2020 SPECIAL ENGLISH EDITION

SDGs in Focus

Science Window

Connecting to the World, Creating Our Desired Future

Many microplastics are found even at beaches filled with beachgoers. It takes the efforts of everyone individually to create a bright future.

JST

SUSTAINABLE DEVELOPMENT GOALS

JST supports efforts to realize Sustainable Development Goals (SDGs).

Science Window

SDGs in Focus

Connecting to the World, Creating Our Desired Future

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What is Science Window?

The world is filled with science and technology that make our lives more convenient, enhance the richness of each day, and support our livelihoods. Widespread "hope" is a key driver of advances in science and technology. We want to realize a better future. As a first step, we produce the Science Window web magazine that presents straightforward, fun information with the aim of bringing science and technology even just a little closer to more people.

This edition of Science Window provides a special feature on initiatives for attaining the SDGs, as well as the usual science and technology information in an easy-to-understand manner.

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Japan Science and Technology Agency

About the SDGs

The Sustainable Development Goals (SDGs) are shared global goals that seek to address various challenges facing the world, including poverty, food, health, education, gender equality, disparities, water and energy, climate change, ocean and terrestrial resources, and peace. Countries around the world agreed to adopt the SDGs at the United Nations General Assembly in 2015. Current efforts aim to achieve these goals by 2030.

The SDGs have highlighted the fact that environmental, economic, and social challenges facing both the world and individual countries are complexly intertwined. Science and technology will surely play a major role in overcoming these challenges; by measuring and analyzing interconnected environmental, economic, and societal phenomenon as scientific data, we hope to develop technologies that will provide an integrated solution to multiple complex issues.

JST intends to deepen partnerships with domestic and overseas universities, research institutions, business communities and societies and contribute to attaining the SDGs through a wide range of science and technology projects. These include our think-tank activities, R&D, collaboration between industry and academia, cultivation of next-generation human resources, and future co-creation involving various stakeholders.

SDGs – Our Vision of the World in 2030

Japan's Science and Technology Can Create a Brighter Future

Have you ever heard of the "SDGs?" The Sustainable Development Goals are a set of objectives the international community is working together to achieve by 2030, addressing the many issues we face on our planet such as climate change, poverty, and marine plastic waste. There are many actions each and every one of us can take to help achieve the SDGs. What are the SDGs, and how can we relate to them as part of our daily lives? We spoke to Professor Norichika Kanie of the Graduate School of Media and Governance, Faculty of Environment and Information Studies at Keio University, one of the leading researchers on the topic of the SDGs.

Professor Norichika Kanie of the Graduate School of Media and Governance, Faculty of Environment and Information Studies, Keio University

Creating a sustainable society

"The SDGs are our vision of the world in 2030," explains Professor Norichika Kanie. The SDGs were unanimously ratified by all members of the United Nations in 2015, and comprise of 17 high-level goals with 169 practical targets to achieve these goals. When ratified an oath was also taken that, "No one will be left behind." The entire international community is now working to achieve the SDGs while carefully balancing economic, social, and environmental needs.

The global expansion of human economic activity and development, and the enormous impact human society now has on the environment, are drivers behind the creation of the SDGs.

Kanie explains, "The pollution and environmental destruction that took place around the world in the 1970s led to an increased awareness of the need for a response, and the concept of 'sustainability' – pursuing social development while protecting the environment – was born. We have since seen the formation of a number of international frameworks with various rules and obligations."

The SDGs – 17 goals to achieve.

The SDGs, however, have a fundamental difference to frameworks with clear rules such as the Kyoto Protocol, an international treaty that requires reductions in greenhouse gas emissions. The SDGs do not represent a set of rules or obligations, but instead a set of objectives.

The spreading SDG movement

Movements to help achieve the SDGs are now spreading throughout Japan. The momentum of these actions has astounded even Kanie.

The Japanese government formed the SDGs Promotion Headquarters in 2016, creating a forum to promote the

SDGs on a national level. This inspired local governments to begin pursuing the SDGs with greater energy, viewing their achievement as a new key to regional vitalization.

"At first, actions by the national and regional governments stood out, but recently corporations have also taken up actions to achieve the SDGs. Taking the SDGs into account when laying out corporate strategy can enable companies to offer the goods and services now sought by the world of the future, thus expanding their market."

Kanie is particularly excited by the spread of the SDG movement among children and young people. Classes are starting to incorporate the SDGs into their curriculum, building greater awareness.

Regarding this spread of the SDG movement, Kanie remarks, "The SDGs only set out the goals we must achieve, we are free to choose the methods. I think that is the very reason so many people can get involved."

What we can do to solve global scale problems

While awareness of the SDGs is spreading, there are undoubtedly many people wondering how they can tackle such massive, global scale social issues.

"The SDGs should serve as a hint to guide our actions when we think, 'I want to help the planet' or 'I want to contribute to society.' Refusing a plastic bag at the store, for example, contributes to goals 12 and 14. We don't have to be perfect, though. If we turn down one of every two bags at the store, we've still reduced the use of plastic bags by 50%. It's important to change our way of thinking and actions starting with what we can do now."

Each of us individually changing our awareness and actions can become a major force for resolving social issues on the global scale. What is most important to us as we seek to change our way of life?

Kanie observes, "The fact that the SDGs do not apply any rules makes being flexible very important. Setting aside a bit of time outside established organizations and rules is one technique to inspire innovative ideas.

Just the other day I was thinking, 'What would be a sustainable leather product?' Many options came to mind: from the perspective of transportation cost and energy, I could choose to produce the product locally; from the perspective of reducing poverty, I could create a product that supports people in developing nations; and from the perspective of avoiding waste, I could create a product that uses leather sourced from animals slaughtered for meat. From the perspective of the SDGs, these are all right answers. I could therefore choose the most achievable option from those that came to mind."

How science and technology can contribute to the SDGs, and how the SDGs will change science and technology

What role do we expect science and technology to play in achieving the SDGs, having long made our lives more abundant?

Kanie remarks, "The science and technology used to help achieve the SDGs does not have to be new."

For example, to reduce transport done by trucks and other vehicles, we could make use of delivery drones or 3D printers to produce parts on site. There are also examples overseas in which routes from emergency vehicles were secured using GIS (Geographic Information System) to identify points of high traffic congestion, allowing the emergency vehicles to arrive at the scene of emergencies much faster. These are all ideas that make use of technology already being used today.

"The SDGs are like a set of exam questions for which we can only see the answers. As we try to find the path to the solutions, the SDGs guide us in finding uses for existing technologies, or spur the research and development of new technologies."

The concept of "partnership" is also a key component to achieving the SDGs.

"The SDGs serve as a 'common language' to build connections with people and things we have never been connected to before. Partnership, which is goal 17, is an extremely important element."

The true essence of the SDGs is to not think of the 17 goals separately, but rather as part of one cohesive whole. It is nearly impossible, however, for any one individual or organization to cover all 17 goals. This creates the need for partnership. Collaborative creation in the field of science and technology, which continues to grow in both sophistication and complexity, will undoubtedly lead to innovation that can help achieve the SDGs.

Japan's science and technology can lead in solving global challenges

Kanie has high expectations for Japan's science and technology.

"Japan stands out in the world with its declining population and aging society, making it a 'leading challenged nation.' The whole world is paying attention to how Japan will overcome these challenges. If we can solve these issues with science and technology created in Japan, we can take the lead in solving problems shared by the entire world."

Kanie has already begun thinking about the "Post-SDGs" world. If Japan continues research and development guided by the SDGs, becoming a global top-runner in science and technology is no mere dream in the post-2030 world.

Creating a "human centered" future

The current definition of science and technology must be redefined in light of the SDGs. On one hand, we must create new science and technology to help achieve the SDGs, and great expectations are placed on them. At the same time, however, there is great concern over how science and technology will change the lives of people around the world.

Kanie elaborates, "Good and evil does not exist within science and technology. It is a fact, however, that it can be put to bad use. For that reason, we must continuously ask ourselves how we can use science and technology to create a better society and future for ourselves. 'Humans' must be at the center of our debate. I believe the SDGs serve as an essential guide for setting our direction."

Norichika Kanie
Professor, Graduate School of Media and Governance, Faculty of Environment and Information Studies, Keio University
Senior Research Fellow, United Nations University Institute for the Advanced Study of Sustainability

Norichika served as an Assistant Professor at the University of Kitakyushu, and an Associate Professor of the Graduate School of Decision Science and Technology at the Tokyo Institute of Technology before assuming his current role at Keio University in 2015. Norichika also served as the project leader for three years of the "Project on Sustainability Transformation Beyond 2015 (POST2015)," Project S-11 of the Environment Research and Technology Development Fund of Japan's Ministry of the Environment.

Ehime Prefecture's Ainan-cho

Venture Companies, Aquaculture Operators, Local Government, a Fishery Cooperative and University Work Together to Rescue Japan's Aquaculture Industry!

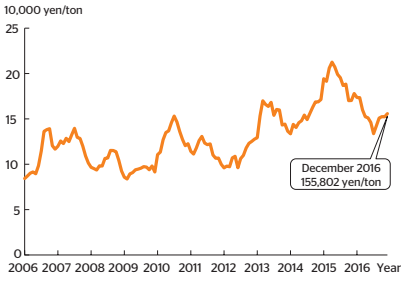
Ehime Prefecture's Ainan-cho has a vibrant aquaculture industry; town administration, a fishery cooperative, aquaculture operators, a university research team, and ICT-related venture companies jointly seek solutions for issues in the aquaculture industry and a position as the "birthplace of aquaculture based on a cutting-edge technology".

Former JAXA researcher solving issues in the aquaculture industry using ICT

UMITRON

UMITRON CEO, Ken Fujiwara

Trend in imported fishmeal



Source: Fisheries Agency, Fiscal 2016 Fisheries White Paper (Ministry of Finance's Trade Statistics, Japan Marine Farming Feed Association, Fisheries Agency)

Rapid growth in fish consumption worldwide

Fish consumption has been rapidly expanding worldwide since the mid-1990s. Sharp increases in demand for animal protein due to population growth, health focus in developed countries, and improved eating standards in developing countries strongly influenced this trend.

Aquaculture emerged as an important global growth industry because natural fish catches are not enough to meet this big an increase in fish demand. However, Japan's aquaculture operations face difficult conditions, including shortages of successors and manpower that prevent expansion of the business scale.

Rescuing aquaculture operations struggling with expensive feed prices

Steep increases in the price of fishmeal pose a particularly large challenge for aquaculture operators. One reason is expanding demand. Pricing also varies considerably with catch volume of anchovy used as a raw material.

Japan's red sea bream farmers spend 72% of their budgets on feed.

Ehime Prefecture's Ainan-cho is pursuing an effort to escape the current situation and transform Japan's aquaculture industry into a growth industry.

Developing a system to optimize feed provision

UMITRON's Ken Fujiwara started developing technology with Ainan-cho in 2016 on the basis that the company's understanding of the current state of Japan's marine industry and technology could make a difference.

UMITRON developed the Umigarden data service. The system enables observation of fish eating feed via cameras installed in the fish cage, and removal of feed provision over a smartphone. Accumulated data contributes to analysis of ideal feed volume and timing.

Mr. Fujiwara traveled to Ainan-cho daily, discussed ideas with local people, and tried various approaches. He recalls how things felt when the project began, "There was lots of manual activity that assumed people go directly to the site, which meant many things could be simplified using technology."

He worked closely with front-line people while gradually getting to know what features were needed.

Hopes to apply aerospace technology to aquaculture

With the Umigarden service already available, the next step is increasing the complexity of marine environment data from 'points' to 'planes' using satellite imagery.

In fact, Mr. Fujiwara conducted research at the Japan Aerospace Exploration Agency (JAXA) before obtaining an MBA at a US graduate school and working for a period at a Japanese trading company assisting venture firms.

"I wanted to launch a venture and engage in work that contributed to the world since my JAXA years. Aquaculture is a very important global industry. I hope to contribute to aquaculture sustainability with a global perspective".

Young marine farmers fighting for the future of Ainan-cho and the fisheries industry

Onishi Suisan

Developing Umigarden with UMITRON

Onishi Suisan, which operates an aquaculture business in Ainan-cho Fukuura, has cultivated fish in the Fukuura sea for nearly 50 years since its founding.

With hot water temperatures throughout the year, the Ainan-cho sea cultivates large volumes of red sea bream because of the quick growth period. However, Onishi Suisan needed to shrink output scale temporarily under pressure from the upswing in feed prices. Onishi Suisan's Hikari Onishi met UMITRON's Fujiwara when the company was looking into whether it was possible to expand output volume.

Mr. Onishi explains, "The catalyst was an introduction through the town's Fisheries Division. I heard about Mr. Fujiwara's vision with interest." His company then worked to develop Umigarden using Onishi Suisan's fish cages.

Optimizing feed supply volume and timing

There were new discoveries roughly a year after deploying the system. The company previously supplied feed multiple times from 8am to 5pm, though it became apparent that times in the early morning and evening were most conducive for eating. "We had been deciding the fee supply timing to fit human schedules, but should have been thinking more about the natural cycles of fish".

Mr. Onishi is actively trying new things with the aim of "building the company to continue for a long time."

He is not thinking just about the company's future. Ainan-cho and the aquaculture industry are important too. "I believe it is essential to build a format that works even as manpower declines, by incorporating new technology".

Onishi Suisan CEO Hikari Onishi

Umigarden installed in fishing cages. Supports feed supply through remote operation from a tank that contains the feed.

Promoting introduction of cutting-edge technology through collaboration with Ehime University and the fishing cooperative

Ainan-cho, Fisheries Division

Ainan-cho Fisheries Division, Fisheries Promotion and Ainan-cho Ocean Resources Development Center, Yosuke Shimizu

Recruiting Ehime University to make the town a site for fisheries research

Ainan-cho, which is located at the southernmost point of Ehime Prefecture, is a town with a lively aquaculture industry for red sea bream, amberjack, and pearls.

Meanwhile the town faces a tough reality of steady aging of the population and manpower shortages in the aquaculture industry. How was it possible for this town to realize co-creation with an ICT joint venture? According to Yosuke Shimizu, an employee in Ainan-cho's Fisheries Division and researcher at the Ainan-cho Marine Resources Development Center, Ainan-cho actively promoted deployment of cutting-edge technology including recruitment of a research facility of Ehime University.

"We are at risk of not being able to maintain industry in Ainan-cho in future years if the core fisheries industry becomes conservative alongside the shrinking productive population. Our contact with Ehime University, which was seeking to strengthen fisheries research, resulted in the establishment of Ehime University's South Ehime Fisheries Research Center."

The town's Fish Disease Diagnostic Office and Marine Resources Development Center occupy the same building as the South Ehime Fisheries Research Center, and aquaculture research advanced through close collaboration of the town, university, and fishing cooperative.

Aiming to create South Ehime brand fish utilizing ICT production management

Precisely this foundation made it possible to quickly embrace the vision presented by UMITRON. Regarding the future Mr. Shimizu explains, "We want Ainan-cho to be known as the place where the fisheries industry first harnessed advanced technologies, through initiatives that combine aquaculture and ICT."

He thinks, "Successful establishment of an 'Ainan-cho brand fish' harvested with an efficient production management process would ensure stable businesses for farm operators and be ideal for consumers too with recognition of the Ainan-cho brand."

At the same time, the town still faces challenges such as the building of communications infrastructure. Nevertheless, the initiative with UMITRON is clearly a first step in stimulating Ainan-cho's fisheries industry and broadening the scope of co-creation.

Ainan-cho's Fukuura, a bay with a ria coast that has hot sea temperatures and moderate waves throughout the year.

Launching a venture company in Ainan-cho, addressing the feed cost issue with insect feed

Ainan Liberacio Co., Ltd.

Developing a fish supplement from silkworm pupae

With assistance from the Japan Science and Technology Agency, Atsushi Ido researched the use of insects in aquaculture at Ehime University. After conducting research on insect feed in Ainan-cho as a researcher at Ehime University's South Ehime Fisheries Research Center, he established Ainan Liberacio for the purpose of commercializing results obtained from this research.

At Ehime University, he discovered a there is substance in silkworm cocoons that activates the immune systems of fish and shellfish. Ainan Liberacio supplies this extracted substance in a powder form as Silkrose. Silkrose is a supplement that is mixed into feed and has been well received by marine farmers and consumers through its reduction of parasites that attach to red sea bream, amberjack, and other cultivated fish.

Silkrose made from the immunoactive substance contained in silkworm and Japanese silkmoth pupae.

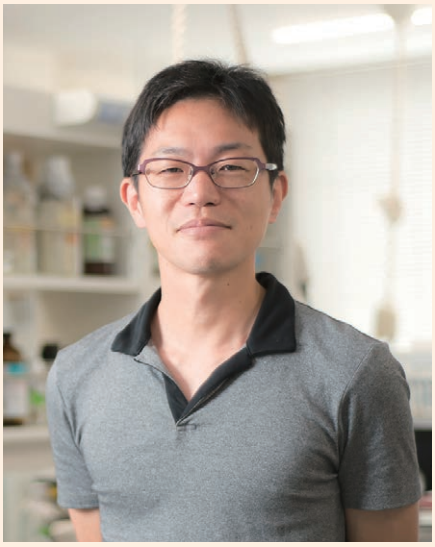
Ainan Liberacio is also conducting research on a fishmeal alternative feed that utilizes fly and horsefly larva, that grow by large amounts in short period, and beetle larva that is known to be a good source of animal protein.

Path from marine farmer resistance to commercialization

Development of insect feed was initially met with resistance from marine farmers due to general disdain for insects. However, attitudes shifted significantly after the Food and Agriculture Organization of the United Nations (FAO) announced the efficacy of insects as an alternative protein source to fishmeal in 2013. A sharp upturn in fishmeal prices helped too. These trends boosted the number of marine farmers willing to consider insect feed.

Mr. Ido, who explains that "I decided to commercialize this product on my own because it is research that contributes positively to the world," possesses the strength to address these issues from the standpoint of both a researcher and businessman.

He obviously wants to expand the company and is also excited about reviving Japan's fisheries industry. "In Norway, salmon aquaculture is a dream profession for young people. Japan's aquaculture industry, meanwhile, is steadily declining. I want to change this trend."



Atsushi Ido, Ainan Liberacio CEO and Guest Associate Professor, Graduate School of Agriculture, Ehime University

Ainan-cho is attracting people with a mission to "revitalize Japan's aquaculture industry." This town will surely foster a new trend in aquaculture.

Tackling the Marine Plastic Pollution Problem

- A Promising Polymer from KANEKA -

Naoaki Taoka (right) and Shunsuke Sato from the Biotechnology Research Laboratories at KANEKA CORPORATION's Takasago Manufacturing Site

Plastic - it surrounds us, and is used everywhere. Easily processed, tough and inexpensive, plastic is an indispensable part of our everyday lives. Yet the irony is that the convenience plastic provides us is also causing an enormous environmental problem in the form of Marine Plastic Pollution. Now a ray of light is shining on this world-shaking issue – science and technology from Japan.

Marine Plastic Pollution: a key discussion point even at the G20 Osaka Summit

The marine plastic pollution problem was a major topic of discussion even at the G20 Summit Meeting, held in Osaka in June 2019 and attended by world leaders.

The marine plastic pollution problem is a serious issue in which plastic debris that is not properly processed ends up flowing into our oceans and polluting the environment. Many of us have seen shocking pictures of the effects of this problem, such as turtles caught in fishing nets and huge amounts of plastic waste found in the stomachs of seabirds.

There are also more than a few people who are concerned about the impacts of marine plastic pollution on our health.

The Japanese chemicals manufacturer KANEKA CORPORATION made its presence known at the Osaka G20 Summit in relation to the marine plastic pollution problem. KANEKA is striving to help solve social issues in a wide range of fields by leveraging its polymer technology-based chemical capabilities and strengths in biotechnology derived from fermentation technology. The company captured the attention of the summit attendees with its presentation of plastic bags, cutlery and other items made from "naturally degradable plastic."

Plastic bags (made of PHBH) used at the Summit venue.

Display of various products (made of PHBH).

The number one problem with conventional petroleum-based plastic is that it's not easily biodegradable in nature. It cannot be broken down into carbon dioxide, water and other substances by microorganisms, and instead remains in landfill and other disposal sites for several decades.

Some types of biodegradable plastic, on the other hand, can be broken down in nature. This includes plastic made from plant materials, which cycles released carbon dioxide back into the atmosphere and therefore doesn't exaggerate global warming. The concept of biodegradable plastic is actually quite old, with plastic discovered by a French researcher about 90 years ago. However, biodegradable plastic has not become widely used due to its price, durability, and other reasons.

So what makes "KANEKA Biodegradable Polymer PHBH" (hereafter, "PHBH") so exceptional? We asked KANEKA CORPORATION's Dr. Shunsuke Sato for the reason.

"Existing biodegradable plastic could only be broken down in a high-temperature environment of around 50-60°C, such as within a compost facility. KANEKA's PHBH is of course biodegradable in natural soil, and we have also confirmed it can be broken down in seawater, its microbial concentration is much lower than soil or compost facility. So we expect it to be useful in solving the problem of marine plastic pollution."

In addition to having a texture that compares favourably with petroleum-based plastics, the hardness of PHBH can be widely adapted to suit its applications.

A world first! The journey to successfully mass producing biodegradable polymer

KANEKA embarked on its journey to develop a biodegradable polymer in 1991. Back then, marine plastic pollution was still not recognized as a problem, and so the company's starting point was a desire to create an eco-friendly solution that didn't rely on petroleum.

The main materials of PHBH are vegetable fats and oils, such as those used in cooking. The manufacturing process is also extremely unique, as it uses microorganisms. There are some microorganisms that internally store the energy source they ingest as fats, which become the material for making polymers. Naoaki Taoka, who has been working with Sato on research and development, tells the story of discovering these microorganisms back then.

"When I joined KANEKA, my job was to collect microorganisms from mountains and ponds in each region, and find those that produce the substances we were looking for. It just so happened that I coincidentally found the microorganisms that produce PHBH in the soil at the Takasago Manufacturing site where we worked."

However, these microorganisms need to produce massive amounts of PHBH in order to stably produce biodegradable polymer; and unfortunately, the microorganisms discovered at the Takasago Manufacturing site could only produce a tiny amount of PHBH. Incidentally, in 1997 while conducting some joint research, KANEKA and RIKEN discovered a gene cluster related to the synthesis of PHBH.

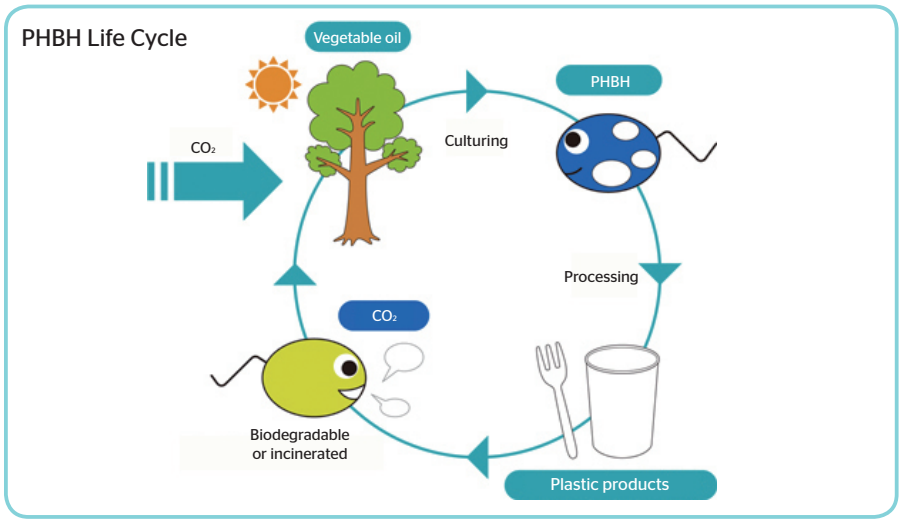
Through a process of repeated genetic engineering based on this discovery, KANEKA's biotechnology research team were able to create microorganisms that can store huge amounts of PHBH internally.

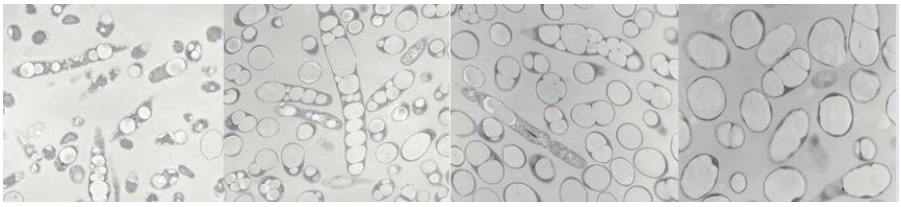
That is when things got tough though, reflects Sato.

"We had created these microorganisms, but there were still many challenges to overcome in order to use them as materials for plastic. For example, removing the cellular components – the "membrane" of the microorganisms. We were developing eco-friendly materials, so even as we were refining PHBH, we proceeded in a way that did not harm the environment."

They were able to find a solution to this problem by collaborating with another team at KANEKA; one of the company's strengths is how they work together to solve a wide range of social issues.

Another difficulty the team faced was scaling up from the tiny test equipment they started their research and development with to larger equipment for commercial production. KANEKA was able to overcome this challenge by applying the expertise it had already acquired in the mass production of useful substances using polymer and fermentation technologies. The team also received support from the Japan Science and Technology Agency (JST) at that time, and thanks to all of these factors, KANEKA became the first in the world to successfully produce 1000 tons annually of biodegradable plastic.





Electronic microscopic photos of microorganisms as they store PHBH internally

What we can do now for the global environment

Sato shared his future prospects for the very promising PHBH.

"What will be the effects of marine plastic from here on? And what will be the worst case scenario for the earth and humankind? I don't think we have done enough research yet on these questions; but, it may also be too late if we wait to see the effects of marine plastic on nature before we take any steps to address the problem. So that's why we need to have faith that we can make a difference, and do what we can now. I want to keep working on developing materials that can help us achieve a sustainable society."

Sato was quite matter-of-fact when commetning, "I don't think PHBH alone can solve the marine plastic pollution problem and global warming." Yet if we can expand the use of PHBH, it can take us one step closer to a solution. We want to place our hope and belief in Japan's scientific and technological capabilities.

Naoaki Taoka
KANEKA CORPORATION
Takasago Manufacturing Site
Biotechnology Research Laboratory
Bioproducts Research Group
Leader

Shunsuke Sato
KANEKA CORPORATION
Takasago Manufacturing Site
Biotechnology Research Laboratory
Bioproducts Research Group
Senior Member

Looking Closely at Waste, and Changing the Future

- Considering Ways to Deal with Waste in the Era of SDGs -

At the G20 Summit of world leaders, the participating countries reached an agreement to reduce marine plastic pollution to zero by 2050. Eliminating or paying for the use of plastic bags has also become a worldwide topic, but what can each of us do to solve the waste problem? We asked Misuzu Asari from the Kyoto University Graduate School of Global Environmental Studies, who for the past 20 years has been working to find a solution to the problem of waste.

Associate Professor Misuzu Asari from the Kyoto University Graduate School of Global Environmental Studies

A detailed survey of household waste gives us a glimpse of modern lifestyles

As a part of her efforts to tackle the waste problem, Misuzu Asari has been conducting a "Survey on the Detailed Composition of Household Waste" to clarify what exactly makes up the waste thrown out by households. By sorting the waste by materials and usage and then studying the components in detail, Asari can get useful information on how to reduce the amount of waste.

Although the amount of household waste in Japan has decreased since peaking at 54.83 million tonnes in 2000, about 44.32 million tonnes of waste is still being generated each year. This is not just a problem of wasting resources; there are also concerns about the huge impact marine plastic pollution has on sea creatures, and the effects of microplastics on the ecosystem. So we must reduce the amount of waste in general, including plastic, to help achieve Goal 14 (Life below water) and Goal 12 (Responsible consumption and production) of the Sustainable Development Goals (SDGs).

"My former teacher, Hiroshi Takatsuki (Kyoto University Professor Emeritus, Head of the Miyako Ecology Center), wanted to know what was in the waste of households, so he started a detailed survey of household waste in 1980. I became involved in this initiative in 1999, and even in just the 20 years since then the contents of waste have changed drastically due to our falling birth families becoming more nuclear waste. For instance, the amount of unopened and untouched food products that are thrown away has become quite noticeable. A possible reason for this is that people are buying food sold in bundles, which they are unable to eat all of."

Asari has been making policy proposals to government agencies and advising manufacturers, distributors and other companies on waste reduction initiatives. Consumers also need to be encouraged to only buy what they can eat, so Asari has been working to raise environmental awareness encouraging people to think about the problem of waste.

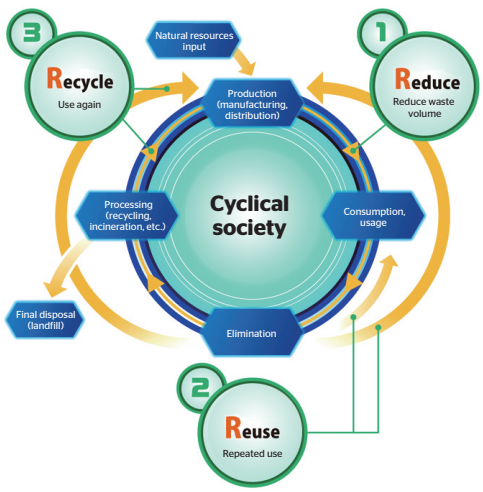
"Recently, achieving the SDGs is something that is being demanded more in society, and I also feel there is a heightened awareness about environmental issues. However, even though they were taught about the environment in elementary school, the generation that entered Kyoto University in around 2010 doesn't have any real experience of environmental destruction happening around them when they were young, such as when pollution became a social problem for my generation. Although people know more about environmental issues now, it seems to me they are less aware of these issues as something that also affects them. Feeling that we cannot go on like this I formed the organization "École de Kyodai." As well as holding various environment-related events at Kyoto University, the organization runs a range of projects that will hopefully get the participants interested in environmental issues, even just a little." (Asari)

École de Kyodai: created by coining the words "Eco" and "World", with the aim of promoting an understanding of "Think globally, act locally, feel on campus!". The word École is French for school.

The Waste problem is a global issue that is connected to all SDGs

Asari started the "Bikkuri! Eco 100 Sen" (Surprising! Eco 100 Selection) exhibition of eco-friendly products and initiatives in 2005. Following that, she made use of the relevant systems in Kyoto City to run the "Civic Collaboration Power Generation" project for installing solar cell panels on the roofs of municipal elementary schools and other facilities, with funding from the citizens of Kyoto. Asari has also been publishing the "Bikkuri! Eco Shimbun" (Surprising! Eco Newspaper), which is used as teaching material for

Cyclical society and 3Rs



3Rs: Reduce, Reuse, Recycle
Recycling-oriented society: a society that strives to limit environmental burdens as much as possible, and carefully use the earth's limited resources through the 3Rs and other activities.

environmental education as well.

"140,000 copies of the Bikkuri! Eco Shimbun are published for each edition, using profits from the Civic Collaboration Power Generation project. The paper is distributed to all elementary, junior and senior high school students that attend a Kyoto City municipal school. The "3R & Low Carbon Society Examination" has also been set up with the intention of trying to make knowledge of environmental issues entrenched in people's minds, and I'm involved in creating the exam questions. My hope is for these activities to make a wide range of people more aware of and interested in environmental issues. Also when we look at the waste problem on a larger scale, it becomes not just an environmental issue - it is a problem connected to all 17 SDGs."

It is easy to focus on the waste problem as an environmental issue in a country like Japan, which has a developed waste disposal system. Yet there are some developing countries where waste collection itself has become an issue. Within the problem of waste are many of the issues (sanitation in daily life, child poverty, etc.) the United Nations advocates addressing to achieve the SDGs.

"Japan cannot solve the various issues raised in the SDGs simply by providing financial aid to make waste disposal facilities. Developing countries are facing more urgent issues, such as securing clean water, which come before setting up a waste disposal system. The waste problem tends to be put aside. We must first have a thorough understanding of the situation in each country, and then utilize Japanese technology accordingly, as well as educate and train capable people who can create new social systems."

Reducing waste with conscious actions, and the manufacture of goods for recycling

2030 has been set as the target year for achieving the SDGs, and there is also a recognized need for the younger generation to understand what the SDGs are. However, it is not so easy to include SDGs in the class content of elementary schools, and to communicate the 3Rs to the students.

"The SDGs can also feel like someone else's problem in an affluent country such as Japan. So in order to perceive the SDGs as something that relates to yourself as well, first you should try and find situations and things in your daily life that are somewhat connected to the 17 SDGs, and then take action to achieve those goals. The Kyoto Municipal Ansyu Elementary School reached out to us after learning about the "1 SDG a day" activity in the Bikkuri! Eco Shimbun", and now this activity is included in their education on SDGs.

If we can educate and train children in this way so that they grow up with the ability to think about the future of the region they live in from the viewpoint of SDGS, and also skilfully utilize Japan's science and technology, then we can contribute to solving the waste problem not only in Japan, but worldwide as well.

Lastly, we asked Asari about what type of science and technology is needed from here on to solve the waste problem.

"Japan's recycling technology is extremely developed, but going forward we will also probably need to manufacture goods that will ultimately be recycled."

The plastic we use today is made using various additives and paints according to its usage, so it is difficult to use such plastic to reproduce the original products and the same quality plastic items. There will likely need to be restrictions on the additives and paints used in processing plastic so that it is easier to recycle. The world is also waiting for the development and widespread use of biodegradable plastic that can be broken down by microorganisms in nature. This type of plastic is however relatively expensive compared to existing plastic used today, and cannot claim better functionality, so there is still room for improvement.

We need to start thinking about ways we can lessen the harmful impact of plastic, and also take the initiative in practicing the 3Rs while we expectantly watch the development of science and technology in this area. If each person becomes aware of how their actions effect the environment, makes a bit of an effort, and also bears the higher costs to some degree, then we can probably create a better and brighter future for everyone.

At the Guadalcanal island of Honiara in the Solomon Islands. The bottom picture shows a mountain of waste discovered by the students accompanying Asari. Their real-life experiences at the island made the students realize the waste problem is their problem too.

These pictures show students working in a class on SDGs at the Kyoto Municipal Ansyu Elementary School. The students write about "1 SDG a day" in their SDGs notebook (created by Asari for elementary school students), as a way of understanding the 17 goals. They also do field work for this activity. The students look at the goals with the free and flexible thinking that children have, and find fresh perspectives on the SDGs as they think about creating a comfortable and convenient town they can live in forever.

Misuzu Asari
Associate Professor at the Kyoto University Graduate School of Global Environmental Studies

Asari is researching the modelling of materials flow and consumer behaviour to build a product management system that includes appropriate cycling and disposal methods for household waste and other waste. Alongside her research activities, Asari is also actively working to make Kyoto University an "eco campus", while serving as a director of the company "Bikkuri Eco Power Generation Plant" and an executive director of the "3R & Low Carbon Society Examination."
École de Kyodai : https://eco.kyoto-u.ac.jp/

Initiative to Foster Inquiry and Independence in Science

High School Student Summit Held by Amagasaki Oda High School in Hyogo Prefecture

How much microplastic is found in sand on the Suma coastline? High School Student Summit members from the Seto Inland Sea area looked into it.

How much microplastic (small pieces of waste plastic measuring less than 5mm) exists in sand from the Suma coastline? Members of the "Environmental and Disaster Prevention Local Activities High School Summit" (hereafter High School Summit), consisting of high school students from the Seto Inland Sea area (mainly students at Amagasaki Oda High School in Hyogo Prefecture), addressed this theme. They plan to develop a self-determined joint research initiative through three Workshop sessions and present results at the High School Student Summit on November 16. This article covers the 1st Workshop session.

High School Summit planned and operated by students

On July 21, 2019, the first Sunday of summer vacation, 38 high school students met at Suma Aqualife Park Kobe located on the Suma coastline of the Seto Inland Sea. The workshop for a "microplastics investigation" of the lively beach at the Aqualife Park began. This meeting was part of the High School Student Summit held by Amagasaki Oda High School in Hyogo Prefecture, part of the Super Science High School Assistance Project* (hereafter SSH). The summit began in 2005.

Students attending Amagasaki Oda High School form a student implementation committee with students from seven nearby schools and plan and operate the High School Student Summit. Participants in the High School Student Summit come from a total of 35 schools, predominantly high schools in the Seto Inland Sea area (not only the seven schools from the student implementation committee). Furthermore, Kyoto University, University of Hyogo, Ministry of Land, Infrastructure, Transport and Tourism, Japan Coast Guard, Suma Aqualife Park, and others enthusiastically support research activities by the high school students. How did not Amagasaki Oda High School start this type of collaboration?

*The Super Science High School Assistance Project is a Ministry of Education, Culture, Sports, Science and Technology program putting R&D on an educational curriculum and placing emphasis on scientific education. The program aims to cultivate human resources for the global science and technology arena and has designated 212 schools with SSH status since 2019.

Started with information exchange in the High School Student Forum and then became the High School Student Summit

Yasuhiro Nakatani, principal at Amagasaki Oda High School, reflects on how collaboration with other schools began.

"The start was an investigation into water quality of rivers in Amagasaki by a student in 2008 as a topic for a science research class. Next came an initiative for environmental investigation of Amagasaki Port and efforts to improve water quality from 2009 and the High School Student Forum that began in 2011 for the purpose of exchanging information."

Students broadened the scope of research activities to Osaka Bay from 2011 and went further to Seto Inland Sea from 2012. They subsequently changed the name to High School Student Summit and widened the scope to disaster prevention, which is integrally linked to environmental issues, and are conducting related research activities.

First Workshop of the High School Student Summit held on July 21

Let's review specific initiatives at the 1st Student Implementation Committee and Local Inquiry Skill Workshop held on July 21.

Hiroyuki Yoshida, Director of Suma Aqualife Park, delivered a lecture on local characteristics of Seto Inland Sea and the Suma coastline. Surrounded by land, the Seto Inland Sea is more easily affected by human activity because of its large tide flow and relatively quiet waves. The Suma coastline is equipped with break walls and artificial beaches to address narrowing of beaches that previously existed. Massive amounts of waste come onto the coastline after floods, and the path of typhoons strongly affects waste volume. After an explanation of the method for carrying out the microplastics investigation, students headed to the Suma coastline.

First they collected microplastics, which have become a major problem for the Suma coastline, from sand on the beach and then investigated the number of pieces, mass, color, type, and other aspects. Using smartphones students transmitted data about the collection spot and other factors to a server and utilized GIS to display information related to microplastics on a map. A unique feature of

the High School Student Summit is that it involves not only research implemented separately by the high schools, but also joint research conducted by the seven schools. This fiscal year added use of GIS to enable presentation of the investigation results on an environmental map of Seto Inland Sea.

Even students who were initially shy gradually relaxed as they took part in the investigation working together. In the discussion afterwards there was a particularly active exchange of opinions among the students about what they learned from the investigation results.

Joint research topics decided by the High School Student Summit

After the discussion, individual teams reported on their investigation results and students reflected on the activity. Teams reported how much microplastic they found at particular locations and the group discussed what could be surmised. Some teams used graphs to show correlation in distance from the shore and height differences with the number of microplastics.

Students decided to implement measurements for common items in respective areas by their schools and map of results on a map of Japan using the measuring technique learned on this day and GIS. They also decided to deepen observations based on shared results at a 2nd Workshop and announce results of the joint research at a final announcement event in November. It will be interesting to see their research results regarding how much microplastic exists in sand from various spots on the Seto Inland Sea and whether it differ by area?

Investigation steps:

(1) Decide the investigation spot and measure and record distance from and height disparity with the beach edge.

(2) Collect sand to a depth of about seven centimeters within a space of 50 square centimeters indicated by the frame.

(3) Take out and count the number of microplastics found in the collected sand.

(4) Input measured data and location information using a smartphone.

Fueling the curiosity of students

The 1st Workshop finished after about seven hours. We spoke with three students from the student implementation committee about their experience.

"I selected Amagasaki Oda High School because I wanted to participate in the High School Student Summit and engage in research on environmental issues facing Seto Inland Sea. I'm excited to have taken this first step. Another school appears to be conducting an environmental study of the sea floor too. I'd like to also participate in that project at some point."

"This is my second year participating in the High School Student Summit. My attitude has significantly changed such as avoiding purchases of drinks in PET bottles as much as possible. I previously was not that interested in science. However, I've learned about differences in the color, size, and volume of microplastics by conducting multiple field studies and discussed research. This experience has raised my interest."

"I'm very proud of having conducted research on microplastics, a problem that is attracting global attention. Recently economic activity contributing to the problem has attracted my interest too, in addition to the science. It was refreshing to hear the different views of other people at today's workshop because I had been heavily focused on just the measurement method."

This was just the first Workshop, but students clearly recognized and learned new things. It will be interesting to watch how the students grow through the 2nd Workshop and the final announcement event.

Summarize opinions (individual teams).

Present conclusions from measurement results (individual teams).

Ways to Foster Healthy Local Areas – Fall 2018 Issue

Technology to Create Autonomous Local Resources –Iwate Prefecture's Yamada-cho, Shizuoka Prefecture's Hamamatsu, and Elsewhere.

Publication date: October 17, 2018

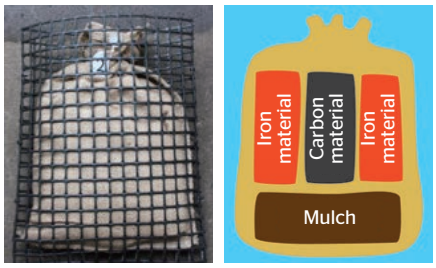
Oyster farming technology using iron and carbon is spreading from disaster-affected areas to other areas around Japan and overseas. How is a single technology implemented and advanced in these various areas? To find out more we spoke to Akira Kojima, the inventor of the technology.

Aiming to curtail the "red lake" phenomenon

The main cause of water bloom that turns the lake surface color to green and red tide that makes the sea surface become red is a heightened concentration of nitrogen and phosphorous in the water due to an inflow of wastewater from human activity and resulting abnormal expansion of phytoplankton using these nutrients. The temporary rapid increase in phytoplankton depletes oxygen and kills shellfish and fish farmed in the water. Mr. Kojima, who was researching water purification using carbon fiber, focused on phosphorous as a cause in his efforts to solve the problem.

When iron and phosphorus dissolved in water combine, the precipitate becomes insoluble and so the concentration of phosphorus in the water decreases. However, iron does not dissolve just by putting it in water. While thinking about how to dissolve iron, Mr. Kojima "remembered that iron dissolves when iron and carbon come into contact in water."

He started research in cooperation with an iron material recycling company and developed the "iron device" that pairs iron and carbon. Placing these iron devices in lakes struggling with water-bloom trouble successfully reduced phosphorous concentration in the water and eliminated water bloom.



Iron devices contain iron, carbon and mulch in a hemp bag and are dangled in sea water. Photos from Akira Kojima

Unexpected effect of iron devices

After that, he placed iron devices in Sadoshima's Kamo Lake. Iron devices dangled from oyster rafts not only curtailed "red tide" occurrence, but also had an unexpected effect. Harvest volume of high-quality healthy-sized oysters increased.

"Oysters grow by consuming phytoplankton. Breeding phytoplankton, meanwhile, requires iron as a nutrient. The stable iron supply from the iron device appears to have provided enough phytoplankton to cultivate oysters." This discovery came in 2010.

Helping revitalization after the earthquake

Tsunami waves from the Great East Japan Earthquake devastated the Sanriku coastline and its vibrant oyster farming industry in March 2011. Upon learning about the loss of rafts and other breeding equipment and difficulty reviving the industry, Mr. Kojima spoke to a matching planner at the Japan Science and Technology Agency about whether he might be able to help revitalization from the earthquake disaster. This led to joint research with the Sanriku Yamada Fisheries Cooperative Union (Yamada-cho, Iwate Prefecture) in Yamada Bay in October 2012.

Producing high-quality oysters in a short period

Application of iron devices promotes oyster growth and shortens time needed until the harvest. Mr. Kojima visited Yamada Bay almost daily, discussing the project with local people and verifying the materials and shape of iron devices. "I learned that obtaining desired results required tinkering for the specific area despite using the same principle."

Oysters harvested two years after installing the devices had 30% more raw shellfish weight and 70% more glycogen, the umami portion, than previously. Mr. Kojima recalls that, "Success in harvesting oysters with high added value was a major step toward autonomy."

Yamada Bay when joint research started.

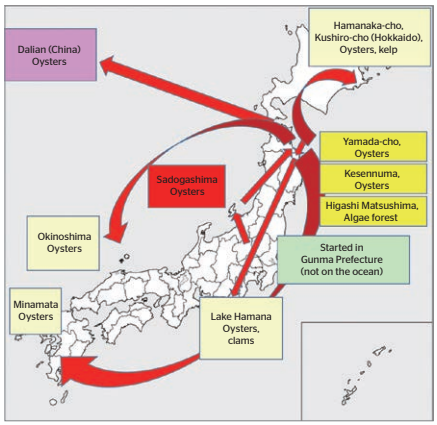
Lowering iron devices into the water from the rafts.

Oysters harvested with the iron device after two years.

Cultivated to a larger size.

Photos from Akira Kojima

Spreading around Japan, and headed to China too



Water purification technology developed in Gunma Prefecture, which is not on the ocean, has helped improve the fishery industry in various areas, starting with Sadoshima.

The iron devices, which support production of high-quality oysters in a short amount of time, attracted interest from oyster farming areas that wanted to increase output and develop brands.

Real-world experiments have moved forward in Miyagi Prefecture's Kesennuma, which was also impacted by the Great East Japan Earthquake, as well as Hokkaido's Hamanaka-cho, Shizuoka Prefecture's Hamamatsu, Shimane Prefecture's Oki Islands, and Kumamoto Prefecture's Minamata. The Minamata initiative is contributing to revitalization after the Kumamoto Earthquake (2016). There are efforts to deploy iron devices in China's Dalian area too.

While iron device structure and other aspects are modified to address conditions in the various areas, Mr. Kojima notes that there is something more important than just optimizing the technology. "To determine an approach suited to the local area, it is necessary to directly meet with and speak to local people and present a sincere proposal based on an understanding of the other party."

Promoting activities involving the whole area

Spillover effects from iron devices go beyond just advancement of the oyster farming industry. Mikkabi-cho (Kita-ku, Hamamatsu) in Shizuoka Prefecture has engaged the whole area through multifaceted activities, including education and industrial promotion.

Mikkabi Middle School, located in the vicinity of Inohana Lake outfitted with iron devices, implements a variety of projects on the theme of "doing something to help the local area" with 20 year goals as part of its comprehensive education. Mr. Kojima is an adviser to the team that aims to "farm oysters and develop a local industry." He comments that "middle school students are utilizing iron devices with their unique creativity." Furthermore, the project helps promote farmed oysters at local events and has developed original menus as contributions to creating new regional appeal.

Targeting a clean and prosperous Inohana Lake

Middle school students confirm the effect of iron devices. Local residents and the Mikkabi Youth Group worked together to make the rafts.

Confirming the effect of iron devices in Inohana Lake over time with Mr. Kojima as the adviser.

Mr. Kojima's involvement with Inohana Lake goes back to 2006. It started with a consultation with Mr. Kojima about improving water quality by Waranokai, a citizen's group trying to boost activity in Mikkabi-cho. Mr. Kojima, who was working on water purification with carbon materials at the time, proposed a method of utilizing charcoal made from old tangerine (mikan) trees - tangerines being a local specialty. Results steadily surfaced with improved water transparency and increase in shellfish, fish, and other living beings.

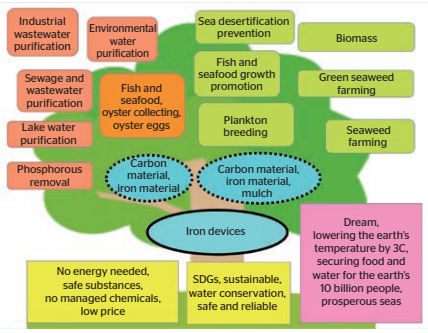
The group has worked to revitalize oyster farming through the use of iron device technology since 2013.

Mr. Kojima discussing views with Waranokai members.

Application as a technology to "create prosperous seas"

Mr. Kojima explains that, "The iron device is a safe and sustainable technology. I want to enhance this technology and apply it broadly in various regions in order to ensure abundant seas 100 years from now."

Technology with a solid purpose should be applicable to various regions with the same issues and contribute to the creation of new local resources. Cultivation of technology through interaction between technologists and local people is likely to make it possible for the technology to become a "self-established local resource" once it moves out of the hands of the technologist.



"The iron device is a supplement for 'creating forests in the sea' and is a technology that can contribute to realizing the SDGs," according to Mr. Kojima. (Prepared using an image provided by Akira Kojima)

Akira Kojima

Born in Kiryu, Gunma Prefecture in 1943. Started working at Gunma College, National Institute of Technology after graduating from Gunma University's Faculty of Engineering in 1968. He has served as Director of the Akira Kojima Research Institute and Principal of Maebashi General Technology Business College since 2016. His fields of expertise include inorganic materials, composite materials, and environmental chemistry. He has conducted R&D on carbon materials for many years.

'STI for SDGs' AWARD

Giving the STI for SDGs Award!

The STI for SDGs Award recognizes excellent initiatives to find solutions to issues facing local societies utilizing Science, Technology and Innovation (STI).

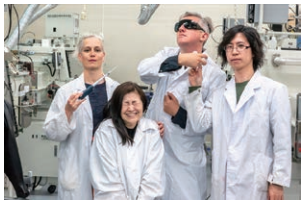
The program aims to promote further advancement of initiatives and horizontal application to other areas with similar social issues and thereby make contributions to achieving the SDGs.

MEXT Minister Award

Japan Advanced Institute of Science and Technology (JAIST)

Cutting-edge plant dyeing aimed at detoxifying dye wastewater

Raised the level of natural dye performance to chemical dyes. Built a local co-creation framework and realized natural dyeing processes for *yuzen* (a traditional Japanese dyeing technique) and dresses.

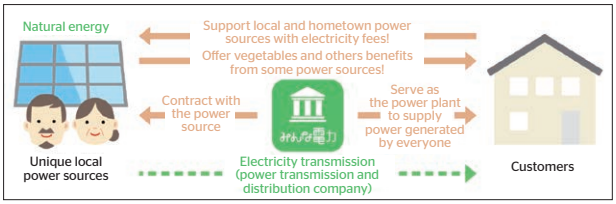


JST President Award

Minna-denryoku, Inc.

"Visible Power" that links renewable energy producers and consumers through "support" and blockchain

Linked power generation plants and consumers with blockchain and realized visualization of electric power and choice freedom. Contributed to local area advancement too.



Excellent Practice Awards

The National Agriculture and Food Research Organization (NARO)

Initiative to reduce greenhouse gas emissions caused by farming and realize stable food production utilizing technology that addresses climate change

Solidified technology to reduce methane emissions from paddy fields. Successfully developed a rice breed for hot weather and offering it as a brand.

i-Compology Corporation

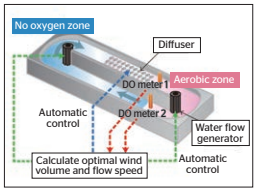
Promotion of SDGs utilizing bioplastic composite materials

Manufactures plastic alternatives with biomass from thinned wood and other mountainous area resources and brings them to market.

Kochi University, Natural Sciences Cluster Agriculture Unit

Kochi-led initiative to improve the sustainability of sewage treatment
New technology development by industry, government, and academia for nationwide application

Developed new technology for sewage treatment with industry, government, and academia cooperation. Lowered costs and enhanced sustainability of sewage treatment by local cities.



Smileyearth Co.

Leading local industry in the "birthplace of Japanese towels" into the future with a cyclical stress-free towel production process

Solved river pollution caused by reliance on chemicals in towel production, a local industry, using STI.

Next Generation Award

Kumamoto Prefectural Amakusa High School, Science Team

How many centimeters in your area? – Initiative to estimate the amount of increase in sea level due to global warming led by high school students

Estimated future sea levels by area using sediment deposit analysis and temperature forecasts. Actively promoting collaboration too.

Japan Science and Technology Agency

SUSTAINABLE DEVELOPMENT GOALS

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Department for Promotion of Science in Society
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