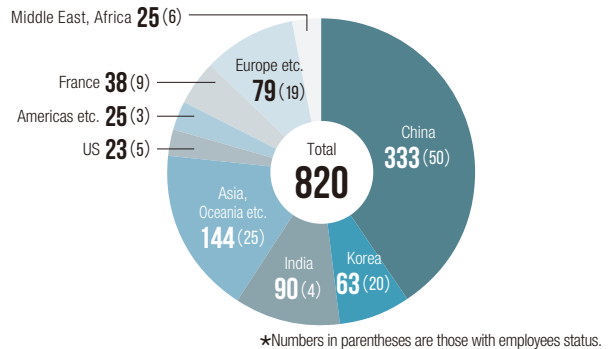
In terms of regional statistics, more than 70% were from Asia with those from Europe making up the second largest group. The Department of Information Technology and Human Factors accepted the most (approx. 26.8%), followed by the Department of Energy and Environment (approx. 19.5%), and the Department of Materials and Chemistry (16.6%). We will continue to develop close collaboration with overseas research institutions through personnel exchange.

➜ Number of foreign researchers

Employees　　　　　　Contract employees
Visiting researchers　　Technical trainees

Persons

FY	Employees	Visiting researchers	Contract employees	Technical trainees
2015	98	201	212	146
2016	116	172	187	163
2017	132	244	200	180
2018	141	282	220	177

➜ Number of foreign researchers by country and region in FY 2018

Middle East, Africa **25**(6)
France **38**(9)
Americas etc. **25**(3)
US **23**(5)
Europe etc. **79**(19)
Asia, Oceania etc. **144**(25)
India **90**(4)
Korea **63**(20)
China **333**(50)
Total **820**

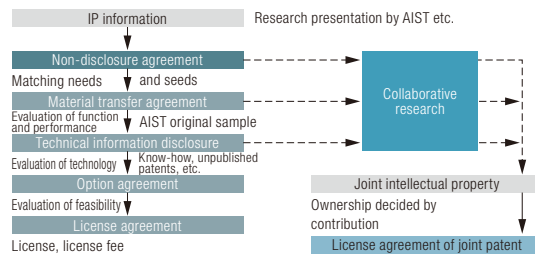＊Numbers in parentheses are those with employees status.

■ 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

IP information　　　　Research presentation by AIST etc.

Non-disclosure agreement
Matching needs　and seeds
Material transfer agreement
Evaluation of function and performance　AIST original sample
Technical information disclosure
Evaluation of technology　Know-how, unpublished patents, etc.
Option agreement
Evaluation of feasibility
License agreement
License, license fee

Collaborative research

Joint intellectual property
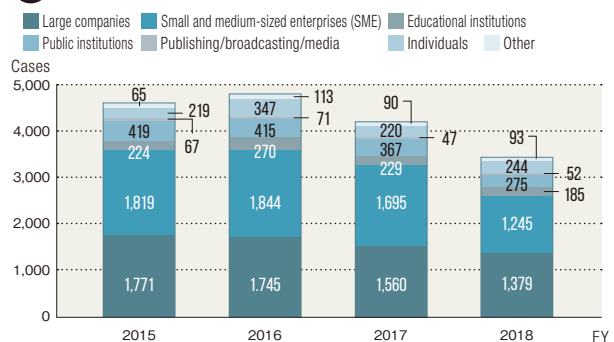Ownership decided by contribution
License agreement of joint patent

■ Technical Advice Service

This is a system by which AIST provides advice on technical issues to companies, universities, and public research organizations. Our specialized staff such as SME coordinators and researchers work together to provide answers.

Example of technical advice service

[Consultation request] A request to provide a technique to prevent chain abrasion
[Actions taken and answers given] Provided a technique to improve abrasion resistance by plating the shaft of the industrial chain and heat-treating the surface by lasers.

➜ Number of technical consultations

Large companies　　Small and medium-sized enterprises (SME)　　Educational institutions
Public institutions　　Publishing/broadcasting/media　　Individuals　　Other

Cases

FY	Large companies	SME	Educational institutions	Public institutions	Publishing/broadcasting/media	Individuals	Other
2015	1,771	1,819	224	419	65	219	67
2016	1,745	1,844	270	415	347	113	71
2017	1,560	1,695	229	367	220	90	47
2018	1,379	1,245	275	244	93	52	185

■ Innovation School

AIST's 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 think, and develop one's own career.

In FY 2018, we employed 15 postdoctoral researchers and conducted lectures, seminars, and long-term business training as part of the training course of human resources for innovation. To improve our education programs for graduate students, we ran a half-year course on basic research skills, and 40 students completed the program of lectures, seminars, and technical training. Moreover, we accepted 3 graduate students who were interested in the program as observers.

Curriculum of the Innovation School

1. **Lectures and exercise at AIST**
   - Lectures on philosophy and research management and on postdoctoral human resources desired by society
   - Lectures on intellectual property, environmental ethics, companies and industries
   - Lectures on research cases (of AIST, other national research institutes), research scenarios, how to create an innovative project
   - 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, ability to think

2. **Research at AIST**
   - Working on research topics in laboratories
   - Experiencing research at AIST

3. **On-the-job training with companies (about 3 months on average, part of the training course of human resources for innovation)**
   Through actual work at companies, students learn research development activities and productization, the speed of technology development, the importance of cost awareness and teamwork, and collaboration with other departments.

Expanding the vision and providing opportunities to young researchers

Students of the school say such things as "I found that the knowledge and the experience in my research is also applicable to companies," or "The communication skills learned in the school was helpful." They realize from experience that there are a variety of opportunities to work as researchers; to develop such insights as "The most important thing is the awareness that I work in an organization," or "You need to share a language with those with expertise in each area"; and to broaden their horizons. Companies that have accepted trainees say that "We gained valuable technological knowledge from the students," or "The students inspired those of our employees who were from the same generation." The companies rate the trainees' research capabilities and work attitudes highly.

Since the school started, 307 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.

At a lecture

A lecture by the president

Progress report presentation

■ 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 2018,

338 students in graduate programs (240 master's, 98 doctoral students) engaged in R&D at AIST.

Voices of research assistants

The best part of being an RA is that you can interact on a daily basis with researchers and students of different fields whom you would not meet at university. (Third-year student of doctoral program)
Research at AIST is high-level, and I am learning new research approaches daily. (Second-year student of master's program)

**→ Employment requirements for AIST Research Assistants** (as of July 2019)

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 2018	338	

■ Cross-appointment Program

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 will increase 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 47 researchers from 17 universities, 1 private company, and 1 institution, and send 15 researchers to 6 universities and 2 private companies, and 3 institutions. (As of April 1, 2019).

→ Number of program users ■ Acceptance ■ Temporary transfer
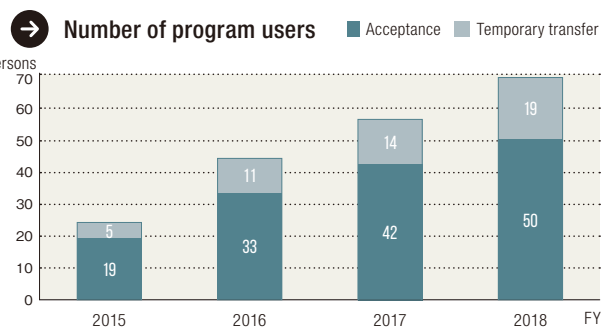
■ TIA Collaborative Research Program ("Kakehashi")

"Kakehashi" (a Japanese word for "linking bridge") is a program that promotes collaboration among the five organizations of TIA (AIST, National Institute for Materials Science, the University of Tsukuba, High Energy Accelerator Research Organization, and the University of Tokyo). Since it started in FY 2016, Kakehashi has been supporting projects with the aims of finding "seeds" and "sprouts" of research and technology

at various stages, nurturing "buds" through collaboration and transferring "fruits" to industry.
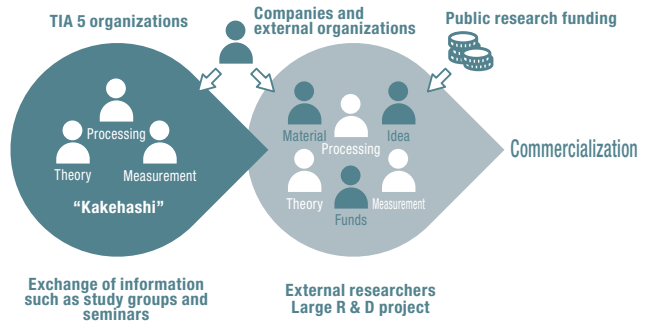
■ Activities in FY 2018

The 47 Kakehashi projects in FY 2018 cover biotechnology and computational materials science, as well as numerous fields covering interdisciplinary areas.

Ten collaborative groups and organizations were formed with Kakehashi as a start, and many workshops and symposia were held.

■ Implementation of company-proposed themes

We have started implementation of themes proposed by companies with TIA mediating to organize teams. 2 companies made proposals in FY 2018, and 4 cases were implemented. For FY 2019, proposals by 3 companies have been selected.

→ **Image of "Kakehashi"**

TIA 5 organizations

Companies and external organizations

Public research funding

Processing
Theory   Measurement
"Kakehashi"

Material   Idea
Processing
Theory   Measurement
Funds

Commercialization

Exchange of information such as study groups and seminars

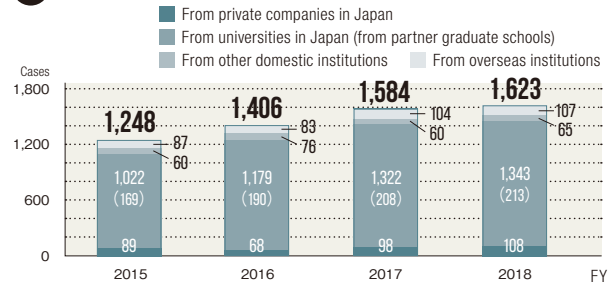External researchers
Large R & D project

■ Technical Training

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. In FY 2018, 1,623 trainees participated in this program.

■ 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
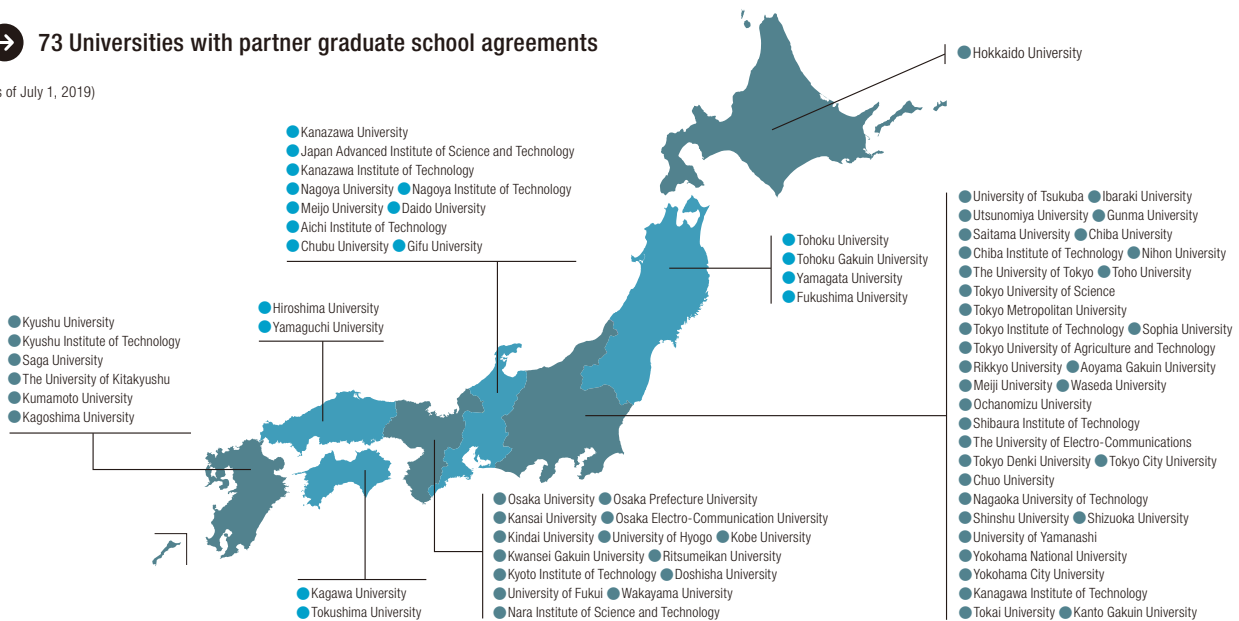
training to the graduate students on the site of AIST. This program is deemed to be part of the students' academic degree programs.

→ **Number of trainees on technical training**

- From private companies in Japan
- From universities in Japan (from partner graduate schools)
- From other domestic institutions
- From overseas institutions

Cases

FY	2015	2016	2017	2018
Total	1,248	1,406	1,584	1,623
overseas	87	83	104	107
other domestic	60	76	60	65
universities	1,022 (169)	1,179 (190)	1,322 (208)	1,343 (213)
private companies	89	68	98	108

→ **73 Universities with partner graduate school agreements**

(as of July 1, 2019)

- Hokkaido University
- Kanazawa University
- Japan Advanced Institute of Science and Technology
- Kanazawa Institute of Technology
- Nagoya University ● Nagoya Institute of Technology
- Meijo University ● Daido University
- Aichi Institute of Technology
- Chubu University ● Gifu University
- Tohoku University
- Tohoku Gakuin University
- Yamagata University
- Fukushima University
- University of Tsukuba ● Ibaraki University
- Utsunomiya University ● Gunma University
- Saitama University ● Chiba University
- Chiba Institute of Technology ● Nihon University
- The University of Tokyo ● Toho University
- Tokyo University of Science
- Tokyo Metropolitan University
- Tokyo Institute of Technology ● Sophia University
- Tokyo University of Agriculture and Technology
- Rikkyo University ● Aoyama Gakuin University
- Meiji University ● Waseda University
- Ochanomizu University
- Shibaura Institute of Technology
- The University of Electro-Communications
- Tokyo Denki University ● Tokyo City University
- Chuo University
- Nagaoka University of Technology
- Shinshu University ● Shizuoka University
- University of Yamanashi
- Yokohama National University
- Yokohama City University
- Kanagawa Institute of Technology
- Tokai University ● Kanto Gakuin University
- Hiroshima University
- Yamaguchi University
- Kyushu University
- Kyushu Institute of Technology
- Saga University
- The University of Kitakyushu
- Kumamoto University
- Kagoshima University
- Osaka University ● Osaka Prefecture University
- Kansai University ● Osaka Electro-Communication University
- Kindai University ● University of Hyogo ● Kobe University
- Kwansei Gakuin University ● Ritsumeikan University
- Kyoto Institute of Technology ● Doshisha University
- University of Fukui ● Wakayama University
- Nara Institute of Science and Technology
- Kagawa University
- Tokushima University

03 Labor Practices

We put first priority on ensuring the health and safety of workers.

■ Occupational Health and Safety

As would be expected in laboratories, AIST uses substances and equipment that may possibly affect the human body and the environment, such as various chemical substances, high-pressure gases, radioactive materials, genetically modified organisms, nano-materials, laser equipment, and machine tools. Accordingly, AIST has an Environmental Safety Charter in place to create a work environment in which all people working here can do so in a safe and healthy manner. AIST is working to improve the health and safety of its employees as a top priority.

Safety and Health Committee meetings and site meetings of AIST bases

Safety and health managers hold Safety and Health Committee meetings, which are attended by labor and management representatives, at each AIST site and research base every month to discuss health and safety issues.

Representatives from each AIST department at the base discuss safety and health issues at the Safety and Health Committee meetings and at other 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

AIST's 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 Environmental Safety Charter.

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. The FY 2018 revisions include the following.

1) Following the enforcement of the Clinical Trials Act, based on revisions of the Regulations on Ethics, Safety and Health Administration Related to Life Science Experiments corresponding to specified clinical trials under the act, a section was added concerning inspection and approval procedures. 2) A section was added that risk assessment is to be conducted at each research unit based on quantitative regulations of the Japan Industrial Safety and Health Association so that everyone rightly recognizes the hazardousness of experiments using chemical substances and conducts experiments safely. 3) Following reports on patrol, accidents, and near-miss incidents at AIST, a section was added that expands the attendees of mandatory courses to those managing or handling hazardous chemicals and high-pressure gases defined in this guideline to further prevent accidents and to foster safety culture.

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.

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★In the event of a disaster, the safety confirmation system automatically sends bulk safety confirmation emails to 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. At this meeting, AIST connects 14 research bases across the country through a teleconferencing system to exchange information on accidents, near-miss incidents, health issues, and information security at the regional research bases, AIST Tsukuba, and other sites. The aim is to share details of recurrence prevention measures and thus improve safety and health.

FY 2018 saw a decrease in the number of total cases compared to FY 2017, but compared to FY 2016, there were still more accidents resulting in injuries. To address this situation, we provide safety education to make sure that proper protective equipment is worn, prepare work procedure manuals for high-risk tasks, and conduct risk prediction activities to foster safety culture.

➜ Incidence of accidents resulting in absences from work

- - □ - - All industries — ○ — AIST
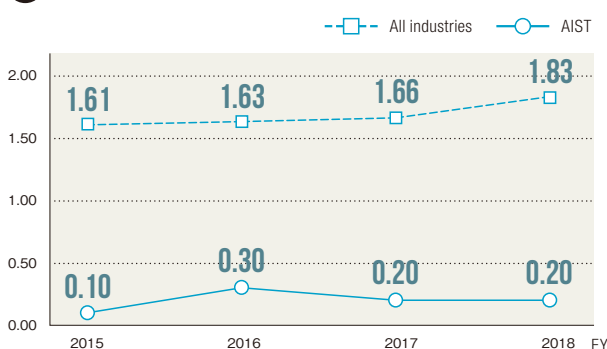
- Incidence of accidents resulting in absences from work
Frequency of accidents expressed as the number of casualties from industrial accidents per million cumulative work hours. Incidence of accidents resulting in absence from work = number of casualties from industrial accidents /number of cumulative work hours 1,000,000

➜ Trends in the number of occupational accidents
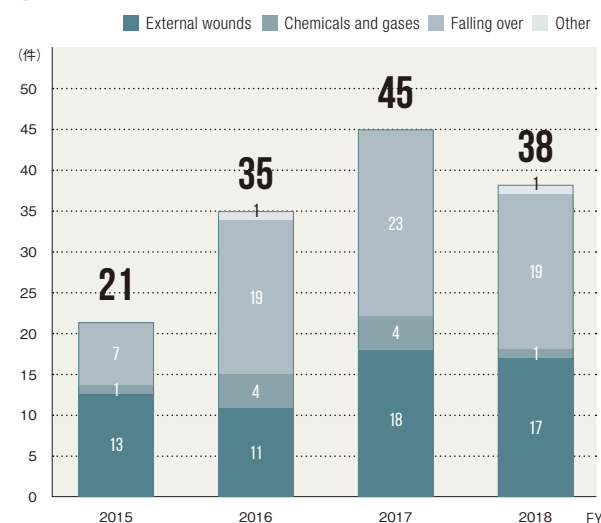
Safety education and support for license acquisition

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. To use institute vehicles, it is compulsory to take courses on safe driving according to regulations for work vehicle management, and safe driving is promoted. To broaden learning opportunities, an e-learning system is used in parts of the safety training for life science experiments.

A program of education and training for animal experiments teaches participants how to design a suitable experimental plan and gives them the knowledge and attitudes needed to conduct experiments; it is based on the 3Rs stipulated by law, namely Replacement (i.e., use alternative methods), Reduction (reduce the number of animals used), and Refinement (reduce pain). 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. 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.

➜ Main education and training programs and workshops held in FY 2018

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	32
Course on skills required for a Chief Technician's License for Using Specified Chemical Substances	1	24
High-pressure gas safety course (for those handling high-pressure gases for the first time)	4	478
High-pressure gas safety course (for those handling high-pressure gases on an ongoing basis)	4	1138
General safety workshop (for all those responsible for hazardous chemicals, etc.)	4	1064
Education and training for recombinant DNA experiments (e-learning participants)	1	977
Education and training for animal experiments (e-learning participants)	1	239
Education and training on human ethics in life science experiments (e-learning participants)	1	264
Lecture on Clinical Trials Act	1	85
Education and training for biosafety	1	16
Education and training for those involved in animal experiments	1	106
Joint radiation education and training (for radiation workers)	3	347
X-ray education and training (for new users of X-ray equipment)	81	245
Course on compliance with laws and regulations on radioactive materials (for managers)	1	49

■ 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 effectively 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 42 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 2019, hired two persons.

The employees can work for up to 2 years, yet they have a chance to be hired as a permanent employee based on evaluations of their work performance. 31 employees have been rehired as a permanent employee so far.

AIST will continue to hire fixed-term regional employees to support research and development, innovation, and other activities.

➡ **Number of persons newly employed each year**

FY	Number of persons employed
2015	7
2016	10
2017	6
2018	5
2019	2

■ Support for Work–life Balance

■ Support for balancing work with childcare or nursing care

AIST strives to create a working environment conducive to balancing work with childcare or nursing care needs. The numbers of employees who used leave programs are shown on the next page.

In an endeavor to help employees with childcare, three of our research bases—AIST Tsukuba, Chubu, and Kansai—have temporal day care where employees can leave their children while at work. Moreover, employees visiting our research bases with no such facilities or major cities are able to use the private-sector, day-care centers or babysitters that we have contracted. The numbers of employees who used these facilities are shown on the next page.

Meanwhile, as part of initiatives to support nursing care, we held a work-life balance seminar, in which an outside expert lectured on strategies and wisdom in managing both work and nursing care compatibly. About 100 employees attended the seminar, many of whom took the seminar for their future needs. The seminar was followed by an explanatory session regarding AIST's childcare and nursing care systems.

Information on childcare and nursing care services is available on our intranet sites titled "Childcare Square" and "Nursing care Square," respectively, which supply information on the relevant programs.

AIST, in addition to standard working hours, has both flextime and discretionary work systems in place to allow for flexible working arrangements. The flextime system is used by 30.4% of employees while the discretionary work system by 52.7% (as of the end of FY 2018), inviting comments that the system enables flexible way of working without time constraints. The average overtime hours of employees (excluding workers under the discretionary work system and work supervisors) per month is 23.3 hours (FY 2018). We support work-life balance of employees by providing an environment that enables selection of working forms regardless of whether they have childcare and nursing care.

■ Action Plan to Support the Development of Next-Generation Human Resources

AIST's Fourth Action Plan to Support the Development of Next-Generation Human Resources, effective from April 2017 through March 2020, is primarily aimed at enabling employees to return to work smoothly from maternity or childcare leave. Toward that end, we endeavor to offer pertinent information to the needs of individual employees. Initiatives undertaken in FY 2018 include an information meeting on maternity and childcare systems, and individual interviews with employees who returned from childcare leave to understand the needs and to provide appropriate support.

To familiarize employees with our childcare and nursing care support systems, we have prepared and are distributing leaflets that introduce respective systems. We also organized information meetings at AIST Tsukuba, Hokkaido, and Chugoku for childcare and nursing care programs in FY 2018. Furthermore, in FY 2018, we launched six lunch meetings, five on childcare and one on nursing care, at AIST Tsukuba. The lunch meetings provided employees with opportunities to gather and exchange information.

Teleworking program for childcare

Continuing from 2017, we have offered a teleworking program, as part of initiatives that help researchers to minimize career interruptions for life event and play an active role in spite of working hour constraints, in accordance with our action plan under the Act on the Promotion of Female Participation and Career Advancement in the Workplace. Employees may be allowed to work from home using IT equipment for the period approved by the president. The number of users of this program was 23 (five male and 18 female) employees in FY 2018.

The support program for researchers who have restriction on working hours due to childcare and nursing care

As a measure to support researchers who have restriction on working hours for childcare, nursing care, and other reasons, we have started providing subsidies for employment expense of supplemental staff (contracted employee for research assistance and dispatch workers) on a trial basis from FY 2017. During FY 2018, 11 employees were supported (for childcare).

Introducing "Premium Friday"

On February 24, 2017, AIST introduced "Premium Friday," a government-led program that encourages employers to allow employees to clock off early on a Friday of each month. AIST employees have been advised to, on each Premium Friday, finish work by around 3 p.m. and leave the office early to the extent of not causing any problems for work. As a result, on Premium Fridays between April 2018 and February 2019, about 20% of employees left work either earlier than usual or on time without overtime. Accordingly, this program can be expected to bring benefits such as motivating employees to identify and adjust their working hours as well as encouraging them to clock off early and take paid leave. In view of that, AIST intends to continue with this program.

➡ Numbers of people who used the various leave programs

	FY2015		FY2016		FY2017		FY2018	
	Male	Female	Male	Female	Male	Female	Male	Female
Leave to care for sick children	116	185	110	192	124	224	139	217
Special childcare leave	43	11	32	11	27	14	42	22
Extended childcare leave*	3	33	4	27	2	38	9	48
Nursing care leave	47	30	51	37	69	45	72	57
Extended nursing care leave*	0	2	1	0	2	4	0	8

*Number of employees starting the leave within the fiscal year

➡ Numbers of employees who used child daycare services (totals)

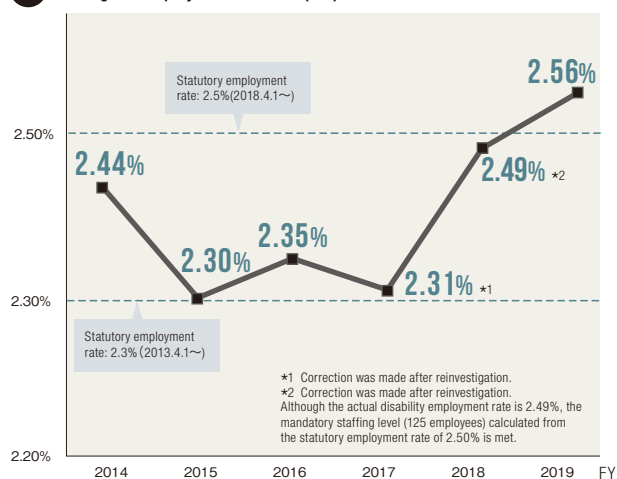|	FY2015		FY2016		FY2017		FY2018	
	Permanent employees	Contract employees	Permanent employees	Contract employees	Permanent employees	Contract employees	Permanent employees	Contract employees
AIST Tsukuba	1,202	864	1,135	1,016	1,872	1,069	1,681	897
AIST Chubu	43	93	7	33	5	112	15	87
AIST Kansai	228	15	190	10	229	5	136	21
Private child daycare facilities and babysitters	13	0	7	1	32	26	41	12

■ Efforts to Hire People with Disabilities

AIST actively hires people with disabilities. In April 2018, the statutory employment rate for people with disabilities was increased to 2.5%. We hired people with disabilities at every opportunity and achieved the statutory employment rate. (The disability employment rate as of June 1, 2019 was 2.56%.)

We create a work environment that helps the physically challenged work with ease and provides support for them in cooperation with each region's Support Center for People with Disabilities. Thus, we aim to increase the percentage of physically challenged people who are taken on as employees and remain at work. (This percentage was 92.38% in FY 2018.)
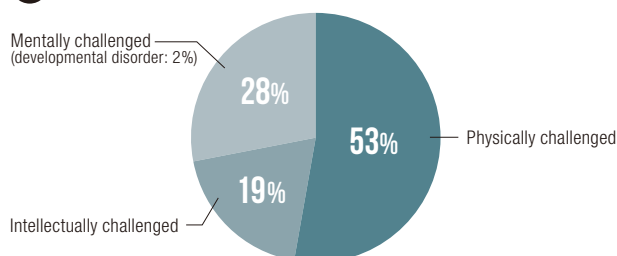
➡ Change in employment rates for people with disabilities (% of June 1 of each year)

Statutory employment rate: 2.5%(2018.4.1~)

2.44%
2.30%
2.35%
2.31% *1
2.49% *2
2.56%

Statutory employment rate: 2.3% (2013.4.1~)

*1 Correction was made after reinvestigation.
*2 Correction was made after reinvestigation.
Although the actual disability employment rate is 2.49%, the mandatory staffing level (125 employees) calculated from the statutory employment rate of 2.50% is met.

2014 2015 2016 2017 2018 2019 FY

➡ Percentages of people with disabilities remaining at work

FY	2015	2016	2017	2018
Number of people at the beginning of the fiscal year	91	87	88	105
Number of people who left AIST within the fiscal year	12	10	11	8
Employee turnover rate	13.19%	11.49%	12.50%	7.62%
Employee retention rate	86.81%	88.51%	87.50%	92.38%

➡ Employment rates by disability type As of June 1, 2018

Mentally challenged (developmental disorder: 2%)
28%
53% — Physically challenged
19%
Intellectually challenged

■ Response to the Disability Discrimination Elimination Act

On April 1, 2016, the Act on the Promotion of Elimination of Discrimination against Persons with Disabilities (Disability Discrimination Elimination Act) was implemented. This law aims to create a tolerant and inclusive society in which everyone can live in peace without being discriminated against because of their disabilities.

In line with the law, AIST put in place a system to promote the elimination of discrimination against people with disabilities; we developed guidelines specifying what attitudes and actions employees should take in dealing with disability issues, and we established consultation services at research bases throughout Japan to provide advice to people with disabilities and those working with them. Moreover, to further deepen employees' knowledge and understanding of the law, we have continued to invite experts to hold study sessions and we have provided an e-learning system.

These initiatives have increased employee awareness and understanding to such a degree that individual employees are now making voluntary efforts to create a society in which persons with disabilities can live with peace of mind. For example, prior to holding an event, the expected participants are asked about their needs and wishes so that we can pay attention suitable for the characteristics of their disabilities; and the facilities on AIST premises used by visitors have been made barrier-free (such as by eliminating level differences of pedestrian passageways and installing tactile paving) based on employee suggestions.

By continuing to work on initiatives like these, AIST employees are expected to give consideration and assistance to persons with disabilities not only at day-to-day work but also in their personal lives.

Eliminating level differences of pedestrian passageways

Installing tactile paving

■ 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 12 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 do cleaning, among other tasks. In 2018, cooperating with the Public Relations Information Office, the team has put copies of PR magazine "AIST LINK" into envelopes and placed address seals on them. The team will try various tasks and hopes to be able to utilize its ability.

File cleaning

Inserting copies of "AIST LINK" magazine into envelopes and attaching address seals

■ AIST Chubu

The AIST Chubu Challenged Team currently has five members and one instructor.

The team's tasks include cleaning and weeding the premises, cleaning meeting rooms, collecting, sorting, and recycling of used paper, and rearranging furniture in preparation for events. The team is active in various other areas, such as helping bind copies of AIST Chubu's public relations magazine.

■ AIST Kansai

The AIST Kansai Challenged Team presently comprises two members and one instructor, working primarily 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, implanting pesticides in trunks, and doing other tasks by hand or using various machinery and tools. When it rains, the members chiefly clean the windows, mop the floors, and shred discarded documents, in the buildings. In addition, upon request from departments of AIST Kansai, the members help out with various other tasks, such as removal of discarded furniture.

Challenged team members

Binding copies of PR magazine

Clearing weeds with a weeder

Weeding

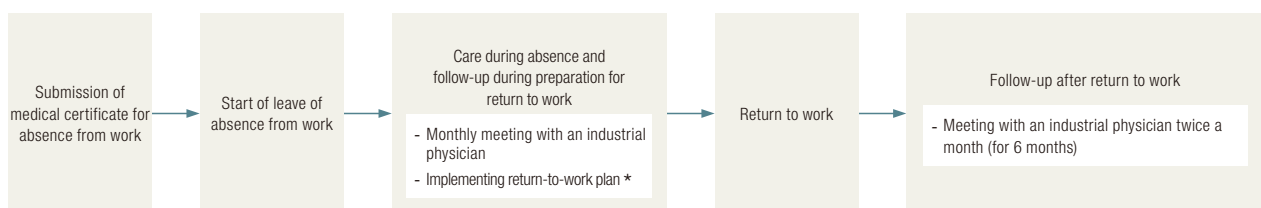## ■ Health Management and Mental Health

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.

From FY 2016 we have introduced 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.

➜ 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

→ Numbers and percentages of permanent and contract employees who underwent periodic medical examinations (including health screening), 2015–2018

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

FY	2015	2016	2017	2018
(1) Employees (excluding (2)) *1	99.6%	99.7%	99.8%	99.9%
	2,978／2,989	3,022／3,031	3,061／3,067	3,065／3,068
(2) Contract employees *2	100%	99.9%	99.8%	99.9%
	2,150／2,150	2,319／2,322	2,436／2,440	2,455／2,456

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

→ Numbers of permanent and contract employees (including temporary employees) who underwent special medical examinations in FY 2017–2018

Top: no. of examinees/ total no. of applicable employees in spring.
Bottom: no. of examinees/ total no. of applicable employees in autumn

FY		2017			2018		
Special medical examination		Permanent employee	Contract employee	Total	Permanent employee	Contract employee	Total
Medical examination for organic solvent poisoning prevention	Spring	758／758	581／581	1,339／1,339	748／748	793／793	1,541／1,541
	Autumn	759／759	614／614	1,373／1,373	735／735	798／798	1,533／1,533
Medical examination for specified-chemical poisoning	Spring	459／459	303／303	762／762	451／451	429／429	880／880
	Autumn	466／466	326／326	792／792	446／446	426／426	872／872
Medical examination for ionizing radiation exposure	Spring	313／313	92／92	405／405	334／334	140／140	474／474
	Autumn	325／325	91／91	416／416	335／335	132／132	467／467
Medical examination for lead poisoning	Spring	13／13	7／7	20／20	9／9	10／10	19／19
	Autumn	14／14	7／7	21／21	9／9	12／12	21／21
Medical examination for laser injury	Spring	272／272	117／117	389／389	298／298	153／153	451／451
	Autumn	43／43	20／20	63／63	40／40	20／20	60／60
Medical examination for pneumoconiosis	Spring	11／11	19／19	30／30	8／8	19／19	27／27
	Autumn	0／0	2／2	2／2	0／0	3／3	3／3
Medical examination for asbestos exposure	Spring	5／5	1／1	6／6	5／5	2／2	7／7
	Autumn	5／5	2／2	7／7	5／5	2／2	7／7

→ Numbers of employees with significant findings from AIST's medical examinations, and numbers of employees who received face-to-face counseling

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

FY		2015	2016	2017	2018
With significant findings (D-diagnosed)	No. of employees	103	117	134	152
	Percentage of employees	2.8%	2.5%	2.2%	3.5%
With significant findings (E-diagnosed)	No. of employees	818	970	907	822
	Percentage of employees	21.0%	20.5%	14.6%	19.1%

② Numbers of employees who received counseling, and their percentages to employees with significant findings

FY		2015	2016	2017	2018
With significant findings (D-diagnosed)	No. of employees who received counseling	71	98	110	123
	Percentage of employees who received counseling	68.9%	83.8%	82.0%	80.9%
With significant findings (E-diagnosed)	No. of employees who received counseling	801	862	791	718
	Percentage of employees who received counseling	97.9%	88.9%	87.2%	87.3%

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 of face-to-face health consultations (FY 2015-2018)

Cases

FY		2015	2016	2017	2018
Industrial physician	Body	2,020	1,651	1,451	1,573
	Mental	587	594	540	551
Industrial health staff		3,655	3,345	3,356	3,850
Total		6,262	5,590	5,347	5,974

→ Flu shots (at AIST)

Persons

FY	2015	2016	2017	2018
AIST Tsukuba/Tokyo	1,912	1,927	1876	1,201
Regional research bases	543	538	664	566
Grand total	2,455	2,465	2,540	1,767

→ Other activities

Persons

FY	2015	2016	2017	2018
Refreshing exercise	243	219	246	192
Walking lessons	–	–	377	175
Emergency first-aid workshop	188	154	80	138
Mental health seminars	73	133	79	115
Workshop (training)	180	407	187	227

04 Fair Operating Practices

Aiming at an organization that is trusted by society, we conduct our activities with sincerity

■ Management of Conflict-of-Interest

Promoting industry- academia -government collaborations and disseminating research achievements are AIST's key missions. However, there may be cases in which our executive or employee has personal interest in a partner organization in one of those collaborations. In that event, their personal interest derived from the collaboration may frequently conflict with their duties and research responsibilities as an executive or employee of AIST, a public research institute, with the result that a conflict of interest arises. In view of that, AIST has set rules and guidelines governing conflict-of-interest management to properly control these conflicts. In doing so, we aim to create an environment in which our executives and employees can advance industry-academia-government collaborations with no worry and to live up to the trust society places in us.

Our executives and employees are asked to declare their own status of conflict-of-interest every fiscal year. In FY 2018, all the personnel subject to this rule (3, 392 people) submitted these declarations. Of these, six personnel were deemed at risk of conflicts of interest and were interviewed by outside conflict-of-interest counselors to look into their activities. Additionally, the Advisory Board consisting of outside experts and the Conflict-of-Interest Management Committee in AIST deliberated and confirmed that there was no concern for problems arising. The six personnel plus those who declared their conflict-of-interest status were provided with advice and guidance on how to promote industry-academia-government collaborations going forward.

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.

Accordingly, when executives and employees intend to conduct medical research that is subject to these guidelines, they are required to make applications and then undergo examination by the Conflict-of-Interest Management Committee for Clinical Research, whose members include outside experts. The committee examined five applications in FY 2018. Concerning three of these cases, the declarants were individually notified of the necessary measures, such as revisions of the experimental plan, how to correspond to persons to be studied, and precautions to be taken in presenting results.

■ Information Security

In order to obtain high-level information security, AIST is strengthening the information network and the management system of information security.

AIST conducts audits and provides training to all users of our information network to improve information security awareness and to enable appropriate use of the network with awareness of responsibility.

■ Information security measures

AIST conducts constant monitoring of external communication and the internal network for suspicious communication.

Additionally, the Computer Security Incident Response Team (CSIRT) has been established to respond promptly to information security incidents.

Furthermore, we have strengthened security by introducing a two-step authentication system to login to the e-mail system.

■ Information security training

AIST requires all users to take information security training that explains the importance of information security and rules on information security once or more every year. By continuing the training, AIST seeks to maintain and improve information security awareness.

■ Information security audit

AIST conducts information security audits every year to objectively evaluate whether management and operation are properly implemented in accordance with the information security policy. In FY 2018, we conducted management audits of 81 units and audits of 34 outsourcing contractors in charge of AIST network management.

■ Implementation of Security Export Control

The security export control is an important effort in maintaining peace and security in the international community. In Japan, in addition to the regulations on weapons trade itself, the export of goods and transfer of technologies that may be used for the development and manufacture of weapons are regulated according to the "Foreign Exchange and Foreign Trade Act" to prevent the proliferation of weapons of mass destruction and excessive accumulation of conventional weapons. Therefore, companies and institutions that may develop relationships with overseas companies and institutions must have tight export control.

In FY 2004, AIST formulated Rules for the Security Export Control and gave notification of them under the title "Internal Compliance Program" to the Ministry of Economy, Trade and Industry. In accordance with these rules, we have tight security export controls in place.

Security Export Control activities include: (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.

In recent years, as more international research cooperation is encouraged with foreign institutions and universities, there has been an increase in the importance of raising awareness of security export control among employees. Accordingly, security export control is in place as mentioned above, and individual employees are now fully aware of security export control.

AIST will continue to promote further implementation of security export control in the future to maintain peace and safety as a member of the international community.

Training in export control within AIST

■ Promoting Rational Procurement

Each year, we formulate and announce AIST Rational Procurement Policy, in compliance with the May 25, 2015 decision of the Minister for Internal Affairs and Communications on the promotion of measures to rationalize incorporated administrative agencies' procurement. Our policy aims to 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. To that end, it details the measures we take to establish internal controls and prevent misconduct relating to negotiated contracts, and specifies the indicators appropriate to assessing these measures. To ensure the implementation of this policy, we have set up a Contract Oversight Committee, whose members include outside experts, to have individual contracts inspected ex post. The summarized proceedings of the committee's meetings are also disclosed.

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. The results are publicized and reported to the competent minister.

■ Implementing Market Testing

In accordance with the Basic Policies on Public Service Reform adopted by the Cabinet on July 15, 2011, AIST Tsukuba combined eight services relating to its facility management into one procurement contract, which was implemented for three years from FY 2012 to 2014.

From FY 2015 onward, to make procurement even more competitive, this one contract covering eight services was divided into the following five contracts from the perspective of optimization: (1) maintenance and management of AIST Tsukuba facilities, (2) management of trees and vegetation on AIST Tsukuba premises, (3) safeguarding and cleaning of AIST Tsukuba buildings, (4) operation and management of the Research Collaboration Center, the Science Square Tsukuba, and the Geological Museum, and (5) driving, maintenance, and management of AIST Tsukuba vehicles. These contracts were implemented for three years through FY 2017.

By optimizing these services through division into five contracts, a number of benefits have been obtained in terms of service quality, the primary ones for FY 2017 being listed on the right.

Maintenance and improvement of the quality of services

- Understanding each other's work (holding work report meetings)
- Ensuring safety
- Ensuring continuity of work
- Being environmentally friendly
- Ensuring a comfortable facility environment

Average satisfaction rates in a questionnaire survey of facility users:

• Operation and management of the Research Collaboration Center (Sakura Kan)	**98%** (recommended minimum approval rate 90%)
• Operation and management of the Research Collaboration Center (Keyaki Kan)	**99%** (recommended minimum approval rate 90%)
• Operation and management of Science Square Tsukuba	**97%** (recommended minimum approval rate 90%)
• Operation and management of the Geological Museum	**98%** (recommended minimum approval rate 90%)

05 Community Involvement

> ## Promoting social applications that are firmly rooted in local communities

■ AIST Design School

This is said to be the age of VUCA (volatility, uncertainty, complexity and ambiguity), an age in which it is unclear what things should be created and what issues should be addressed with R&D. The question is no longer just "how do we make it" but also "what do we make, and why?" In 2018, with the goal of making researchers and engineers in AIST and businesses into talented personnel who can drive social innovation, AIST launched the AIST Design School and a project to search for pathways to apply technology in society. The AIST Design School Preparatory Office (from July 2019, the AIST Design School Office) is located and operates at AIST Kashiwa, a new research base.

At AIST Design School, students identify and define social problems, and test and study the exploration and implementation (as design processes) of solutions in communities and regions. Accordingly, importance is placed on collaboration with the Kashiwanoha Campus neighborhood, and the final fruits of design processes are implemented as "things" in the area. The school held a graduation exhibition in FY 2018.

■ Graduation studies exhibition: When the city meets the researcher

Three teams independently identified themes from the results of tests and study of design processes.

The teams designed and conducted workshops, talk sessions and the like. David Sim, creative director of Gehl Architects in Denmark, was invited for a special project. He conducted a town-walking workshop on the topic of "the Soft City making life easier for people."

■ Theme 1: Measure whatever! Everyone examines their own data in the IoT age

The team conducted a light talk session on the theme of "my data" in the age of the Internet of Things (IoT). They invited panelists, who discussed the theme: Suzuki Masatomo, professor of law at Niigata University Graduate School of Modern Society and Culture, who is an expert on personal information; researchers from AIST's Human Augmentation Research Center; and the NPO Village Support, which runs local activities in Kashiwa City.

◾ Theme 2: Building relationships through dancing robots!? Imagining the future of Kashiwanoha through exchanges between high school and elementary school students

On the theme of collaboration between different generations, the team held workshops in which high school students learned how to use robots, passed their learning on to elementary school students, and the students together imagined the robots of the future.

◾ Theme 3: Our exciting lives in the town of the future: Imagining, creating and presenting Kashiwanoha

On the theme of collaboration in a town with changing generations, the team conducted workshops about using experience design to make the future Kashiwanoha a town that children want to live in. The workshops were held in spaces comfortable for both children and adults, outside of both school and the home. In the workshops, children outlined various technological ideas and presented texts and drawings of "exciting lives." The children used a range of materials such as cardboard, paper, and fabric to give form to the concept "exciting." These "exciting lives" were presented in the exhibition with the children's own words.

◾ AIST Hometown Supporters

AIST Hometown Supporters is a new scheme, launched in FY 2018, to make connections between the regions and AIST. AIST staff attend a range of events inside and outside AIST in the prefectures of their own regions. The main activities include supporting to run events and giving lectures.

In FY 2018, over 200 hometown supporters registered, spread across every prefecture, and about 40 activities were conducted. Within the AIST, the activities included helping with open days at regional centers and introducing AIST to students on field trips at Science Square Tsukuba. Outside the AIST, they included lectures by invitation at local public facilities.
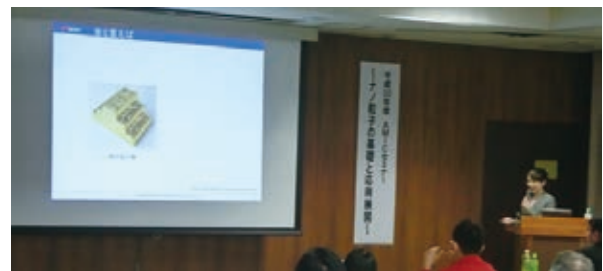
An invited lecture

A lecture at an open day

Meeting visitors at Science Square Tsukuba

● AIST Hometown Supporters website:
https://unit.aist.go.jp/rcpd/furusapo/

06 Human Rights

We create an environment where all those related to AIST treat each other with respect.

■ Respect for Basic Human Rights

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

From the "Compliance Guideline"

Paragraph 1: Respect for human rights
– We respect human rights. We do not say or act in any way that ignores human rights.
❶ We respect basic human rights. We do not discriminate against people on the basis of race, nationality, age, sex, religion, belief, or social status.
❷ We do not say or act in any way that ignores human rights, including by harassment.

■ Protecting Human Rights in Research

AIST conducts research involving human subjects, which are categorized into ergonomic research and medical research. The latter is 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 2018, we implemented 42 new and 164 ongoing research projects involving ergonomic experiments; 26 new and 85 ongoing research projects involving experiments with human derivative samples; and five new and four ongoing research projects involving applied biomedical engineering experiments.

Prior to conducting an ergonomic experiment, the experimental protocol is reviewed by the Committee on Ergonomic Experiments, which includes five 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 mentioned above, by either the Committee for the Ethics on the Applied Biomedical Engineering and Technology or the Committee for the Ethics on the Experiments with Human Derivative Samples, which include 13 and 12 external members, respectively. In addition, we have the Conflict-of-Interest Management Committee for Clinical Research in place, which was set up in FY 2016 to examine solely conflicts of interest in medical research. This committee reviewed five cases in FY 2018.

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.

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★Subtitled "Ethical Principles for Medical Research Involving Human Subjects," this is a code of conduct 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 hurts the dignity of the person being harassed and causes emotional distress and disadvantage. Conversely, if a person who conducted an act of harassment with no intention to do so is held responsible for that act, he or she may suffer from adverse health effects. The presence of harassment may lead to deterioration in the work environment, reduced motivation to work, and 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, a higher-level 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 2018

Training program	Trainees	Objectives	Number of trainees in FY 2018
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.	122
e-learning training for employees	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.	5,895
e-learning training (English)	Foreign researchers and contract employees who have difficulty in understanding Japanese	Same contents as e-learning training (in English)	162
Harassment Counselor and Sexual Harassment Counselor Training	Harassment counselors, sexual harassment counselors, and counselors for pregnancy, childcare, eldercare harassment	Participants learn the harassment prevention knowledge and skills required by counselors. These include face-to-face counseling techniques based on lectures and role-play sessions.	39
Harassment Prevention Seminar	AIST employees who wish to attend the seminar	Participants learn the basics of harassment issues and harassment prevention through lectures and work.	369

→ Flow of the counseling process
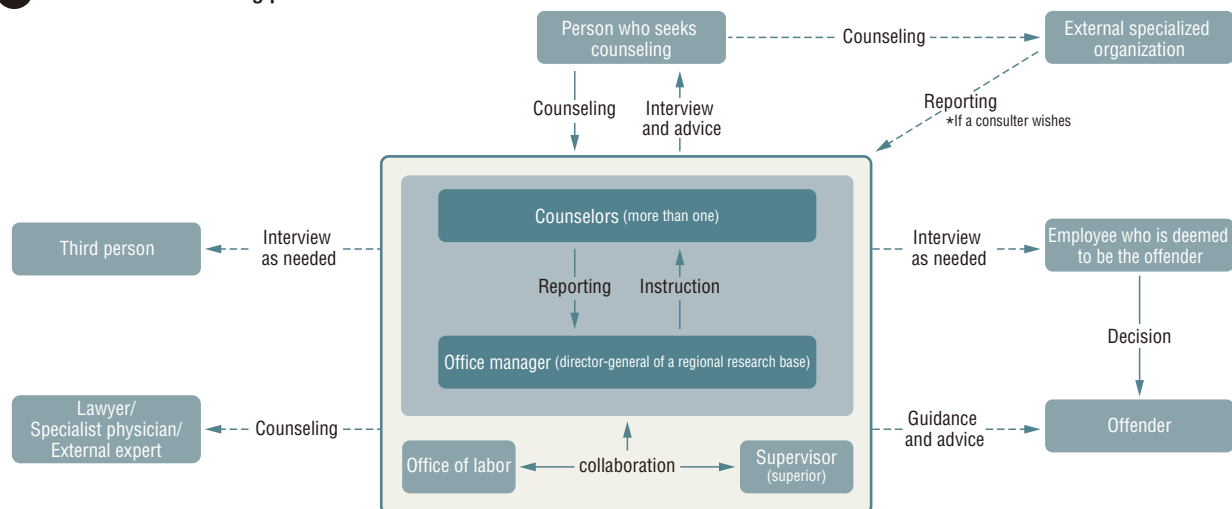
★Those who seek counseling can include people other than the employees involved (i.e. they can be the employee who is deemed to be the offender, the employee who is deemed to be the victim, or someone else, such as a colleague or supervisor). ★Counseling can be sought by means of a face-to-face meeting, 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.

■ Raising Awareness and Taking Steps to Promote Diversity

Utilizing a diverse workforce is essential to pursuing creative research and building vibrant workplaces. To provide a working environment that embraces the values and ideas of employees with various backgrounds, whether gender, age, or nationality, AIST formulated in October 2015 its Measures to Promote Diversity in the Fourth Medium- to Long-Term Target Period. To achieve these measures, we have devised and taken various steps under five action plans concerning: (1) proactively hiring female researchers and making the most of their abilities, (2) supporting foreign researchers in their recruitment and work, (3) achieving work-life balance, (4) developing careers, and (5) comprehensively promoting diversity.

AIST has set the goal of at least 18% of researchers it hires being female during the fourth medium- to long-term target period (FY 2015 to 2019), which is higher than the 16.7% achieved for the third target period (FY 2010 to 2014). We have achieved our goal and the percentage as of April 1, 2019 was 19.0%. To increase the percentage of female researchers hired by AIST, we are working to attract more applicants, by assisting students with career exploration, holding a round table talk of female science students and AIST's female researchers, and organizing laboratory tours. Through these and other means, we strive to discover talented students and hire them proactively. During FY 2018, events for female students were held at AIST Tsukuba. They were attended by 46 university students nationwide, some of whom were inspired by these events and are now engaged in research at AIST. We have also achieved our goal of at least 5% of our managers being female by the end of the fourth target period, and the percentage as of the end of FY 2018 was 6.3%.

To instill and raise diversity awareness, we proactively hold seminars and training for employees. Newly hired employees and group leaders learn about diversity promotion as part of their training, with a view to building a better understanding about diversity among all employees, both male and female. Moreover, in FY 2018 AIST Tsukuba provided a training program encouraging career advancement for their interested personnel. Employees are also encouraged to take external career-development training offered by various providers, as a means of supporting their career advancement.

In addition, 7 gender-neutral toilets were set up in Cyber-Physical-System Research Facility at AIST Waterfront. We try to make a pleasant working environment for people of all attributes regardless of gender or sex.

As a managing institution of the Diversity Support Office, a consortium of Japanese research and educational institutions aimed at enhancing cooperation and promoting diversity even more strongly, AIST organizes information exchange meetings, among other duties. In FY 2018, we acted as the chair. Also, AIST, in partnership with the University of Tsukuba and IBM Japan, was selected by MEXT as a collaboration-type program under its Fiscal 2016 Initiative for Realizing Diversity in the Research Environment. Supported by this initiative that subsidizes projects designed to develop human resources in science and technology, AIST, together with the two partner organizations, continues working to further advance our action plan under the Act on the Promotion of Female Participation and Career Advancement in the Workplace. AIST was awarded a Grade 3 (the highest grade) Eruboshi certification by the government in September 2016 in accordance with the above-mentioned Act, and annually discloses information on women's participation in our activities. We will continue to drive diversity through various measures.

Gender-neutral toilet (Cyber-Physical-System Research Facility, AIST Tokyo Waterfront)

The Eruboshi logo: certification mark Level 3

■ Supporting Foreign Researchers

To build a working environment friendly to non-Japanese researchers, AIST provides work support and information in English.

The AIST International Center (AIC) provides foreign researchers with guidance, consultation, and assistance in English, among other services, to help them live and work in Japan. The service most frequently requested from foreign researchers is to act as their proxy in filing applications with the Mito Branch Office of the Tokyo Regional Immigration Bureau. In FY 2018, acting as proxy for foreign researchers, AIC filed 121 applications for extension of period of stay and others, which accounted for more than two thirds of all the applications it filed. Moreover, in FY 2018, there were 27 inquiries concerning points-based preferential treatment for highly skilled foreign professionals promoted by the Ministry of Justice.

A favorably reputed service is the Japanese language classes, and in FY 2018, a total of 38 foreigners took these classes. Foreign researchers having a busy schedule find it highly convenient to be able to take Japanese language lessons at AIST. Additionally, flower arrangement and tea ceremony classes are provided for foreign researchers and their family members.

To help foreign researchers work to their best, we hold AIC seminars in which internal rules and programs are explained to foreign researchers in English, collaborating with relevant departments. In FY 2018, we held seminars on childbirth, childcare, and year-end tax adjustment and others, and a total of 46 persons attended. Most gave positive feedback while some requested for seminars to be held on other internal programs.
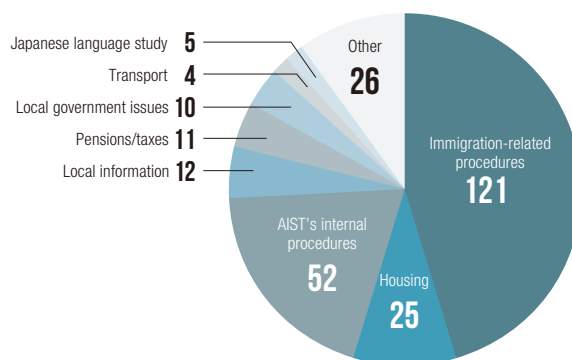
As a means of information provision, AIC Newsletter has been electronically distributed, almost monthly, since October 2015. The number of subscribers has exceeded 100. Having issued 38 times by the end of FY 2018, the newsletter provides a variety of information in English in a timely manner, covering such topics as timetables for helping file applications for extension of period of stay, upcoming AIC events, after-event reports, and links to webpages detailing AIST programs.

On the AIST English website, we have added a section that offers information helpful to those living or staying around AIST Tsukuba so that visitors from outside Japan and foreign researchers working at AIST can quickly obtain useful information. We also work to enhance the English pages on AIST's intranet, by monitoring its content and sharing information with relevant departments. For foreign researchers whose Japanese proficiency is not yet sufficient, we offer e-learning courses in English to familiarize them with AIST's organization, ethics, and rules.

Together with relevant departments, we provide integrated assistance, ranging from support for living and working in Japan to language help.

→ Breakdown of consultations in FY 2018

Japanese language study **5**
Transport **4**
Local government issues **10**
Pensions/taxes **11**
Local information **12**
Other **26**
Immigration-related procedures **121**
AIST's internal procedures **52**
Housing **25**

Closing ceremony of the Japanese language course

The flower arrangement course

AIC seminar

07 Environmental Report

AIST has a Charter of Environment and Safety in place and promotes environment-conscious activities.

■ 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.

■ Charter of Environment and Safety

- We promote research that helps to conserve the global environment and human safety; we aim to realize a safe, secure, and high-quality life and a society in harmony with the environment.
- We comply with laws and regulations on environment and safety, set our own standards such as guidelines, and seek to increase efforts for environmental protection and promotion of health and safety on a daily basis.
- We actively disseminate information on environment and safety and seek to achieve harmony and integration with local communities. We take prompt and appropriate actions in the event of an accident or disaster and seek to

pass on the lessons learned to society under the principle of disclosure.

■ 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.

■ Environmental Compliance

We aim to promote AIST's compliance with laws and regulations, social norms, internal codes of conduct for researchers, and internal rules, and to realize AIST's motto, "in society, for society".

We take the following environmental protection actions to help protect the global environment and create a sustainable society.

1. We comply with international environmental regulations and regulations of the national and local government, and we work to prevent pollution and conserve the natural environment.
2. We promote research that helps to protect the global environment and human safety, and we proactively work to improve energy efficiency, conserve natural resources, and recycle resources.

Topics: ABCI, an Energy Efficient Large-Scale AI Cloud Computing System

The AI Bridging Cloud Infrastructure (ABCI) is a large-scale, energy-efficient cloud computing system capable of high-level artificial intelligence processing. It has been built in the AI Data Center at AIST Kashiwa and started operations on August 1, 2018. ABCI is equipped with 4352 high-performance, energy-efficient graphics processing units. Through direct cooling of arithmetic processing units and other devices with water at a temperature close to the temperature of outside air, it achieves a world top-class power usage effectiveness (PUE).

Generally, large amounts of electricity are required for cooling to remove heat produced from computing systems in data centers. In the case of ABCI, it was essential to realize a data center with very high energy efficiency, enabling high-density mounting to withstand a power consumption of 70 kW per computing server rack and energy-efficient operations with a yearly average PUE of 1.1 or less. Instead of specialized technologies for supercomputers, commodity technologies devised for rapid technology transfer to commercial data centers were adopted to design from zero a dedicated data center for ABCI that can be found nowhere else.

In conventional data centers, computing systems are cooled indirectly by cool air at 20°C or below blowing up from beneath the floor. In ABCI, however, cooling water is used with a specified maximum temperature of 32°C. Free cooling operations are possible throughout the year and, with a cutting-edge cooling system that uses this high-temperature cooling water and combines direct water-cooling with indirect water-cooling (a system that uses overhead air conditioning to exchange waste heat with the water indirectly), energy efficiency is greatly improved. As a result, in the Green500 list that shows PUE values of supercomputers, ABCI was ranked third in the world (first in Japan) in June 2019.

Terminology

●Green500 List

A list ranking the power usage effectiveness (benchmark speed performance value/power consumption) of supercomputers from position 1 to position 500. https://www.top500.org/green500/

●Graphics Processing Unit （GPU）

These were originally dedicated processors for computer graphics. As graphics processing has become more complicated, the performance and versatility of GPUs have increased, and they have evolved into general-purpose vector/array processors for high-performance computing. They are used widely to accelerate deep learning.

●Power Usage Effectiveness (PUE)

An index representing the efficiency of power use in a data center. Power consumption for the whole data center is divided by the power consumption of actual computing equipment such as servers. The closer the value is to 1.0, the better.

●Free cooling

A system that employs outside air in a cooling unit to produce relatively high-temperature cooling water for use in cooling. The system does not use a refrigeration unit with high power consumption, thus providing a large energy-saving effect.

The AI Data Center

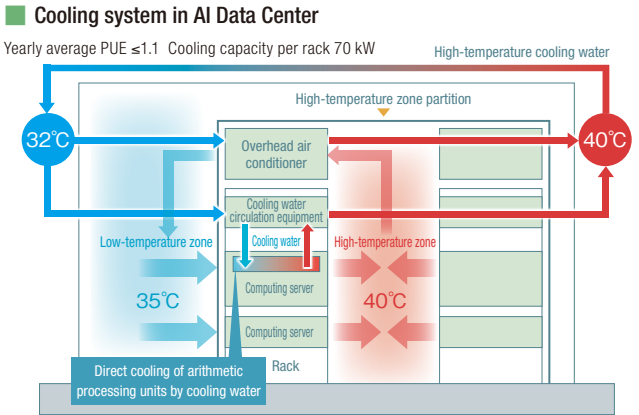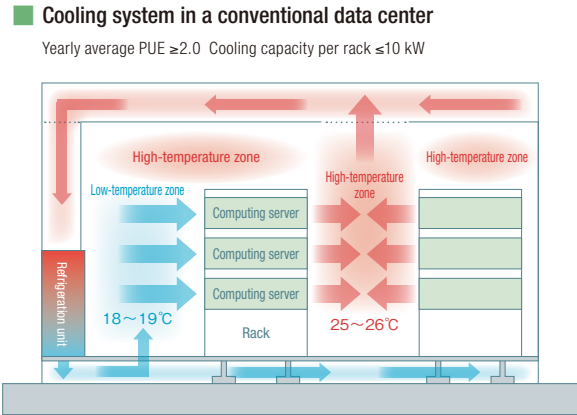Inside a server room in the AI Data Center

Equipment outside the AI Data Center
(R: AI Data Center, L: cooling units)

→ **Comparison of cooling systems of a conventional data center and the AI Data Center**

■ Cooling system in a conventional data center

Yearly average PUE ≥2.0 Cooling capacity per rack ≤10 kW

■ Cooling system in AI Data Center

Yearly average PUE ≤1.1 Cooling capacity per rack 70 kW

■ Environmental Targets and Results

Major environmental targets and results are summarized below. Details of the content and results for each item are available on the relevant pages.

→ Environmental Targets and Results

CO₂ emissions (details on p. 57)	
Target:	Reduce by average of 4% compared with FY 2014 over three years from 2017 to 2019 (target value: 119,000 t-CO₂)
Result:	109,700 t-CO₂ in FY 2018 (◎)

Promotion of green procurement (details on p. 55)	
Target:	100% procurement rate for designated procurement items
Result:	100% procurement rate for designated procurement items (○)

Promotion of green contracts(details on p. 56)	
Target:	Sign a qualified contract for power supply and industrial waste disposal in principle
Result:	Signed a qualified contract for power supply and industrial waste disposal in principle (○)

★A qualified contract based on the environmental threshold system

This is a bidding system with screening by the sum of score points of carbon dioxide emission coefficient, unutilized energy usage, new energy usage, and planned amount of green power certificate to be transferred to the purchaser. The bidder that has a certain total score that surpasses the threshold and presents the lowest price has the right to enter into the contract.

■ Overview of Environmental Burdens

AIST assesses the environmental burdens generated by its activities so as to reduce these burdens and pay due care to the environmental effects of its activities. The tables below show the amounts of energy used and waste released through AIST's activities.

→ Amounts of energy used and waste released by AIST's activities

( ): FY 2018 results

INPUT

Energy   2,049TJ (2,223TJ)

Electricity	211,530 MWh	(206,251MWh)
Renewable energy (generated at AIST)	2,073 MWh	(2,140MWh)
City gas	3,265 thousand m³	(4,563 thousand m³)
Propane gas	950kg	(1,400kg)
Liquid fuel	39kL (30kL)	
Purchased energy	17TJ (18TJ)	

Resources

Clean water	937 thousand m³	(968 thousand m³)
Groundwater	14t housand m³	(16 thousand m³)

REUSE / RECYCLE

Recycled water	920 thousand m³	(1,032 thousand m³)
Equipment, materials, etc. (reused at AIST)	785 cases	(572 cases)

OUTPUT

Atmospheric emissions

Greenhouse gases	110 thousand t-CO₂	(109 thousand t-CO₂)
NOx	2.02t	(2.69t)
SOx	0.02t	(0.02t)

Waste

Specially controlled industrial waste	478t	(399t)
Industrial waste	1,689t	(1,305t)
Non-industrial waste	602t	(567t)

Aquatic emissions

Sewerage discharges	888 thousand m³	(872 thousand m³)
Public waters	19 thousand m³	(19 thousand m³)

Water quality

BOD 699kg (1,095kg)		Nitrogen 513kg (770kg)	
COD 748kg (806kg)		Phosphorus 81kg (53kg)	
Suspended substances 465kg (555kg)			

■ Rationalization of Energy Use

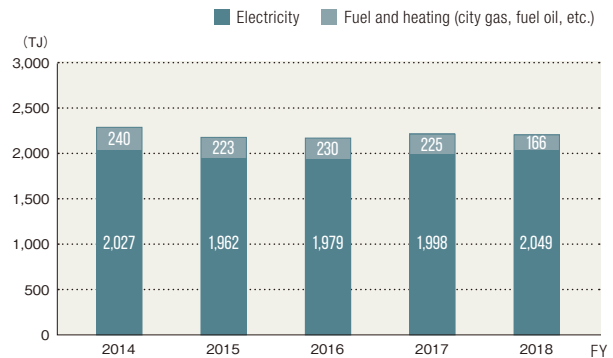AIST, as a specified business stipulated by the Act on Rationalizing Energy Use, promotes the rationalization of energy use. Although the five-year rolling average of base unit energy consumption was 99.2%, above the benchmark of 99% given in the act, the amount of energy used in FY 2018 was 0.3% less than in the previous year. In business evaluations by class published by the Agency for Natural Resources and Energy (Ministry of Economy, Trade and Industry), AIST is recognized as an A class organization. We will continue to strive for energy savings.

➔ Changes in amounts of energy used

■ Electricity　　■ Fuel and heating (city gas, fuel oil, etc.)

(TJ)

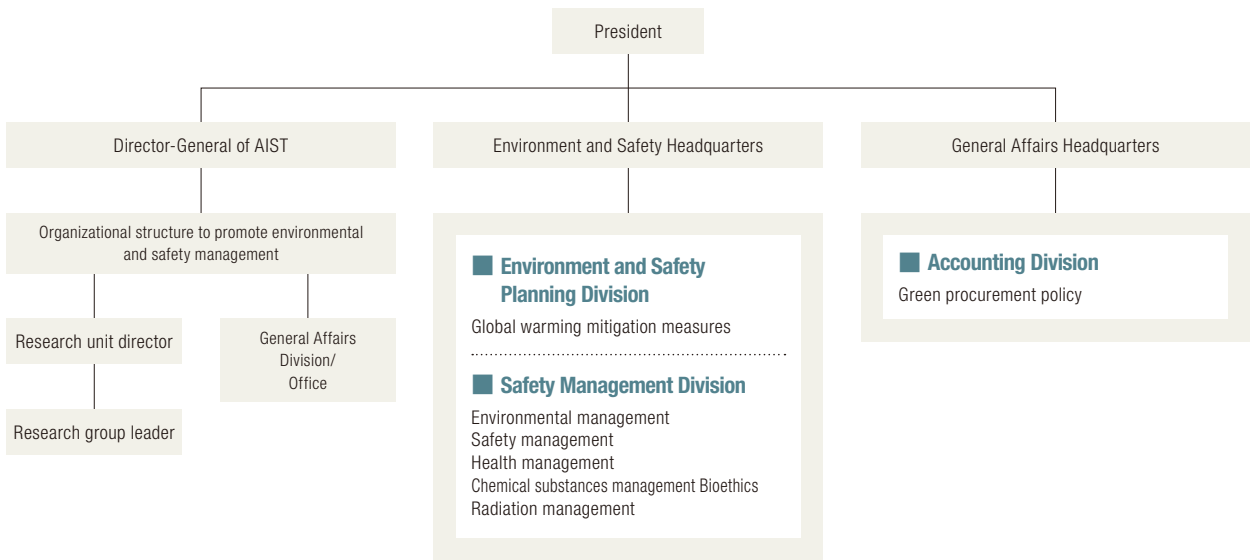| FY	Fuel and heating	Electricity
2014	240	2,027
2015	223	1,962
2016	230	1,979
2017	225	1,998
2018	166	2,049

■ Management Structure

AIST's headquarters organizations (Environment and Safety Headquarters and General Affairs Headquarters) and operating units work together closely to implement our environmental policies and environmental initiatives covering the whole of AIST.

The Environment and Safety Headquarters determines policy for the reduction of greenhouse gas emissions—an ongoing issue—and the General Affairs Headquarters develops and monitors AIST's green procurement policy.

These policies are embodied in the implementation plans of each regional research base and site under the leadership of the Director-General.

➔ Structure for environment and safety projects

President

Director-General of AIST

Organizational structure to promote environmental and safety management

Research unit director

Research group leader

General Affairs Division/ Office

Environment and Safety Headquarters

■ **Environment and Safety Planning Division**

Global warming mitigation measures

■ **Safety Management Division**

Environmental management
Safety management
Health management
Chemical substances management Bioethics
Radiation management

General Affairs Headquarters

■ **Accounting Division**
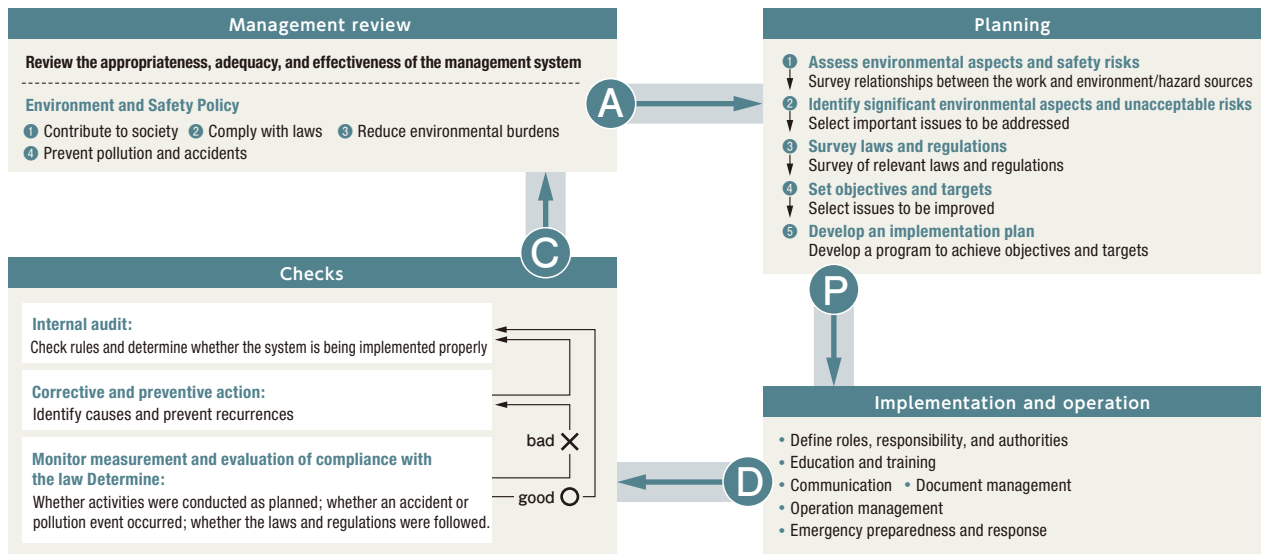
Green procurement policy

■ Environmental and Safety Management System

AIST has its own environmental and safety management system (ESMS) in place. It combines two subsystems: an environmental management system to reduce the environmental impacts of its activity and preserve the natural environment and an occupational health and safety management system to reduce potential risks in the workplace and improve health and safety.

In FY 2018, we conducted an internal audit of the environment and safety at each research base and site, and we checked implementation of the environmental and safety management program (ESMP). The results are reflected in the ESMP of FY 2019, and we aim at the upward spiral of the environmental and safety management.

→ Structure of AIST's environmental and safety management system

Management review

Review the appropriateness, adequacy, and effectiveness of the management system

Environment and Safety Policy
❶ Contribute to society ❷ Comply with laws ❸ Reduce environmental burdens
❹ Prevent pollution and accidents

Planning

❶ Assess environmental aspects and safety risks
  Survey relationships between the work and environment/hazard sources
❷ Identify significant environmental aspects and unacceptable risks
  Select important issues to be addressed
❸ Survey laws and regulations
  Survey of relevant laws and regulations
❹ Set objectives and targets
  Select issues to be improved
❺ Develop an implementation plan
  Develop a program to achieve objectives and targets

Checks

Internal audit:
Check rules and determine whether the system is being implemented properly

Corrective and preventive action:
Identify causes and prevent recurrences

Monitor measurement and evaluation of compliance with the law Determine:
Whether activities were conducted as planned; whether an accident or pollution event occurred; whether the laws and regulations were followed.

bad ✕
good ○

Implementation and operation

• Define roles, responsibility, and authorities
• Education and training
• Communication • Document management
• Operation management
• Emergency preparedness and response

■ Environmental Education

AIST provides environmental education 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—to new employees and those who have joined AIST under the industry-academia -government exchange program, the international exchange program, and dispatched workers. We are continuing to enhance our environmental education and training.

■ Green procurement and other initiatives

When AIST purchases products, parts, and materials needed for R&D or outsources processing and prototype manufacturing, among other tasks, consideration is given not only to the quality and prices of goods and services but also to their environmental impact. In this way, we advance green procurement (contract) that gives priority to goods and services that have less impact on the environment. To promote this practice, each year AIST discloses its policy for promoting the procurement of eco-friendly goods and services,[*1] 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 government's Basic Policy for Promotion of Procurement of Eco-friendly Goods and Services.

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.[*2]

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.

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*1 : For more information, please visit our website.
　　https://www.aist.go.jp/aist_j/procure/kouhoyou/green/

*2 : For more information, please visit our website.
　　https://www.aist.go.jp/aist_j/procure/kouhoyou/syuroshisetsu/

■ Status of procurement of eco-friendly goods

In FY 2018, AIST purchased 275 items in 21 categories among the 241 items in 20 categories designated in the Green Purchasing Act (types of eco-friendly goods and services to be preferentially purchased by the government and other organizations). Excluding two items (media storage cases, vehicles (excluding general official vehicles)) because of their required functions and performance, AIST achieved 100% procurement rate for each designated procurement item (i.e. those that met

➜ **Purchase results of major designated procurement items**

Area	Item		Target	Total quantity purchased	Purchase of specified purchase items	Target attainment
Paper	Photocopier paper		100%	101,191.9kg	101,191.9kg	100%
	Forms		100%	353.2kg	353.2kg	100%
	Coated paper for inkjet color printers		100%	510.9kg	510.9kg	100%
	Toilet rolls		100%	15,075.8kg	15,075.8kg	100%
	Tissue paper		100%	12,345.9kg	12,345.9kg	100%
Stationery	Mechanical pencils		100%	753	753	100%
	Mechanical pencil leads		100%	512	512	100%
	Ballpoint pens		100%	13,583	13,583	100%
	Marker pens		100%	17,090	17,090	100%
	Media cases		100%	967	725	75%
	Glue (including glue sticks and glue pouches)		100%	2,325	2,325	100%
	Adhesive tape		100%	798	798	100%
	Files		100%	143,139	143,139	100%
Office furniture, etc.	Chairs		100%	1,196	1,196	100%
	Desks		100%	601	601	100%
Copying devices	Photocopiers, etc. [*3]	Purchased	100%	6	6	100%
		Leased/rented (new)		106	106	
		Leased/rented (extension)		0	0	
	Scanners	Purchased	100%	145	145	100%
		Leased/rented (new)		0	0	
		Leased/rented (extension)		0	0	
	Toner cartridges		100%	6,543	6,543	100%
	Ink cartridge		100%	4,112	4,112	100%
Office equipment	Paper shredders	Purchased	100%	54	54	100%
		Leased/rented (new)		0	0	
		Leased/rented (extension)		0	0	
Vehicles, etc.	Non-general official vehicles	Purchased	100%	2	2	67%
		Leased/rented (new)		4	2	
		Leased/rented (extension)		0	0	
Fire extinguishers	Fire extinguishers		100%	88	88	100%
Services	Passenger transportation		100%	1,654	1,654	100%

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

the criteria established by the government for items that reduce environmental loads). The environmental loads are also considered in purchasing eco-friendly products (such as trash bags) that are not designated procurement items.

As of April 2019, of the 61 AIST-owned vehicles for business (including research), 7 are hybrid vehicles, 1 is a plug-in hybrid vehicle, and 4 are electric vehicles. In replacing the automobiles, preference will be given to hybrid and low-emission vehicles.

■ Green Contract Activities

When signing contracts with contractors and suppliers, AIST promotes a green contract that takes into consideration reduction of greenhouse gases on the basis of the "Act on Promotion of Contracts of National Governments and Other Entities Involving Due Care for Reduction of Greenhouse Gas Emission (Green Contract Act)." In FY 2018, we signed the following green contracts.

For automobile purchases, we evaluated the price and environmental performance (fuel economy) of 9 vehicles for lease in a comprehensive evaluation bidding system in which the bidder with the highest rating entered into the contracts.

For contracts for power supply, we adopted the environmental threshold system at AIST Tsukuba Central and East, AIST Tsukuba West, AIST Tsukuba North, AIST Tohoku, Fukushima Renewable Energy Institute, AIST Tokyo Waterfront, AIST Chubu, AIST Kansai, and AIST Shikoku.

The system was also adopted for 18 industrial waste contracts for collection, transport, and disposal.

Number of green contracts

Type of green contract	Number of cases
Automobile purchase	9
Contract for power supply	8
Industrial waste	18

Actions against Global Warming

AIST has set a target and an implementation plan for reducing greenhouse gas emissions as part of the effort to reduce environmental burden substances generated by our operations. In FY 2018, AIST promoted research facility integration to achieve the target in the Fourth Medium- to Long-Term Plan of reducing greenhouse gas emissions from the FY 2014 level by 4% averaged over the three years FY 2017 to FY 2019. As a result, AIST achieved an 11.1% reduction in greenhouse gas emissions compared with FY 2014.

In December 2016, in response to a plan for government measures to reduce greenhouse gas emissions[*1]

approved by the Cabinet in May 2016, the Ministry of Economy, Trade and Industry adopted a plan for specific measures.[*2] The ministry's plan sets a target of reducing total greenhouse gas emissions by 40% from the FY 2013 level by FY 2030, with a medium-term target of a 10% reduction by FY 2020. AIST is working on a medium- to long-term energy efficiency plan to achieve these targets.
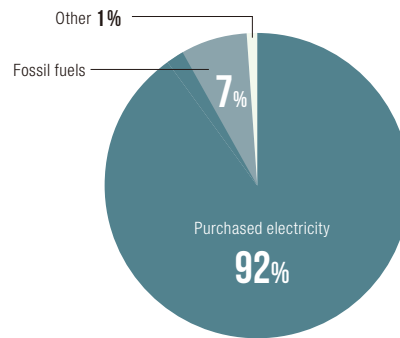
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[*1] : Full title, "Plan specifying measures to be taken by the government to reduce greenhouse gas emissions associated with the government's administrative operations and activities" (cabinet decision, May 13, 2016)

[*2] : Full title, "Plan specifying measures to be taken by the Ministry of Economy, Trade and Industry to reduce greenhouse gas emissions with the Ministry's administrative operations and activities"

Changes in CO_2 emissions by year

(thousand t-CO_2)

119 (target)

2014	2015	2016	2017	2018
124	113	112	109	110
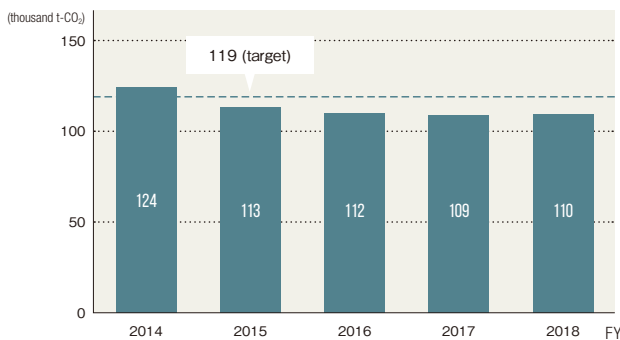
Breakdown of sources of CO_2 emissions

Other 1%
Fossil fuels 7%
Purchased electricity 92%

Reducing CO_2 Emissions by Using Renewable Energy

AIST has installed solar power generation facilities at AIST Tsukuba and also at AIST Tohoku, AIST Fukushima, AIST Tokyo Waterfront, AIST Chubu, AIST Kansai, AIST Chugoku, and AIST Kyushu. Our existing solar power systems are being used effectively, and solar and other renewable energy systems have been installed

in our new buildings, such as the Social Innovation Research Building at AIST Kashiwa, and the Cyber-Physical-System Research Facility at AIST Waterfront, both completed in FY 2018.

The amount of solar power generated in FY 2018 was 1843 MWh. This is equivalent to the annual power use of 512 households and helped reduce CO_2 emissions by 786 t/year. Wind power generation by AIST was 229 MWh and helped reduce CO_2 emissions by 121 t/year. In total, AIST generated 2073 MWh of renewable energy. This is equivalent to about 1% of total electricity consumption.

Progress in renewable energy generation and CO_2 emissions reduction

■ Solar power-generated electricity (MWh) ■ Wind power-generated electricity (MWh)
○— CO_2 emissions reduction effect(t)
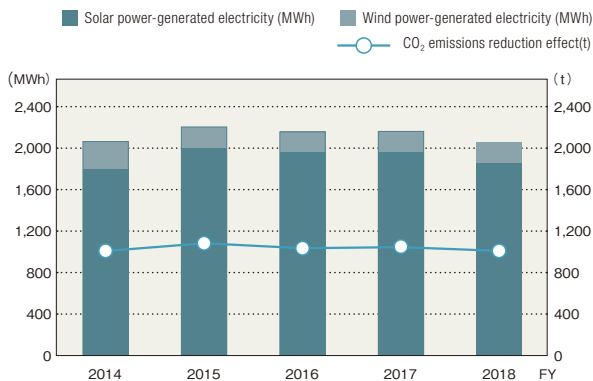
The solar power generation system at AIST Chubu

■ Appropriate Management of Chemical Substances

As AIST conducts research, it uses a wide variety of chemicals, usually in small quantities. Chemicals are properly used and stored to prevent fume releases, fires and leaks, and are properly treated for disposal.

■ Treatment of liquid waste and effluent gases after the use of chemicals

Liquid waste:

At AIST Tsukuba, inorganic liquid waste is rendered harmless in the treatment facility on the premises and is then discharged into the public sewerage system. AIST Tsukuba has outsourced the disposal of all organic liquid waste to an industrial waste treatment service provider since 2013. Regional research bases outsource the disposal of their organic and inorganic liquid wastes to industrial waste disposal service providers.

Effluent gases:

Toxic vapor-producing chemicals are used in fume hoods, and the toxic vapors are discharged through effluent gas treatment systems. Through the Chemical and Gas Management System described below, AIST provides each researcher with information on the chemicals that may be used only in a fume hood and must be rendered harmless before being discharged.

Chemical and Gas Management System

The wide variety of chemicals used in research are registered in the Chemical and Gas Management System at times of delivery. Via AIST's intranet, the Chemical and Gas Management System allows all employees to view information on the laws and regulations applicable to the chemicals being used and information on the properties and handling of each chemical (safety data sheets*). For Fire Service Law hazardous materials and high-pressure gases that have regulated
storage amounts, the stored amount for each room is compiled and can be quickly viewed. The system is also used to collect information on chemicals that are subject to the Pollution Release and Transfer Register (PRTR) Act as shown below and to send reports to government agencies.

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*Safety data sheet: a document that provides information on the risks, toxicity, physicochemical properties, handling precautions, restrictions and so forth, of chemicals.

■ Collecting Information on Released Chemical Substances

AIST reports on releases and transfers of chemicals subject to the PRTR Act (see "PRTR system"* below) and applicable municipal ordinances. At AIST, the following chemicals are used in large quantities: organic solvents to dissolve or extract various organic compounds; hydrogen fluoride to clean semiconductors; and ferric chloride to treat hydrogen fluoride liquid waste. The use of these chemicals must be reported every year.

➜ Amounts of chemicals reported under the Chemical Control Program

Releases and transfers of chemicals subject to the PRTR Act (chemicals used in quantities of more than 1 ton)

Research site	Substance	Amount used	Amount released	Amount transferred	
			Air	Sewer	Waste
AIST Tsukuba Central 5	n-hexane(kg)	1,400	430	0	980
AIST Tsukuba West	Ferric chloride (kg)	84,000	0	0	0
	N,N-dimethyl acetamide (kg)	1,200	0	0	34
	Hydrogrn fluoride and aqueous salts thereof (kg)	3,700	0	370	600

Tokyo Metropolitan Government: Releases and transfers of chemicals subject to ordinances relating to the health and safety of citizens and the environment (chemicals used in quantities of more than 100 kg)

Research site	Substance	Amount used	Amount released	Amount transferred	
			Air	Sewer	Waste
AIST Tokyo Waterfront	Ethyl acetate (kg)	122	12	0	110
(Bio-IT integrated technology facility)	Methanol (kg)	271	16	0	255

Osaka Prefectural Government: Subject to ordinances relating to preserving the living environment of Osaka Prefecture (chemicals used in quantities of more than 1 ton)

Research site	Substance	Amount used	Amount released	Amount transferred	
			Air	Sewer	Waste
AIST Kansai	VOC (kg)	1,900	120	0	1,800

＊PRTR system

The official name of the PRTR Act is "The Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof." Facilities that use any of the 462 designated type 1 chemicals in quantities of more than 1 ton per year (more than 0.5 tons in the case of some chemicals) must report the amount released to the environment and the amount transferred to other facilities (the amount sold and the amount disposed of by waste disposal service providers).

■ Storage of PCB Waste Materials

At each research base and site, polychlorinated biphenyl (PCB) waste from capacitors and transformers is stored as specially controlled industrial waste in accordance with statutory guidelines. A Specially Controlled Industrial Waste Manager inspects the stored PCB waste once a month to make sure it is properly stored.

In FY 2018 we dismantled experimental equipment with old production dates that was discovered during a thorough investigation of products using PCB, and capacitors possibly containing PCB were taken out. Analysis of capacitors from which insulation oil could

be drawn out was done and the waste materials were classified as PCB waste (high concentration or low concentration) or non-PCB waste. Non-PCB waste was disposed of as industrial waste; PCB waste was managed in accordance with the disposal plan.

We are outsourcing the disposal of high- and low-concentration PCB waste to the Japan Environmental Storage and Safety Corporation (JESCO) and a licensed detoxification service provider to systematically complete the disposal within the period specified by law.

➔ **Storage and disposal of PCB-containing items and PCB waste**

| Waste type	Quantity stored at the end of FY 2017	Quantity added in FY 2018	Quantity disposed of in FY 2018	Quantity stored at the end of FY 2018
Capacitors	20	409	3	426
Electrical ballasts	1,748	1	0	1,749
Transformers	6	0	4	2
Oils/paints (L)	106	0	0	106
Other contaminated materials	Stored as research chemicals, etc.	Use of waste cloth used for analysis	—	Stored as research chemicals, etc.

■ Reduction in Waste Generation

AIST seeks to reduce waste by applying the 3R (Reduce, Reuse and Recycle) principles and thus to reduce environmental burdens loads. We are focusing particularly on the reuse of research equipment, because this reuse can also contribute to cost savings (see "Effective Use of Resources" on the following page).

As part of our responsibility as a waste generator, every year we conduct on-site inspections of waste treatment facilities to make sure the waste is appropriately treated. In FY 2018, we conducted on-site inspections of 19 intermediate waste treatment and landfill facilities. In order to reduce landfill waste, we are working on reuse and recycling of waste materials.

➡ Changes in amounts of disposed waste
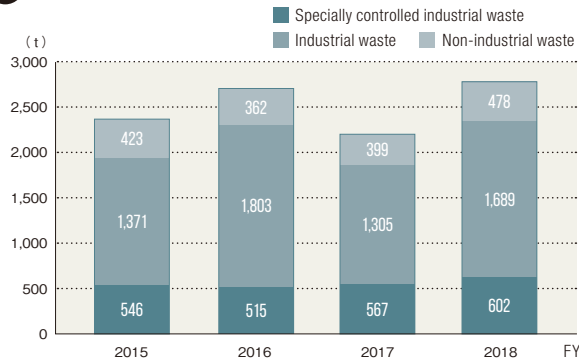
➡ Changes in amounts of landfill waste ● Landfill waste
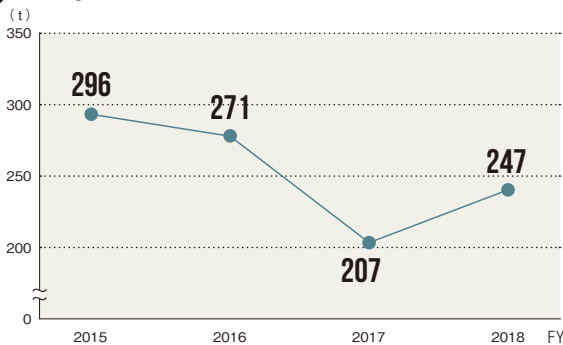
➡ Breakdown of generated waste (FY 2018)

Waste type	Amount disposed of (t)	Amount landfilled (t)	Percentage of waste landfilled (%)
Non-industrial waste	602	111	18
Industrial waste	1,689	118	7
Plastic waste	377	42	11
Metal scrap	415	3	1
Sludge	245	34	14
Glass/concrete/ceramic waste	60	10	17
Slag	104	0	0
Other	488	29	6
Specially controlled industrial waste	478	18	4
Flammable waste oil	16	1	6
Strong acids	375	5	1
Infectious waste	17	7	41
Waste oil (hazardous)	3	0	0
Sludge (hazardous)	6	0	0
Acid waste (hazardous)	2	0	0
Other	59	5	9
Total	2,769	247	9

Column: AIST's work on international standards for tackling marine plastic pollution

Since about 2015, there have been arguments, particularly from Europe, that efforts to tackle the problem of marine plastic pollution are necessary. The issue has been raised in United Nations bodies and discussed at G7 summits. At the G20 summit in Osaka in July 2019, the "Osaka Blue Ocean Vision" was formulated with the goal of reducing additional marine plastic pollution to zero by 2050. To inspire the innovations needed to achieve this vision (developing new materials, reliable methods for evaluating marine biodegradation and so forth), in May 2019 the Japanese Ministry of Economy, Trade and Industry (METI) formulated the "Roadmap for Popularizing Development and Introduction of Marine Biodegradable Plastics".

To support these innovations in accordance with the roadmap,

METI website: Roadmap for Popularizing Development and Introduction of Marine Biodegradable Plastics Formulated
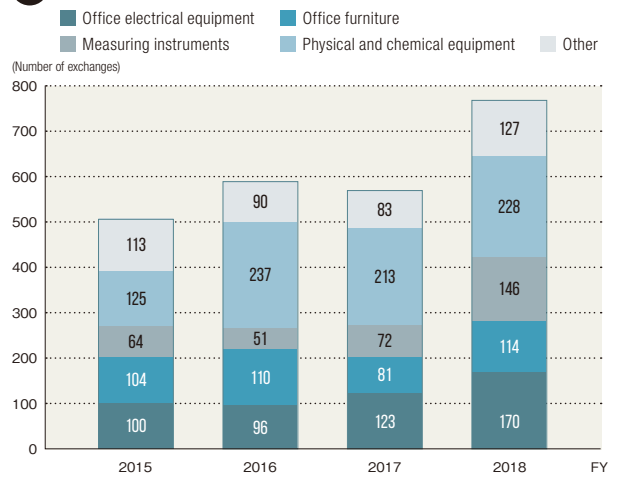
Roadmap Marine Biodegradable   [Search]

AIST played a central role in setting up the "Committee on Study of Standardizations for Marine Biodegradable Plastics" in July 2019, to establish ISO standards on marine biodegradation in a framework of public–private collaborations. AIST has for some time been working to establish ISO standards for evaluating biodegradable plastics, providing the ISO with the chair for a working group of a technical committee for international discussions and with proposals for biodegradation evaluation methods. In the committee set up in July, AIST, the National Institute of Technology and Evaluation (NITE), the Japan BioPlastics Association, the Japan Plastics Industry Federation, relevant companies, contract analytical laboratories, and government ministries and agencies are considering the establishment of standards for marine biodegradation. In the future, ISO standards for marine biodegradable plastics—governing evaluation technologies, requirements, and products—will be proposed and will make clear which new innovations relating to marine biodegradation are trustworthy.

■ Effective Use of Resources

Since 2005, an AIST intranet-based article recycling system has been in place to exchange information on wanted and available items, including research equipment, office electrical equipment, furniture and consumables, to promote reuse within AIST. We also give away items no longer useful in AIST to external organizations. In these ways we facilitate the reduction and reuse of waste.

→ Exchanges of items for reuse

■ Office electrical equipment   ■ Office furniture
■ Measuring instruments   ■ Physical and chemical equipment   □ Other

(Number of exchanges)

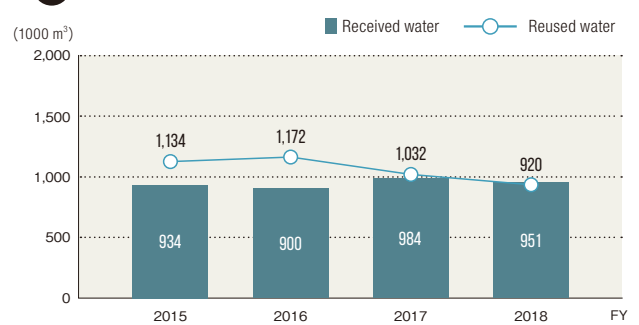| FY	Office electrical equipment	Office furniture	Measuring instruments	Physical and chemical equipment	Other
2015	100	104	64	125	113
2016	96	110	51	237	90
2017	123	81	72	213	83
2018	170	114	146	228	127

■ Conservation of Water Resources

For the efficient use of water resources at Tsukuba Central and AIST Tokyo Waterfront, research wastewater is neutralized, treated with reducing agents, and reused for cooling laboratory equipment and flushing toilets.

→ Breakdown of water received in FY 2015–2018

Unit: 1000 m³

FY	2015	2016	2017	2018
Potable water	914	881	968	937
Groundwater	20	19	16	14
Industrial water	0	0	0	0
Total	934	900	984	951

→ Changes in amounts of water received and reused

(1000 m³)

■ Received water   —○— Reused water

FY	Received water	Reused water
2015	934	1,134
2016	900	1,172
2017	984	1,032
2018	951	920

Water reuse plant at AIST Tsukuba

■ Compliance with the Convention on Biological Diversity and the Cartagena Act: Welfare and Management of Animals

In 1992, the Convention on Biological Diversity for conservation of biodiversity and sustainable use of biological resources was adopted. The Cartagena Protocol was subsequently created to protect biodiversity through the safe transport, handling and use of living modified organisms that could have adverse effects on the conservation and sustainable use of biodiversity. In Japan, the Act on the Conservation and Sustainable use of Biological Diversity through Regulations on the Use of Living Modified Organisms (the Cartagena Act) came into effect in 2004. To comply with international rules based on the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (Access and Benefit Sharing (ABS)), which was adopted in 2010, AIST drew up "Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization Guidelines" (ABS Guidelines) in 2017.

To comply with the Cartagena Act, AIST holds committee meetings attended by external experts to conduct preliminary reviews of experiments involving living modified organisms and the handling of living modified organisms. In addition, to obtain the knowledge needed for compliance and to conduct appropriate experiments, AIST 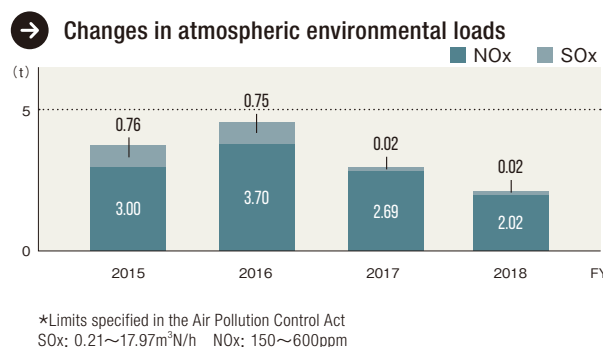requires the researchers and the research support staff involved with these experiments to undergo education and training once a year. There were 193 such experiments in FY 2018. We conduct yearly on-site inspections of all laboratories that use living modified organisms, to ensure that the organisms are labeled as specified in the act, that they are managed correctly, and that containment measures are taken to prevent dispersal of the organisms. We also provide on-site guidance as needed.

To comply with the Nagoya Protocol, AIST set up a consultation service in the research planning office of the Department of Life Science and Biotechnology; it responded to 7 enquiries in FY 2018.

When experiments on animals are conducted at AIST, the experimental design is reviewed in advance by a committee attended by external experts with consideration for the 3R principles (Replacement, Reduction and Refinement) outlined in the Act on Welfare and Management of Animals. The results of annual self-assessments conforming to "Standards Relating to the Care and Management of Laboratory Animals and the Alleviation of Pain" are posted on a public website. Since 2016, we have been subject to external inspections and certification by the Japan Health Sciences Foundation.

■ Prevention of Air Pollution

The major sources of air pollutants at AIST are the boilers used as cold and heat sources for air conditioning. To reduce sulfur oxide (SOx) emissions, we mainly use city gas and kerosene as fuel for the boilers. Twice a year (once for heating boilers) we measure the concentrations of NOx and SOx in the effluent gases produced. Regarding NOx, it was 59ppm against the emission standard of 150ppm for heating boilers, and 14ppm against the emission standard of 600ppm for cogeneration devices, and the measurement results were all within the limits specified in the Air Pollution Control Act. Of SOx, there has been little emission since 2017, and the results fall far below the emission standard.

➡ **Changes in atmospheric environmental loads**

■ NOx ■ SOx

*Limits specified in the Air Pollution Control Act
SOx: 0.21~17.97m³N/h   NOx: 150~600ppm

■ Leakage of Fluorocarbons

In accordance with the Act on Rational Use and Proper Management of Fluorocarbons, AIST checks for

→ Estimated leakage of CFCs (FY 2018)

Type	R-number	Estimated t-CO$_2$e released by R-number	Estimated t-CO$_2$ released by type
CFC	R502	-5.6*	-5.6*
HCFC	R22	3.1	3.1
HFC	R32	0.2	584.7
	R134a	249.4	
	R404A	48.1	
	R407C	41.4	
	R410A	245.6	
Total			582.2

★ Estimated leakage: In the System for Reporting and Publishing the Calculated Amount of Leaked Fluorocarbons (the Ministry of Environment and the Ministry of Economy, Trade and Industry), estimated leakages are calculated by subtracting the maximum filling amount from the recovered amount. Therefore, in a case of recovery only, the amount is expressed in a negative value.

leakage of fluorocarbons in periodic inspections and spot checks of refrigeration and air conditioning equipment and the like, with the aim of restricting emissions of fluorocarbons into the atmosphere. In FY 2018, during recovery and refilling of refrigerants in air conditioners and the like at Tsukuba Central 2, about 6 t-CO$_2$e of CFCs[1], about 3 t-CO$_2$e of HCFCs[1] and about 585 t-CO$_2$e of HFCs[2] were released, a total of about 582 t-CO$_2$e.

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[1] : CFCs (chlorofluorocarbons), HCFCs (hydrochlorofluorocarbons) are refrigerants classified as specified CFCs that damage the ozone layer. Production of CFCs was banned in 1996, and AIST has not refilled since.
[2] : HFCs (hydrofluorocarbons) are refrigerants classified as CFC substitutes that do not damage the ozone layer. However, they are powerful greenhouse gases and are being progressively replaced with non-fluorocarbon refrigerants.

■ Prevention of Water Pollution

At AIST, the fourth and subsequent washing waters from laboratories are sent as research wastewater to wastewater treatment plants. The wastewater undergoes processes such as pH adjustment, coagulation and sedimentation, filtration, and activated charcoal absorption 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 conducts periodic inspections of buried research wastewater pipes in accordance with the Water Pollution Prevention Act. The results of the periodic inspections were that damage was discovered in some pipes at AIST Hokkaido and AIST Tsukuba. However, it was verified that only water from the fourth and subsequent washing waters that did not contain hazardous substances had been discharged; there was no pollution of groundwater or soil.

Wastewater treatment plant at AIST Tsukuba

■ Monitoring of groundwater at AIST Kansai and AIST Chubu

Arsenic exceeding groundwater standards was detected in a groundwater survey conducted in April 2012 at AIST Kansai. Hence, the water quality of groundwater observation wells has been measured on a regular basis under the guidance of the government of Ikeda City, where AIST Kansai is located. We will continue this monitoring.

→ Results of groundwater analysis at AIST Kansai (units: mg/L)

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 2018	0.014	October 2018	0.011
May 2018	0.021	November 2018	0.024
June 2018	0.019	December 2018	0.018
July 2018	0.021	January 2019	0.020
August 2018	0.010	February 2019	0.035
September 2018	0.021	March 2019	0.017

Fluorine and fluorine compounds exceeding the standards were detected in the soil at AIST Chubu in a survey conducted in June 2012. Under the guidance of the government of Nagoya City, where AIST Chubu is located, one groundwater observation well was drilled and the water quality of the groundwater is measured once a year to prevent the spread of contamination. In the measurements of water quality taken in FY 2018, no particular issues were identified. We will continue this monitoring.

■ Accidents Affecting the Environment

To ensure compliance with environmental laws and regulations, AIST has an Environmental and Safety Management System (ESMS) in place. No environmental accidents* occurred in FY 2018. We have a system to minimize damage in the event of an accident.

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＊ At AIST, environmental accidents are accidents that occur during operational activities from air pollution, water pollution, soil contamination and others that cause damage to the human health and living environment.

→ AIST Tsukuba Central Emergency Contact System
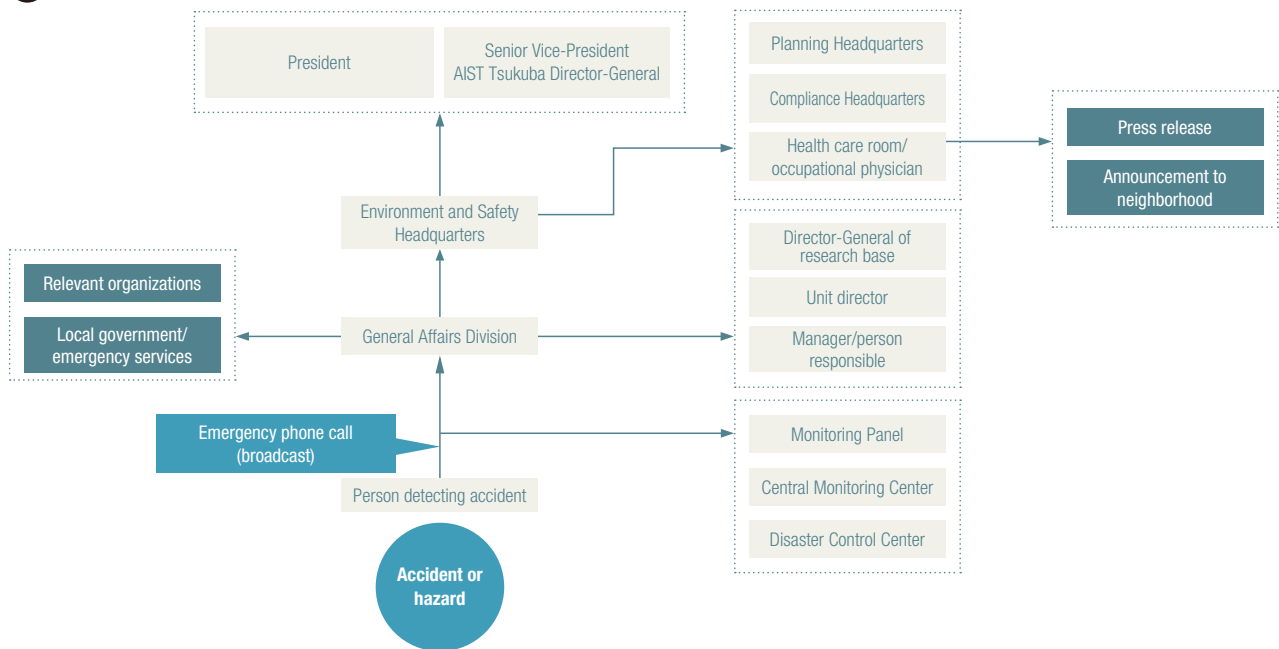
■ Drills to prepare for environmental accidents

AIST conducts contact, communication, and emergency action drills to minimize damage in the event of an environmental accident such as a leakage of oil or a chemical. In FY 2018, we conducted 18 accident drills across all research bases on events such as leakage of hazardous materials from rooftop flue gas-cleaning equipment and leakage of research wastewater during transport. We will continue to conduct drills for various environmental accidents on a regular basis.

→ Environmental accident drills in FY 2015–2018

FY	2015	2016	2017	2018
Number of drills	20	18	17	18

Emergency action drills

■ Noise Measurement

To prevent the noise generated by research institutions and facilities from adversely affecting the surrounding environment, AIST conducts voluntary periodic measurements of noise at all research bases. The results in 2018 showed that there were no adverse effects outside any research base.

■ Reports on Accidents that Occurred in FY 2018

■ Electric shock suffered by worker and electric outage

On November 24, 2018, a subcontracted worker accidentally touched an energized bus duct (main electrical system) carrying 6,600V during a legal inspection of electrical facilities at Central 1 high rise of AIST Tsukuba. The worker was rushed to the hospital, his right hand and right abdominal region were burned, but his life was not in danger. Due to this accident, AIST Tsukuba Central and AIST Tsukuba East were out of power for 2 hours. The cause of the accident was that the worker misunderstood the power supply system to be inspected and cleaned a different energized system. This accident was reported as a labor accident to the Labor Standards Inspection Office by the inspection operator, and as an electrical accident to the Kanto Tohoku Industrial Safety and Inspection Department by AIST. AIST will make preventive efforts by differentiating non-energized and energized systems by color.

■ Cooling water leak

On December 17, 2018, at Fukushima Renewable Energy Institute, AIST, while a visitor under the industry–academia–government system was draining cooling water from plant pipes to reconstruct the outdoor plant experiment facility, about 30 liters of ethylene glycol of 30% concentration leaked into the ground. The cause of the accident was because the visitor overlooked closing the shut-off valve indicated in the operation manual and started the procedure. There was no human or material damage. Preventive efforts will be made, and thorough confirmation of the operational manual and the presence of staff during procedures will be instructed.

■ Overflow of research waste water

On January 28, 2019, waste water overflowed from the monitoring tank of the research waste water treatment equipment of building 1 at AIST Kyushu. All of the spilled waste water remained within the waste water basin and none flowed outside. The cause was that the monitoring tank was filled to the brim because the tap of the laboratory was left running and the power of the monitoring instrument was turned off. Preventive efforts will be made, and thorough checks whether the tap is closed and 24 hour operation of monitoring instruments will be conducted in case research waste water increases.

Third Party Views

Director, Workers Club for Eco-harmonic Renewable Society (NPO) **YAMAGUCHI Tamio**

Each year, I am allowed to see an early draft of the AIST Report and offer my comments. These comments are fed back to staff in the Institute and discussed, and the outcomes of these discussions are discussed with me. This document creation process is disadvantageous in terms of work efficiency, but I am confident that it is effective for continuously improving social responsibility and openness. I think that persistently taking these pains is one reason the Institute won a prize for excellence at the Environmental Communication Awards 2018.

Three aspects of this AIST Report were of particular interest to me: 1) how the motto "in society, for society" is being put into practice; 2) responses to the problems affecting R&D in Japan; and 3) efforts to address social problems inside and outside Japan. The AIST Report met my expectations with the following content.

1) How the motto is put into practice is reported in the conversation with government representatives in the Opening Interview. Illustrative quotes include "When I first arrived in Kashiwanoha, I had the idea that I would use the town itself as a research site," "we have not been stuck in the lab but out testing services in the town with citizens and companies," and "I think of AIST Kashiwa as something like a front lobby opening AIST to the community." How the motto is put into practice is also shown by the Fukushima Renewable Energy Institute, the Research Reports, and so forth.

2) The "negatives inherent in technology" mentioned in 2018's Third Party Views, the struggles of open innovation (Annual Report from the Intellectual Property Strategy Headquarters), the stagnation of international industry–academia–government collaborations, appropriate roles for postdocs, and staff training have emerged as serious problems affecting R&D. The Top Message mentions ameliorating and eliminating the "negatives" as an urgent matter. In the Opening Interview, awareness of this matter is apparent in "to check what unintended side effects the social applications of technology are producing and to modify technologies and systems accordingly." In relation to other problems, the Promotion of Research Activities section introduces various efforts to address the problems and shows that results are being produced.

3) On social problems, researchers say "clearly understanding what problems there are in society is not possible" (page 8) but when I can read "to assist safe, reliable travel in the aging society" and "introducing AI technology to child guidance centers to help save children from abuse" in the Research Reports, it is clear that there is sensitivity to social problems. In the future, AIST Design School will encourage the identification and definition of social problems and the exploration and implementation of solutions, and we can hope for more assured understanding and solutions of social problems. The result will surely be "to create both social value and economic value" as emphasized in the Top Message.

In this way, the contents of the AIST Report address the interests of diverse stakeholders. However, I have two suggestions for further improvement. The first is to report on how the work of the Institute referred to by the slogan "Will you embark on the future with AIST?" maps onto the SDGs set at the global scale for 2030 and on the findings of R&D based on the SDGs. As alluded to in the Top Message, the SDGs are being integrated into management and pursued by many companies. As well as companies, national and local governments, NGOs and so forth are at work in every sector. Research institutes are no exception; many initiatives in AIST are linked to the 17 goals and 169 targets. The Research Reports do include the statement "will contribute to Target 16.2 of the Sustainable Development Goals," however, please give stakeholders a fuller picture.

My second suggestion is specification of the term "materiality." As I have discussed, the contents of the AIST Report address the interests of the bulk of stakeholders, but from our conversations it cannot be denied that there are disagreements about some details. I recommend specification of the term in accordance with the processes of the Global Reporting Initiative Standards.

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.

On the publication of the AIST Report 2019

Deputy Director-General, Planning Headquarters **OBARA Haruhiko**

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

In this year's AIST Report, the Opening Interview discusses AIST Kashiwa, a new research base established in November 2018. AIST Kashiwa has been in full-scale operation since April 2019, cooperating with the local government of Kashiwa City on its core research into human augmentation technologies, which will be part of the infrastructure for Society 5.0.

The Research Reports cover the activities of the Fukushima Renewable Energy Institute, in particular projects supporting business in disaster areas. Outcomes and the expectations of future activities are described in the form of a conversation between Center Director FURUTANI Hirohide and YAMADERA Kenichi of the Fukushima Prefectural Government's Commerce, Industry & Labour Department.

Robotics technologies that will assist safe, reliable travel in the aging society and AI technology for saving children from abuse are introduced in the Research Reports and serve as examples of the R&D to address social problems that AIST bears responsibility for. This kind of R&D is also mentioned in the Top Message from President Chubachi, in considering the important topic of the role of a public research institute "to create both social value and economic value."

Initiatives such as AIST Design School are reported on, which are personnel training activities that are important in regard to coexisting with society. In Third Party Views, Yamaguchi Tamio of the Junkan Workers Club offers invaluable opinions and guidance worked out through many discussions.

FY2019 is the final year of our fourth medium- to long-term plan. For AIST, with the motto "in society, for society," 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 make connections to build relationships of deeper trust with society.

Research Bases

AIST Hokkaido

Site   AIST Sapporo Odori Site

AIST Tokyo Waterfront

Site
- 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 Chubu

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

Ishikawa Site

AIST Tohoku

Site   Sendai Aoba Site
- AIST-TohokuU athematics for Advanced Materirals Open Innovation Laboratory (MathAM-OIL)

AIST Chugoku

Fukushima Renewable Energy Institute, AIST

**AIST Tsukuba Headquarters
AIST Tsukuba**

Note   Tsukuba Central 1
Tsukuba Central 2
Tsukuba Central 3
Tsukuba Central 5
Tsukuba Central 6
Tsukuba Central 7
Tsukuba West
Tsukuba East

Site   Tsukuba North
Funabashi Site
- AIST-Utokyo AI Chip Design Open Innovation Laboratory (AIDL)

AIST Kashiwa

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

AIST Shikoku

AIST Kansai

Site   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)

AIST Kyushu

Site   Fukuoka Site
- AIST-Kyushu University Hydrogen Materials Laboratory (HydroMate)

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