Chapter 2 Realization of Sustainable Growth and Societal Development into the Future

Section 1 Recovery and Reconstruction from the Great East Japan Earthquake

Numerous efforts have been made to resolve the various issues listed in the Basic Guidelines for Reconstruction in response to the Great East Japan Earthquake (GEJE) (determined by the Reconstruction Headquarters in response to the GEJE on July 29, 2011, "Basic Guidelines for Reconstruction") that show the policy for recovery and revitalization from the GEJE, promptly rebuild victim's lives and realize a secure and safe society, by making full use of science, technology and innovation (STI). This includes the creation of new industries, development of decontamination and improvement of disaster information systems with the most advanced technology by calling upon the joint insight of industry-academia-government.

1 Promotion of Measures to Accomplish the Most Important Issues

(1) Restoration and revival of industries in the disaster areas

The industries in the area suffered significantly from damage by the earthquake, tsunamis and diffusion of radioactive material. The various problems that surfaced from the earthquake disaster are being resolved by making full use of science and technology (S&T) toward realizing a vigorous revival with prompt reconstruction of the base of economic and industrial activities. As well, advanced R&D, taking advantage of strengths and characteristics of each area, is being pursued in the field of research leading to creation of a new growing industry and employment which are expected to help the reconstruction in the disaster areas.

The Ministry of Internal Affairs and Communications (MIC) is planning to establish new facilities for R&D and empirical experiments at Tohoku University and others institutions, with the aid of National Institute of Information and Communications Technology (NICT). The plan is to actively share information about the results at home and abroad, to organize a new R&D and innovation base with industry-academia-government collaboration in the information and communication fields.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has established the "Tohoku Marine Science Center" as a network of universities and research institutes in collaboration with local municipalities and national ministries concerned. The center has been conducting surveys and research to support the restoration of the offshore marine ecosystem which was damaged by tsunamis on the Pacific coast of Tohoku. The results have been used to draft a local fishery plan and to select the locations of fish farms. The center also conducts R&D of technology to foster new industries.

MEXT is also implementing the "Tohoku Medical Megabank" Project, which promotes population-based cohort study in areas affected by the GEJE. The project aims to restore medical services in the disaster areas and to provide advanced medical care, such as preventive method contributing to personalized medicine. The project is being organized in close collaboration with the regional medical information center that is being developed with the support of MIC and the Ministry of Health, Labour and Welfare (MHLW).

MEXT is also promoting the "Tohoku Innovative Materials Technology Initiatives for Reconstruction" with the aim to drive the development of the materials industry in Tohoku area by forming a nanotechnology R&D center through industry-academia-government cooperation and developing cutting-edge materials using world-leading technologies in the nanotechnology and material fields, in which universities and industries in Tohoku are strong.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) is conducting a large-scale experimental study of the farming industry - farming village type model areas being located in Iwate, Miyagi and Fukushima prefectures and the fishery industry - fishing village type of model areas being located in Iwate and Miyagi prefectures. The study is making full use of advanced technology in the fields of agriculture, forestry and fisheries. This is being done to accelerate reconstruction and revival of agriculture, forestry and fishing as key industries in the farming or fishing villages of the disaster areas and to develop a new growing agriculture, forestry and fishing industry. The ministry is also making efforts to analyze the effects of technology introduction, as well as diffusing and promoting research results. Empirical research topics include: application of greenhouse horticulture technology in the mountainous, less favored areas for agriculture, stable year-round culturing of eustoma flowers by nutrient solution and stable, low-cost, efficient oyster culturing technology. For example, in Miyagi prefecture, the use of a bench for strawberry nutrient solution culture used to be uncommon. However, some of the strawberry culturing technology results from the empirical research were adopted as the standard technology at the strawberry production parks in Miyagi prefecture that were restored from damage after the disaster.

The Ministry of Economy, Trade and Industry (METI) is taking measures to promote R&D by industry-academia-government collaboration in growing fields such as medical and renewable energy to create new industries and employment.

For instance, the ministry is assisting activities to revitalize regional industries in Fukushima prefecture, including a joint project to develop and demonstrate medical equipment by manufacturers and medical institutions in Fukushima prefecture and a project led by Fukushima Medical University to found a drug discovery center through the Recovery Fund concerning Nuclear Emergency Preparedness in Fukushima established for restoration from nuclear hazards.

In efforts to promote the introduction of renewable energy, METI has also supported an industry-academia-government project for founding a renewable energy R&D center, a project targeting the commercial operation of the largest floating offshore wind power plant in the world and an initiative to build a disaster-resistant smart community focused on the use of renewable energies.

(2) Restoration and rejuvenation of social infrastructures

In the disaster areas many civil engineering or building structures were destroyed or washed away, social infrastructures were blocked due to the earthquake, tsunamis and liquefaction and enormous damage was caused. In light of such damage, technical advice for restoration of bridges and banks which suffered from the tsunamis is being provided. R&D into the recovery of lifelines and improvement in seismic capacity of structures is also being conducted. Additionally, disaster-resistance of the information and communications facilities is being strengthened. R&D into Information and Communications Technology (ICT) that obtains the damage condition data in the damaged areas in case of a disaster are being conducted.

In the case of the GEJE, intensive use of telephones or widespread and great damage to communication facilities made it impossible to secure the communication means necessary during the disaster.

Having learned lessons from these problems, MIC has vigorously applied its research outcomes such as communication capacity reallocating technology to adjust to increasing telephone demand (network virtualization technology) and a communication system that can be carried in disaster-stricken areas for emergency restoration of communication (movable and deployable ICT resource unit) to communities in Japan and worldwide. A demonstration experiment project using the mobile ICT unit in the Philippines is an example of these activities in cooperation with International Telecommunication Union (ITU) and the Ministry of Science in the Philippines.

R&D of a coordinated control radar system has also been conducted. This technology system is made up of more than two transmission and receiving stations, both able to conduct high accuracy 3D observations without increasing the number of frequencies used. In MIC and NICT, furthermore, R&D of the airborne synthetic aperture radar, Polarimetric and Interferometric Synthetic Aperture Radar System 2 (Pi-SAR2), which can flexibly and as needed observe land surface situations in the event of disaster whatever the weather and the electromagnetic wave sensing technology, which can make a non-destructive diagnosis of structural health of buildings if there is the possibility of damage by earthquakes, is being conducted.

MEXT launched the "Special Project for Reducing Urban Vulnerability to Mega Disasters" to investigate the urban resilience and assess the seismic collapse capacity of building structures using 3-D Full-Scale Earthquake Testing Facility (E-Defense).

The National Research Institute for Earth Science and Disaster Prevention (NIED) has investigated the destruction process of actual structures such as buildings and infrastructures in large-scale shaking experiments using E-Defense and conducted R&D into effective disaster mitigation technologies to minimize damage from disasters.

In addition, the National Institute for Materials Science (NIMS) has comprehensively conducted R&D in the material field, in which Japan excels, for technologies and new structural materials to inspect, diagnose, repair and upgrade infrastructure with the aim of extending the service life and enhancing the earthquake resistance of the social infrastructure, which poses a major social threat because of aging.

The National Institute for Land and Infrastructure Management (NILIM) of MLIT has conducted R&D for technologies to support infrastructure recovery and TEC-FORCE[1] activities using airborne portable SAR and conventional camera sensors to accelerate the initial response to a large earthquake. It also studies advance investigative measures to facilitate post-quake housing recovery and provides technical support to local governments concerning housing recovery.

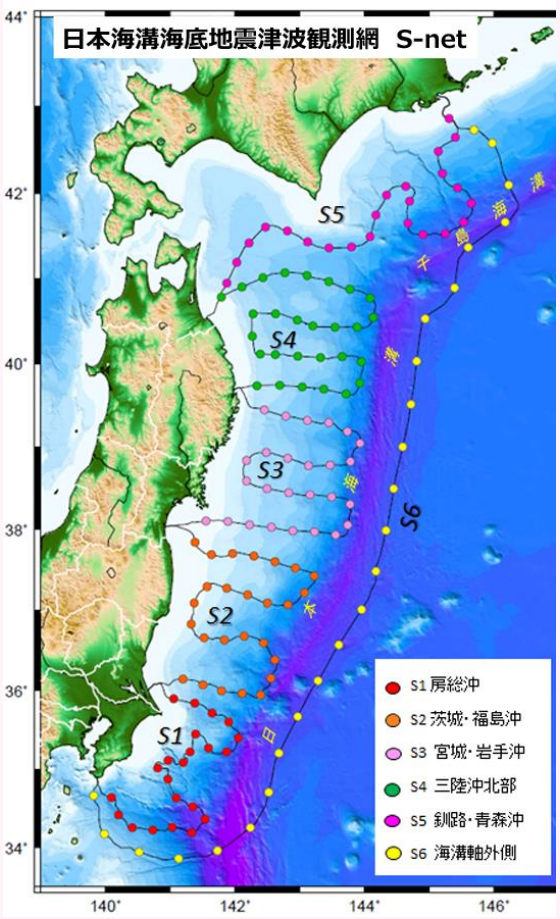
The Public Works Research Institute (PWRI) is conducting research on the characteristics of the resistance behaviors of bridges affected by tsunamis and on the technologies addressing issues associated with such bridge behaviors. It is also researching the feasibility of a liquefaction determination method to urgently deal with the damage caused by the tsunamis and liquefaction which occurred as a result of the Off the Pacific Coast Tohoku Earthquake.

1 Technical Emergency Control Force: MLIT

(3) Realization of safe living in the disaster areas

1) Reinforcing efforts for disaster prevention and mitigation measures in the disaster areas

■ **Figure 2-2-1 / Outline of the Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench**



Source: MEXT

An increase in greater seismic activities has been observed in the vicinity of the aftershock area of the 2011 off the Pacific coast of Tohoku Earthquake. It is likely that great aftershocks or induced seismicity will occur in future, causing strong shaking and a major tsunami. The Headquarters for Earthquake Research Promotion has been promoted the observational system that can help reduce the damage caused by earthquake and tsunami through increasing our understanding of generation mechanism of earthquake and tsunami and providing the accurate and timely information. In addition, a disaster information provision system, developed with the aim of collecting, preparing and transmitting information useful for disaster response, recovery and reconstruction, has been set up in the disaster areas. Furthermore, surveillance and monitoring technology for lifesaving has been developed and research to mitigate damage from fires caused by earthquakes has been conducted. .In FY 2014, MEXT started developing the Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench (S-net), which helps to convey quick and accurate disaster information based on direct detection of earthquakes and tsunamis off the Pacific Coast of the Tohoku Region. Construction in the northern part of Off-Sanriku and off the coasts of Miyagi and Iwate prefectures started in FY 2011 for full-scale operation in FY 2015 (Figure 2-2-1).

The Fire and Disaster Management Agency (FDMA) is developing surveillance and monitoring technology, using an unmanned helicopter, for the rapid location and saving of survivors in tsunami-hit sites, for reconnaissance technology applicable to fire-fighting in debris or water-covered areas and for rescue technology. The prototype has been developed, test operated and improved in advance of practical application.

Development of unmanned helicopter technology for reconnaissance and monitoring
Source: NRIFD

Development of footing and rescue techniques
Source: NRIFD

In preparation for interrelated massive earthquakes, the agency collected knowledge from studies on the prediction of strong ground motion at petrochemical complexes and on preventive measures against and estimation of petroleum tank damage caused by tsunamis, to establish technical standards for tsunami countermeasures and a petroleum tank damage estimation system. Consequently, damage rate curves to estimate the damage rate of petroleum tank piping during tsunami were plotted and knowledge obtained from studying the short-distance spatial amplitude in long-period ground motion and the effect of underground structure on it. In addition, the agency conducted studies on fire-prevention and fire-extinguishing measures at earthquake debris or scrap metal deposits to determine correlation between the fermentation heat value and the risk of thermal ignition.

Fire occurred at tsunami debris and deposits in Natori City.
Source: NRIFD

Fire exposure experiment of a solar cell module
Source: NRIFD

Furthermore, the agency is collecting information on fires that broke out during the GEJE and is conducting studies on preventive technology and fire-prevention measures by determining the characteristics of fires depending on the presence or absence of tsunami damage based on survey analysis of fire or fire spreading causes. The agency conducted the study to clarify risk factors in fire-fighting activities by conducting experiments with a solar power system, the utilization of which is predicted to be promoted in future and to elaborate a policy of safe fire-fighting. Also, the agency is analyzing the gas generated by the combustion of solar power systems and studying the development of power generation control technology.

2) Response to the accident at TEPCO Fukushima NPS

(i) Implementation of radiation monitoring

With respect to the radiation monitoring as a result of the accident at the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company, Incorporated (hereinafter referred to as "TEPCO"), relevant ministries, Fukushima prefecture and other authorities, are: conducting measurements of air dose rates at the monitoring posts, analysis of radioactive substances contained in the soil by type of nucleus, analysis of radioactive substances contained in the water and soil of rivers and seas and monitoring of radioactive substances contained in food and tap water. This is being done in line with the "Comprehensive Monitoring Strategy" (adopted by the Monitoring Coordination Meeting in August of 2011 and revised in March and April of 2012 and in April of 2013) (Figure 2-2-2). The Nuclear Regulatory Authority is the governing body for radiation monitoring. It confirms and analyzes the monitored data by the organizations concerned and publishes a weekly summary on its website[1].

In FY2014, to understand the distribution of radioactive substances released by the accident at the TEPCO Fukushima Daiichi Nuclear Power Station, the ministry brought together information concerning the distribution conditions of gamma-emitting radionuclides such as radiocesium, (Figure 2-2-3). The ministry also published travel survey results conducted in cooperation with local governments. In addition, the ministry conducted aerial monitoring, both within and outside of 80km from the TEPCO Fukushima Daiichi Nuclear Power Station and announced the air dose rates (Figure 2-2-3). In coastal areas, sea water, seafloor beds and marine life off the coasts of Fukushima, Miyagi and Ibaraki prefectures were jointly monitored by the relevant ministries and local governments in line with the "Marine Area Monitoring Procedure" formulated on April 1, 2014.

Air dose rates are measured by a real-time dose measurement system set up in Fukushima prefecture, using portable monitoring posts set up in the whole of Fukushima prefecture and neighboring prefectures and by fixed monitoring posts set up in all prefectures throughout Japan for strengthening the nationwide radiation survey system. These measurements are displayed on the website on a real-time basis (Figure 2-2-4).

1 http://radioactivity.nsr.go.jp/ja/index.html

■ Figure 2-2-2 / Monitoring System Implementation in Ministries in Accordance with the Comprehensive Monitoring Strategy

Major monitoring targets in the Comprehensive Monitoring Plan (modified on April 1, 2014) * Monitoring systems of ministries according to the Comprehensive Monitoring Plan

Monitoring of the environment in general throughout Japan (Nuclear Regulation Authority, relevant prefectural authorities)
- Real-time publication of measurement results of air dose rate at monitoring posts in each prefecture
- Monthly concentration measurement of radioactive substances for precipitation composition (dust in rain or the air), once three months for clean water (at the faucet) to the same accuracy of analysis as the level research before the accident
- Aerial monitoring in the area of a relatively-high level of deposition amount of radioactive substances in the prefectures adjacent to Fukushima Prefecture

Monitoring of the environment in general throughout Fukushima Prefecture (Nuclear Regulation Authority, Nuclear Emergency Response Headquarters, Fukushima Prefecture, TEPCO and others)
- Real-time publication of measurement results of air dose rate at portable monitoring posts placed in Fukushima Prefecture and the prefectures adjacent to Fukushima Prefecture.
- Continuous measurement of air dose rate, airborne dust etc. around the NPP
- Check of distribution of air dose rate and deposition situations of various radioactive substances on the ground as well as survey of radioactive substances transfer in the land areas
- Periodical aerial monitoring within 80 km of the NPP
- Detailed monitoring of the evacuation order areas

Monitoring in marine areas (Nuclear Regulation Authority, MLIT, MAFF, Japan Coast Guard, MOE, Fukushima Prefecture, TEPCO and others)
- Concentration measurement of radioactive substances in marine water, soil and organisms in (1) marine areas adjacent to TEPCO Fukushima Daiichi NPS, (2) coastal areas, (3) offshore areas, (4) oceanic regions and (5) Tokyo Bay, centering on Fukushima Prefecture and neighboring prefectures

Monitoring of water environment (MOE, Fukushima prefecture)
- Concentration measurement of radioactive substances and measurement of the air dose rate in water, sediment and environment samples from rivers, lakes, marches, water sources, ground waters and coastline areas in Fukushima prefecture and neighboring prefectures

*** The results of each monitoring as shown above are collectively published via the portal site set up on the Nuclear Regulation Authority website.**

Monitoring of schools and nursery centers (Nuclear Regulation Authority MEXT, MHLW and Fukushima Prefecture)
- Real-time publication of measurement results of air dose rate at about 2,700 real-time dose measurement systems placed at schools in Fukushima Prefecture
- Concentration measurement of radioactive substances in water in outdoor pools
- Check of radioactive substances concentration in school lunches

Monitoring of seaports, airports, parks, sewage etc. (MLIT, Fukushima Prefecture, local authorities and others)
- Concentration measurement of radioactive substances in sewage sludge
- Measurement of air dose rate at seaports, airports, urban parks etc.

Monitoring of waste in natural parks, etc. (MOE, Fukushima prefecture, municipalities, TEPCO and others)
- Analysis of concentration measurement of radioactive substance in wild plants and animals
- Concentration measurement of radioactive substances in final effluent from waste disposal and treatment facilities and measurement of the air dose rate at site boundary pursuant to the Act on Special Measures in relation to Measures for Environmental Pollution by Radioactive Materials

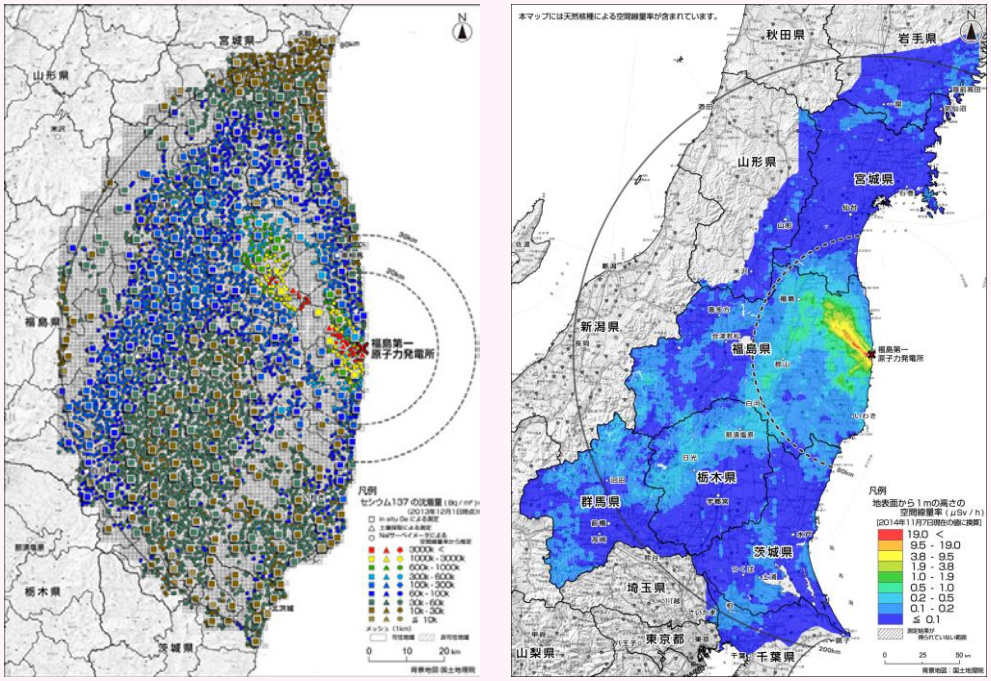
Monitoring of farm soil, forests and pasture (MAFF, Forestry Agency, relevant prefectural authorities Prefecture)
- Understanding of alteration in concentration of radioactive substances and clarification of the transfer characteristics in Fukushima Prefecture and neighboring prefectures
- Concentration measurement of radioactive substances in forest soil, branches, leaves, bark, forests wood and others in test areas in Fukushima Prefecture
- Concentration measurement of radioactive substances in pasture by prefectures
- Concentration measurement of radioactive substances in reservoirs in Fukushima Prefecture.

Monitoring of tap water (MHLW, Nuclear Emergency Response Headquarters and relevant prefectural authorities)
- Concentration measurement of radioactive substances in pure water from purification plants or raw water from intake sources by prefectures and in tap water by water sources in Fukushima Prefecture

Monitoring of foods (MHLW, MAFF, Fisheries Agency, Fukushima Prefecture and relevant prefectural authorities)
- Concentration measurement of radioactive substances in foods
- Measurement of actual exposure dose due to ingestion of contaminated foods

Source: Created by the Nuclear Regulation Authority

■ Figure 2-2-3 / Radioactive Substances Distribution Map

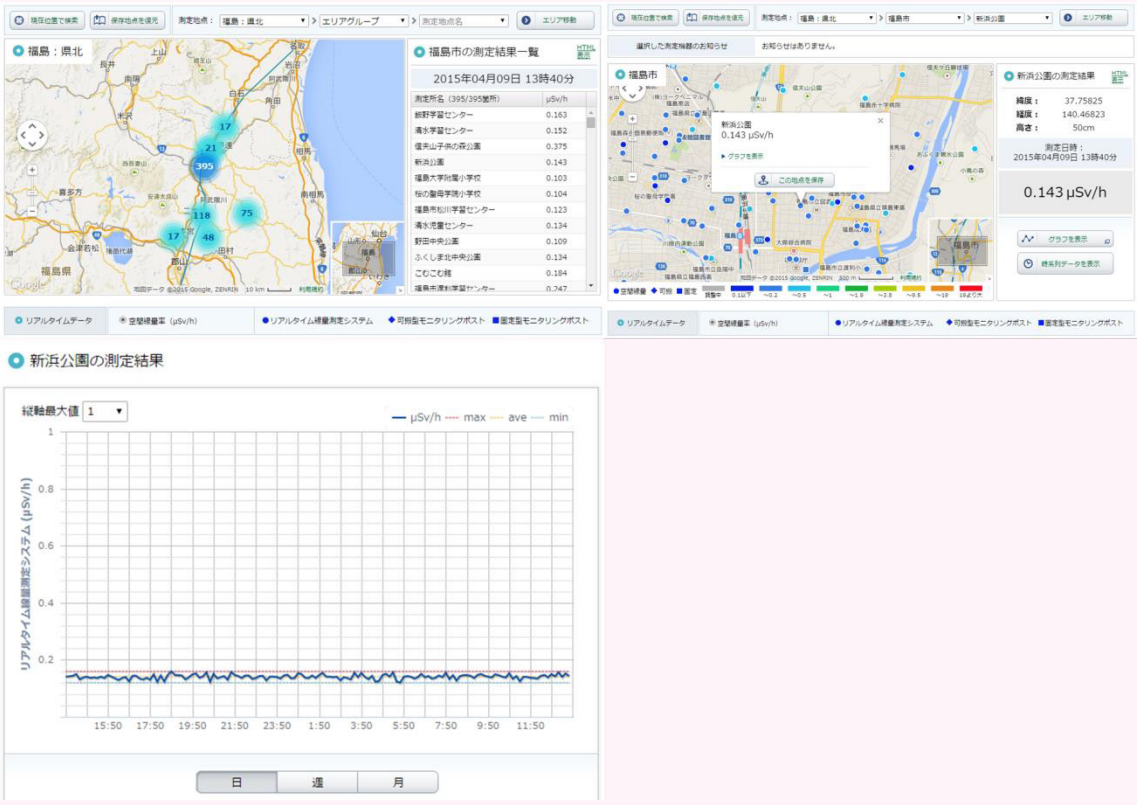


*** Cesium 137 soil concentration map (left)**

*** The spatial dose rate map of Fukushima and neighboring prefectures (As of November 7, 2014: 44 months after the accident) (right)**

Source: Created by the Nuclear Regulation Authority

■ **Figure 2-2-4 / Radiation Measurements Map**



* The system is under the management of the Nuclear Regulation Authority after April 2013
Source: Created by the Nuclear Regulation Authority

MHLW set and adopted a management target value for the radioactive substances in tap water (10 Bq/kg total of cesium 134 and 137) on April 1, 2012, in reviewing of the standard values of radioactive materials in foods and in light of the monitoring results of radioactive materials in tap water. Since that time, the monitoring results have not exceeded the management target value and no intake restrictions have had to be implemented.

MAFF conducted surveys on the distributions of radioactive materials in farmland soil to advance efforts for restarting farming. This includes farmland decontamination. The ministry also conducted surveys on radiocesium concentrations and its cumulative dosage in soil, fallen leaves, living leaves and the trunks of trees in four areas of Fukushima prefecture and published the consolidated distributions of radiocesium in these forests in March 2015.

(ii) Efforts toward decontamination

The organizations concerned are working together to rehabilitate the environment contaminated by radioactive materials released due to the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

The Ministry of the Environment (MOE) accepted outstanding technologies, for example, applicable to improvements in decontamination work and reductions in the volume of materials resulting from decontamination through public advertising and is now under demonstration tests on decontamination technologies to confirm the decontamination effect, economy and safety, etc.

The Japan Atomic Energy Agency (JAEA) is conducting R&D into technology for measuring radiation dose and the behaviors of radioactive substances in the environment, aimed at restoration of environments contaminated by the radioactive substances released by the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

MAFF not only develops decontamination technology aimed at the effective and efficient decontamination of forests and farmlands, but also demonstrates the decontamination technologies for farm land and forestry so far developed, to establish them as methods applicable in the needed places. Their results are published swiftly.

The National Institute of Advanced Industrial Science and Technology (AINST) enhanced the performance of a nanosized absorbent made of inorganic compound called Prussian blue, applied it in a demonstration test for preventing the diffusion of radioactive cesium deposited in storage reservoirs and obtained results that can be used for processing radioactive materials in the agricultural water. This absorbent was also used in the equipment developed for largely reducing the time for analyzing a small quantity of radioactive cesium in the environmental water. The equipment is expected to be used for long-term assessment of the effect on the environmental at various areas.

(iii) Efforts toward the decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company, Incorporated

For the decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4, METI, MEXT and other ministries and agencies concerned conducted R&D necessary for fuel extraction from the spent fuel pools, fuel debris extraction from the interior of the reactors, radioactive waste disposal and other related work in collaboration with the organizations concerned. This was based on the "Medium- to Long-term Roadmap towards Abolition of Units 1-4 of the TEPCO Fukushima Daiichi Nuclear Power Station" created in May 2011 and revised as required. Of the issues which may arise in the process of operation, contaminated water treatment, removal of fuel from spent fuel pools, removal of fuel debris from reactors and disposal of radioactive waste are particularly difficult to handle, due to the considerable technical difficulty and the fact that the government is required to support all R&D concerning these issues.

MEXT announced the "Acceleration Plan of Reactor Decommissioning R&D for Fukushima Daiichi NPS, TEPCO" in June 2014 and based on this, set up the "International collaborative research center on decommissioning" under JAEA in April 2015 to consolidate knowledge in Japan and overseas for safe and steady decommissioning.

To promote the "Medium- to Long-term Human Resource Development and Collaboration with Universities and Research Institutions" specified in the Mid-and-Long-Term Roadmap, MEXT launched the "Program for Decommissioning Basic Research Human Resource" from FY 2014 to support the human resource development required for safe and steady decommissioning by consolidating knowledge from various fields for medium- to long-term basic research, which is difficult for the private sector to deal with independently as part of prioritized human resource development for decommissioning.

(iv) Regarding compensation for nuclear damage

Since the accident at the TEPCO Fukushima Daiichi and Daini Nuclear Power Stations, a number of

residents have been forced to live in evacuation shelters, or to give up business activities such as manufacturing and sales. It is essential that these victims receive compensation promptly, equally and appropriately so that they may return to safe, secure living as quickly as possible.

In accordance with the Act on Compensation for Nuclear Damage (Act No. 147 of 1961), MEXT instituted the Dispute Reconciliation Committee for Nuclear Damage Compensation. The committee has been formulating guidelines to indicate the damaged items that can be classified with certain criteria and the extent of compensation, with the input of local opinions. Furthermore, the Nuclear Damage Compensation Dispute Resolution Center, established in August of 2011, has been conducting reconciliation of alternative dispute resolutions while improving its operations and increasing in personnel.

The government approved the "New Comprehensive Special Business Plan" in January 2014 (followed by revisions in August 2014 and April 2015) which made mention of taking prompt and appropriate compensation for nuclear damage and streamlined management in TEPCO. And the government has been providing assistance to TEPCO through the Nuclear Damage Compensation and Decommissioning Facilitation Corporation and to facilitate the compensation process. Japan concluded the Convention on Supplementary Compensation for Nuclear Damage (Entry into force in April 2015) in order to contribute to establishing the global nuclear liability regime and the related domestic laws[1] were enacted.

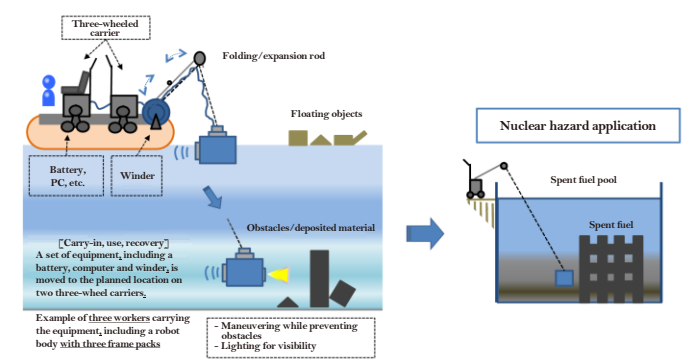
1 "Act on Subsidization, etc. for Nuclear Damage Compensation Funds Attendant upon Implementation of the Convention on Supplementary Compensation for Nuclear Damage" (Act No. 133, November 28, 2014) and "Act for Partial Revision of the Act on Compensation for Nuclear Damage and the Act on Indemnity Agreements for Compensation of Nuclear Damage" (Act No. 134, November 28, 2014)

Column 2-1 Development of disaster response robots joined by student of college of technology in afflicted region

Fukushima prefecture launched the "Disaster Response Robot Industry Intensive Support Program" in FY 2014 using the METI project for creating industries by developing disaster response robots and promoting recovery from the Great East Japan Earthquake.

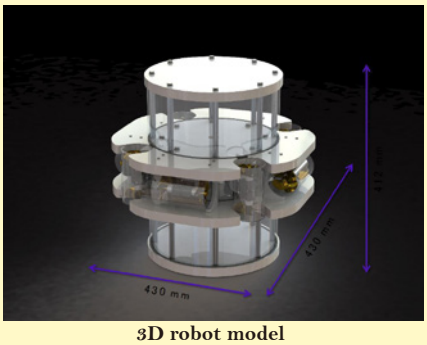
For the public invitation to this program, Fukushima National College of Technology was one of the applicants, including local companies and JAEA, accepted under the project name "Development of disaster response robot system of the investigation of narrowed area underwater" and began developing a compact underwater robot usable for prompt and safe undersea searches following tsunami disasters and spent fuel pools at a nuclear power plant for decommissioning.

Shota Iizuka, (then) freshman in the advanced course of engineering of the mechanical and electric system at Fukushima National College of Technology, took part in this compact underwater robot project under the tuition of Associate Professor Suzuki of the college. The Fukushima National College of Technology was mainly responsible for the conceptual examination of the robot body and the overall design (mechanical design) in the whole robot development project.



Images of overall system
Source: Created by MEXT based on data provided by Fukushima Technical Junior College Development of reconnaissance technology and rescue technology

The project aimed to develop a compact underwater robot with mobility for easy transportation and carrying in on site during disasters, flexibility for attaching optional tools as required and availability for operation in narrow areas. Iizuka started developing a robot to meet these requirements in October 2014, completed the mechanical design of a robot with a compact and simple structure (430mmW, 430mmD, 412mmH), capable of moving horizontally back and forth and right and left and performing swift and safe underwater surveys in December 2014 and sent the design drawing with 3D model data to local companies involved in the project.



3D robot model
Source: Fukushima Technical Junior College

These companies assembled the robot according to the distributed data and completed a prototype in February 2015. The prototypes are under evaluation tests at present and the robot is scheduled for completion in FY 2015.

The robot is expected to serve in the search for missing people during disasters, work for decommissioning of a nuclear reactor and recovery from disasters by creating new industries.

2 System Reform for Restoration and Recovery from Earthquake Disaster

As an effort to quickly and effectively realize industrial revival and area rehabilitation in the disaster areas, Japan is promoting the foundation of R&D bases to accelerate industry-academia-government collaboration in and around the disaster areas.

In particular, Japan is improving R&D bases through collaboration between industry, academia and government in an effort to create new industries to contribute to the restoration of the disaster areas.

■ **Table 2-2-5 / Major Projects for Recovery and Reconstruction from Earthquake Disaster (FY2014)**

Ministry/ agency	Implementation	Project
Reconstruction Agency	Reconstruction Agency	Next-generation Energies for Tohoku Recovery Project
		Tohoku Ecosystem-Associated Marine Sciences program
		Maintenance for National Universities and Inter-university Research Institute Corporations
		Tohoku Medical Megabank Project
		Tohoku Innovative Materials Technology Initiatives for Reconstruction
		A Scheme to Revitalize Agriculture and Fisheries in Disaster Area through Deploying Highly Advanced Technology
		Forest Decontamination Demonstration Project
		Verification of Radioactive Decontamination of Forests and Recovery of Forestry Industry
		Projects to establish Fukushima as a base for renewable energy R&D
		Verification Projects of Decontamination Technology
	NIED	Seafloor observation network for earthquakes and tsunamis along the Japan Trench
	AIST	Projects to establish Fukushima as a base for renewable energy R&D
MIC	MIC	High Resolution Airborne Synthetic Aperture Radar to be Mounted on small Aircraft
	National Research Institute of Fire and Disaster (NRIFD)	Costs of R&D of fire extinguishing robots that respond to energy and industrial infrastructure disasters
MLIT	NILIM	Study on assessment methods and criteria for earthquake-proof safety of nonstructural components (exterior)
		Study on Technology to instantly Predict Large-Scale and Wide-Area Earthquake Damage
		Research on maintaining stable port and harbor operation when a tsunami disaster occurs

Section 2 Promotion of Green Innovation

It is necessary for Japan to strongly promote green innovation to address the following two issues: 1. procurement of a stable energy supply and 2. responding to climate changes faced by Japan as well as the international community. Taking a long-term view, with the aim of building a stable energy supply-demand structure and the world's most advanced low-carbon society through further enhanced environmental and energy technology innovation (in which Japan has a decided advantage), Japan will positively promote the expansion and spread of such technologies or systems at home and abroad to realize sustainable growth in Japan. To accomplish these objectives, Japan must prioritize three issues and promote R&D to resolve them: 1) realizing a stable energy supply and a low-carbon society, 2) increasing and smartening energy utilization efficiency and 3) greening of social infrastructures.

1 Promoting Measures to Accomplish the Important Issues

(1) Realizing of a stable energy supply and a low-carbon society

To realize a stable energy supply and a low-carbon society, the R&D for innovative technology aimed at accelerating the spread of renewable energy and for innovation of the energy transmission system is being

promoted in a manner consistent with Energy Security, Economic Efficiency, Environment and Safety of the energy supply all over Japan. In addition, measures for promotion of biomass utilization have been taken according to the "Basic Plan for the Promotion of Biomass Utilization" (decided by the Cabinet in December 2010) prescribing the basic policies and objectives of Japan.

1) R&D for renewable energy technology

MEXT is promoting R&D toward the rapid improvement of conventional technology for renewable energies such as solar power generation and biomass utilization. In particular, in the fields of plant science and advanced environmental materials, the ministry is promoting R&D aimed at the construction of a "Green Network of Excellence" to comprehensively support studies at the highest global standards. Also, it is promoting human resource development (HRD) in the relevant fields with research targets, facilities and personnel sharing among the leading universities in Japan under a strategic cooperation plan.

To realize the restoration of the affected areas following the GEJE, as well as innovative R&D for renewable energies, the ministry is not only establishing a R&D base for super-efficient solar cells in Fukushima prefecture, but is also implementing R&D on renewable energy technology with cooperation between the local governments, industry and research institutes including universities in the affected areas.

Under the "Development of Environmental Technology Using Nanotechnology," the ministry has also established a research center for industry-academia-government collaborative fundamental R&D to develop technical seeds for solar power generation and other technologies, to support HRD for advanced environment technology.

Japan Science and Technology Agency (JST) has selected the technological fields, such as solar cells, solar energy utilization systems and biotechnology, for the promotion of R&D of innovative technology within a competitive environment. The targeted technologies are aimed at developments with a high potential for greenhouse gas reduction and is not merely an extension of conventional technology.

NIMS conducts R&D for creating new materials to boost the efficiency of next-generation solar cells essential to the diffusion of renewable energy utilization.

MAFF supports efforts to overcome the problems which have become apparent as a result of demonstration experiments previously conducted to establish domestic production bases of biofuels in local areas. The ministry is also focusing on the R&D of technologies to produce biofuels from plants, woods and microalgae and use of renewable energies efficiently in protected cultivation of horticultural crops.

METI is implementing R&D for cost reduction and increased efficiency of renewable energy-related technologies, including solar power generation, wind power generation, biomass utilization, small- to medium-sized hydropower generation and ocean energy power generation. For example, regarding solar power generation, the ministry is conducting R&D into innovative technology such as quantum dot solar cell.

For wind power generation, the ministry is conducting R&D into the establishment of wind turbine design technology applicable to conditions in Japan, as well as a survey and demonstration project for establishment of bottom-mounted offshore wind turbine technology. For geothermal power generation, R&D has been conducted to resolve issues such as high costs and risks by developing technologies to obtain accurate data on underground thermal resources, evaluate and control the geothermal resources for stable

power supply and realize an environmentally friendly advanced power generation system. For biomass energy, the ministry is conducting R&D to increase the efficiency while reducing the cost of a cellulosic ethanol production process, as well as to introduce and disseminate the next-generation biofuels, such as algal biomass, compatible with food production.

MOE is conducting R&D and verification studies of renewable energy technology that can result in a future reduction of carbon dioxide. For example, regarding geothermal power generation, the ministry is engaged in developing and verifying a power generation system for high hot spring heat utilization and safety using a non-chlorofluocarbon agent (ammonia). For uses of biomass, the ministry is conducting R&D and verification for technology to realize combustion of high ratio biomass, included as fuel in thermal power generation plants, with the aim of reducing carbon dioxide emissions. For wind power generation, the ministry has installed and verified the operation of the Japan's first full-scale floating ocean wind power generation plant of a capacity of 2 MW.

MLIT has implemented safety and environmental measures for power generation facilities, including floating facilities, to promote renewable marine energies such as wind, waves and currents.

PWRI has been developing technology that utilizes renewable energy, such as biomass and resource recycling that can lead to a low-carbon, low environmental load society.

NILIM is conducting studies of sewerage disposal technology to reduce greenhouse gas emissions and collect energies and resources, as well as improving energy-saving housing

2) R&D into a dispersion energy system

MEXT and concerned independent administrative institutions are promoting R&D to develop an energy conversion and storage system using fuel cells and batteries with the aim of innovating a dispersion energy system.

JST has targeted superconducting systems, battery devices and other related research fields to promote R&D for innovative technologies with the greatest potential for greenhouse gas reduction. This would be developed within a competitive environment and be based on new S&T knowledge that is not an extension of conventional technology. In addition, JST has cooperated with METI to promote comprehensive R&D from basic research to commercialization for next-generation storage batteries with performance much higher than those in current use.

NIMS is conducting R&D into the creation of new materials for superconducting power transmission or high-performance power generation and storage which will contribute to the development of a microgrid[1] society combining small-scale dispersion power generation and networking.

METI is conducting the technological development and demonstration of batteries and fuel cells. For batteries in particular, the ministry is conducting technological development into performance enhancement and cost reduction of a large-scale battery to be used to introduce and expand renewable energy or a lithium-ion battery for next-generation vehicles such as electric or plug-in hybrid cars. R&D into domestic use and other fixed-use fuel cells, as well as vehicle fuel cells, has focused on lowing costs while increasing durability and reliability. Anticipating the launch of fuel-cell vehicles into the market in December 2014, the ministry planned to install about one hundred hydrogen stations, mainly in four major

1 A system of mutual provision of electricity via a combination of small-scale dispersion power generation, power supply and networking

cities in three years from FY 2013. The technology necessary for this plan has been developed and verified.

A large-scale demonstration to construct smart communities has been conducted in four cities - Yokohama, Toyota, Kansai Science City (Keihanna) and Kitakyushu since FY2011 with the participation of local residents, local governments and private companies. Another demonstration to solve technical and institutional problems in constructing smart communities according to regional energy circumstances has been conducted in other areas. Yet another demonstration has been conducted for realizing "demand response" such as negawatt trade for efficiently reducing peak demand in light of energy restrictions after the Great East Japan Earthquake.

MIC is conducting smart grid related R&D on communication platform technology for the remote-controlling of various appliances in buildings, utilizing high precision and reliability to optimize energy management on a local level. They are also promoting an international standardization (see Section 1-2 (2), Chapter 3).

MOE is conducting the development of an energy interchange system based on direct current for the purpose of the construction of a self-sustained dispersion energy system.

3) Efficiency and low-carbonization of key energy sources

(i) Clean Coal Technology

Although coal, one of key energy sources, has greater supply stability and more economic advantages than petroleum and other key energy sources, it also has more carbon dioxide emissions per unit energy than other fossil fuels in the burning process. This necessitates the development of technology to reduce environmental impact. Taking into account this environmental necessity, METI has promoted the development and commercialization of thermal power generation systems, including the Integrated Coal Gasification Combined Cycle (IGCC) and Integrated Coal Gasification Fuel-Cell Combined Cycle (IGFC) for highly efficient power generation with reduced CO_2 emissions and simultaneously developed clean coal technology, including R&D of an advanced ultra supercritical pressure (A-USC) thermal power generation to improve heat efficiency by developing a boiler-turbine system which withstands high temperatures and high pressures. R&D for Carbon Dioxide Capture and Storage (CCS) has also been conducted.

(ii) Material technology innovation applicable to key energy

NIMS is promoting R&D for material technology innovation. This includes the development of a high-strength, heat-resistant steel applicable for thermal power or nuclear power plants and improvement of damage evaluation technology for nuclear reactor materials.

(iii) Carbon Dioxide Capture and Storage (CCS)

Aiming at the practical use and diffusion of CCS, METI is advancing R&D for demonstration of an integrated system designed to separate and capture carbon dioxide from large carbon dioxide sources and store it to underground storage at depths of more than 1,000m below the surface, as well as developing technology to drastically reduce costs and improve safety. METI and MOE have jointly conducted geological investigations, including elastic wave exploration, to select the areas available for CCS in Japan. MOE has examined potential technologies and systems to transport CO_2 by ship and inject it into the ocean floor for storage.

(iv) Innovative petroleum refinery technology

In response to demands for heavier crude oil[1] and lighter petroleum products[2] and global warming issues, METI has developed innovative oil refining technologies to extract all possible petroleum products and petrochemical raw materials from residual oil produced in heavy crude oil and refinery processes using petroleomics technology for molecular level structural analysis and reaction modeling.

(v) High-efficiency gas turbine

In response to the increasing need for LNG thermal power generation, METI has conducted R&D and verification of technology for raising the gas combustion temperature at LNG thermal power stations to the level of 1700➡C, to improve power generation efficiency, as well as to reduce fuel cost and carbon dioxide emissions.

(vi) Carbon dioxide storage in blue carbon

The Port and Airport Research Institute (PARI) is promoting research which includes conducting on-site surveys in coastal areas and experiments aimed at quantitatively measuring the atmosphere/seawater gas exchange speed and the carbon flow between the seawater and benthic ecosystem (benthic flora and fauna and sediments). This aims to establish a method for measuring blue carbon, which refers to carbon isolated and stored in the oceans and coastal ecosystems and has potential application in and around Japan.

4) R&D into nuclear energy power and fusion

R&D toward decommissioning and decontamination and other efforts for recovery from nuclear hazards have been made according to the "Acceleration Plan of Reactor Decommissioning R&D for Fukushima Daiichi NPS, TEPCO" and other policies has been conducted and R&D and human resource development promoted to support the infrastructure and safety of nuclear power generation.

The New Basic Energy Plan was approved by the Cabinet on April 11, 2014, which designates the requirement to maintain and develop high-level nuclear technologies and human resources to proceed with the decommissioning of Fukushima Daiichi NPS and other aged nuclear power plants, which are increasing in future, safely and smoothly. Based on this requirement, the "WG on Voluntary Improvement of Safety, Technology and Human Resource" was founded in August 2014 under the Nuclear Subcommittee of the Electricity and Gas Industry Committee, Advisory Committee on Energy and Natural Resources, in which discussions on the creation of a Road Map for LWR safety technology and human resources by clarifying the roles of government, utilities, manufacturers, research institutions and academia.

International collaboration with the U.S. and France, etc. and domestic R&D have been promoted for fast reactors pursuant to the Basic Energy Plan. Issues to be solved, such as reorganization of the implementation system, were also discussed for the prototype fast-breeder reactor "MONJU." The government continues to make necessary efforts for R&D on fusion energy, expected to be an essential future energy source, global nuclear cooperation and other aspects of nuclear research.

1 The rate of heavy crude oil is increased
2 The rate of light petroleum products such as gasoline, light heating oil becomes higher than that of heavy petroleum products such as heavy heating oil in domestic demand

(i) Securing and developing human resources in the nuclear field

Fostering a wide range of skilled human resources with a high degree of safety awareness is necessary to support nuclear technology and to ensure further safety, as well as to contribute to international nuclear safety.

MEXT is supporting inter-organizational activities to develop human resources in an effective, efficient and strategic manner in collaboration with the relevant sections of industry, academia and government, based on the "Global Nuclear-HRD Initiative (GN-HRD)". The Initiative supports fostering the human resources that are needed for nuclear safety and risk management in light of the lessons learned from the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

METI also has been supporting human resource development by means of "costs for commissioning human resource development toward improving nuclear safety" to educate field engineers involved in the nuclear facility maintenance and nuclear safety industries. This undertaking is expected to contribute to the decommissioning of the TEPCO Fukushima Daiichi Nuclear Power Station and the safety control of other existing nuclear power stations.

(ii) Basic and fundamental R&D for nuclear science

To support the utilization and development of nuclear energy, basic and fundamental R&D into nuclear science which focuses on the reinforcement of technology bases for utilizing nuclear energy, contributing to safety improvement and creating new knowledge and technology is important.

JAEA is conducting basic and fundamental research into nuclear engineering, reactor engineering, irradiation material science, partitioning and transmutation technology, radiochemistry, computational science, advanced nuclear science and other related areas.

R&D has been promoted for improved safety and diversified applications of high-temperature gas cooling reactors, with high potential for widespread industrial use in power generation and hydrogen production with their inherent safety.

MEXT has launched strategic programs focusing on political requirements according to the "Initiatives for Atomic Energy Basic and Generic Strategic Research" to reinforce basic and generic research and promote research at universities under competitive research environments.

METI conducts R&D under the "Safety Enhancement for LWRs" Program -"R&D Program for Plant Safety Enhancement" to enhance safety measures at commercial power-generation reactors. This is based on what has been learned since the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

(iii) Fast-Breeder Reactor (FBR) cycle technologies

Fast-breeder reactors (FBRs) are suitable for the effective use of resources, given their potential contribution to reducing the volume and hazard potential of high-level radioactive waste by recycling minor actinide contained in spent fuel as fuel and significantly boosting the efficiency of uranium resource utilization by producing more fuel than consumed while generating electricity. The Basic Energy Plan designates international cooperation with the U.S. and France, etc. while promoting domestic R&D on "Monju."

The Basic Energy Plan defines "Monju" as the international R&D center for reducing the volume and hazard potential of radioactive waste and requires detailed studies on the issues to be solved for producing

outcomes in the Monju R&D Plan launched by MEXT. In response to inadequate equipment maintenance in "Monju" and radioactive leak from the Japan Proton Accelerator Research Complex (J-PARC), JAEA started one-year intensive reform in October 2013 and issued a report in September 2014. In this intensive reform, JAEA thoroughly reexamined the organization and operation to change to the safety-first organization. It also reinforced the governing structure of "Monju," for example, to accept engineers from electric utilities and the JAEA president led the safety awareness raising campaign. The intensive reform was extended to March 2015 to deal with remaining issues, such as the foundation of maintenance and quality assurance systems and a report was issued. JAEA submitted a report to the Nuclear Regulation Authority in December 2014 as part of its reform operation. Adoption and improvement of the intensive reform of "Monju" will be a future issue.

MEXT reinforced the reform project by dispatching a "Monju reform supervisor" to the site from April 2014 to ensure the achievement and adoption of reform and at the same time, opens "Monju Reform Promotion Headquarters" on a regular basis for instruction and supervision of JAEA. The ministry continues to strive to recover social trust on "Monju" by improving the governing structure and solving issues (for Japan-France R&D collaboration, see 2 (4)-1) in Section 3 of Chapter 3).

"MONJU" (Tsuruga, Fukui prefecture)
Source: JAEA

(iv) Fusion energy

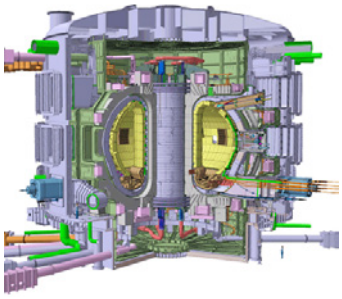
Fusion energy is expected to serve as the prime energy source in future because of the existence of numerous fuel resources, no emissions of greenhouse gas during the process of power generation and the possibility of large-scale power generation from a small amount of fuel. It could completely solve both energy and global environmental problems. With regard to the application of fusion energy, the following three types of reactor have been the subject of advanced R&D and produced world-class results in the fusion field: the Tokamak reactor (JAEA, High Performance Fusion Experiment System: JT-60SA[1])), Helical reactor (National Institute for Fusion Science (NIFS), Large Helical Device (LHD)) and laser fusion reactor (Institute of Laser Engineering, Osaka University, GEKKO-XII Laser).

Based on the international agreements, Japan has also been taking part in the ITER (known as the

1 In August 2008, Break-even Plasma Test Facilities JT-60 was stopped, subsequently dismantled for repair and is now being assembled as JT-60SA.

international thermonuclear experimental reactor) Project[1], which demonstrates the scientific and technological feasibility of fusion energy through the construction and operation of an experimental reactor. Japan, in partnership with Europe, is also advancing fusion R&D in Rokkasho Village, Aomori prefecture and Naka City, Ibaraki prefecture as Broader Approach (BA) activities that complement and support the ITER Project.

International Fusion Energy Research Center (Rokkasho Village, Aomori)
Source: JAEA



ITER
Source: JAEA / ITER Organization

(v) Disseminating radiation application

Radiation application has been widely used in various areas from basic and application research to practical fields such as medical care, industry and agriculture. R&D is critical to promote further radiation application.

In the medical application, diagnosis and cancer treatment by radiation have been partially established treatment using particle beams is advantageous for patients with less physical load because surgical operation accompanying anesthesia or dissection is not necessary. In the agricultural application, Irradiation is used for insect pest control and breed improvement of farm products. Academic research such as the dynamic state of water in plants and process of hazardous metal accumulation has also been conducted. In the industrial application, radiation is used for the production of semiconductors and radial tires. Radiation is also used for the improvement and manufacturing a variety of industrial products and antisepsis of medical equipment. Radiation to semiconductors and the production of new materials and related technological development are promoted in the Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) at JAEA Takasaki Advanced Radiation Research Institute.

1 A project to demonstrate scientific and technological feasibility of fusion energy through the construction and operation of the experimental fusion reactor based on the international agreement of seven parties (Japan, EURATOM, the U.S., Russia, China, Korea and India) with regard to the application of fusion energy, which is expected to completely solve both energy and environmental problems.

(vi) Disposal of radioactive wastes from research facilities

Most of the radioactive wastes produced in research and medical facilities (waste from research facilities) are stored in these facilities at present. The disposal of the radioactive wastes is becoming an important issue in advancing R&D and utilization of atomic energy in future. In response to this issue, JAEA was designated in 2008 to conduct disposal according to the revised "Japan Atomic Energy Agency Act" (Act No. 155 of 2004).

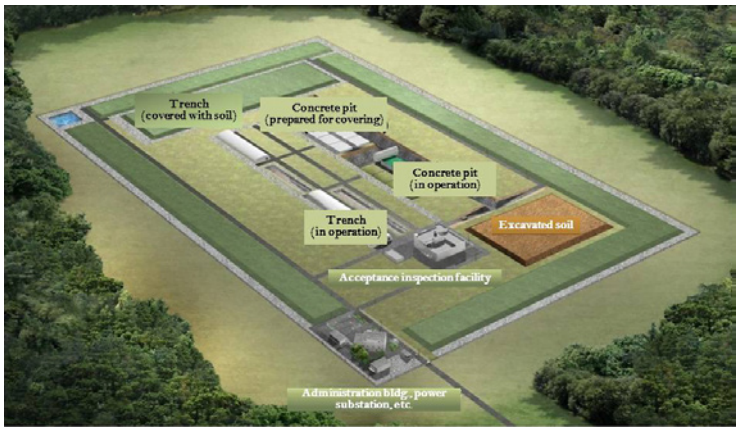


Image of a Disposal Facility
Source: JAEA

JAEA is making efforts to establish site criteria and procedures for disposal facilities in accordance with the "Basic Policy Concerning Implementation of Land Disposal" (decided in December 2008 by ministers of MEXT and METI) and the "General Plan for Implementation of Land Disposal" (approved in November 2009 and a revision approved in March 2014). The aim is to facilitate the disposal of waste from research facilities.

Significantly reducing the volume and hazard potential of high-level radioactive waste is a critical national policy issue, to which JAEA has proceeded with basic R&D in response, using an accelerator for transmutation or group separation.

(vii) Efforts for assuring trust and coexistence with communities

In utilization nuclear energy, it is important to have public understanding and confidence. In an effort to eliminate anxiety about nuclear energy, MEXT is conducting public hearings for residents living in the vicinity of the Fast-Breeder Reactor (FBR) "Monju" to answer any questions they might have, or to allay any concerns with regard to the lessons learned from the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

MEXT also supports activities to promote sustainable development in siting areas for national and regional understanding and coexistence with nuclear facilities, as well as educational programs related to nuclear and other energies.

(viii) International nuclear energy cooperation

MEXT is taking the initiative in promoting the peaceful use of nuclear energy and nuclear non-proliferation through the ministry's contribution to projects of the International Atomic Energy Agency (IAEA) and other international organizations. MEXT is assisting member countries of Forum for Nuclear Cooperation in Asia (FNCA) , most of which are in Asia, in human resource and infrastructure development in the fields of radiation utilization, use of research nuclear reactors and other areas, within the framework of FNCA. In addition, the ministry, through collaboration among industry, academia and government, has accepted trainees from overseas based on the "Nuclear Human Resource Development

Network" and other activities.

Along with the United States, France and other countries advanced in the use of atomic energy, Japan is collaborating in various fields, such as R&D on nuclear systems with high sustainability, through such frameworks as the Generation-IV International Forum (GIF).

(2) Increasing efficiency of energy utilization and introducing smart devices

Toward increased energy utilization efficiency, R&D has been promoting in Japan for more efficient use of fossil resources in the manufacturing sector and for lower carbon emissions and greater energy conservation in the consumer (domestic use, business use) and transport sectors, which account for approximately half of the final energy consumption in Japan. Concerning information and communications technologies necessary for supply and use of energy and innovation of infrastructures, the government is also promoting R&D for further energy conservation.

1) More efficient use of fossil resources in manufacturing

RIKEN has been conducting leading studies on the cyclic use of carbon, which has been consumed in petrochemical products, through interdisciplinary studies among plant science, microorganism science and biochemical and synthetic organic chemistry. Another RIKEN endeavor is R&D on the establishment of innovative bioprocesses toward discovery of new materials derived from biomass.

NIMS is conducting R&D on materials such as photocatalysts that can render hazardous materials in water, air and soil harmless.

METI is making efforts to diversify chemical raw materials, innovate manufacturing processes, promote innovation by applying advanced chemical technology and advanced chemical manufacturing processes and improve the common evaluation criteria for chemical materials to promote R&D for Green and Sustainable Chemistry that contributes to the realization of a sustainable society in which humans achieve harmony with nature. With the aim of simultaneously solving problems of resources and the environment, such as hikes in oil prices and depletion risk, the ministry is conducting technological development, such as that of innovative catalysts to produce essential chemical products including plastics with solar energy using carbon dioxide and water, without depending on oil (Artificial Photosynthesis Project) and that of producing high-performance organosilicon materials from sand. It has done this since FY2012 under the "Future Development Research" program. Through the applications of technology of producing chemical products from inedible biomass and other materials and of printing, the ministry is also developing technology that produces further energy-saving and high-efficiency electrical devices, such as electrical (electronic paper, large-area sensors) than conventional ones; and evaluation methods of materials for lithium-ion cells, organic EL, organic thin-film solar cells and lithium-ion battery to prompt material development.

In steel manufacturing, the ministry is developing innovative carbon dioxide reduction technology, including technology to partially substitute hydrogen for coke as a reductant in steel manufacturing and to separate and capture carbon dioxide from blast furnace gas toward further improving the utilization efficiency of fossil fuels.

The ministry also has been promoting the development of empirical studies on, basic technology for high-efficiency production of high value-added products (e.g., vaccines, functional foods) from genetically

modified plants, thereby promoting the commercialization of safe, high-efficiency material production technologies that make the most of plant biological functions.

With the aim of constructing decentralized energy systems using fuel cells, the ministry is also supporting development and demonstration of innovative hydrogen production technologies for producing the high-purity hydrogen that is necessary for fuel-cell cars by efficient utilization of hydrogen generated by existing equipment at refineries and by promoting the development and demonstration of facilities for efficiently shipping the high-purity hydrogen that is generated.

2) Low carbon emissions and energy savings in the consumer and transport sectors

RIKEN has been conducting R&D on technologies for devices that radically lower power consumption and greatly improve energy conversion efficiency, toward the creation of a new material science that enables innovation in electricity consumption under completely novel concepts.

NIMS is developing long-lasting, functionally stable, low-cost fuel cells that will help to improve the efficiency of energy use in industries and homes, which consume large amounts of energy at present. The institute is conducting R&D toward technical breakthroughs in magnets for motors, wide-gap semiconductors and LED lighting systems that are already used for various purposes. The institute is also conducting R&D on innovative material technology for lightweight materials for mobile structures which contribute to energy savings.

The Japan Aerospace Exploration Agency (JAXA) has been conducting R&D for low fuel consumption and environmental load of airplanes and intends to accelerate R&D in this area to be directly related to international competition by upgrading the aeronautics industry to a "super growth industry" that can be rated on a par with the automobile industry. For instance, R&D will include technologies to make engines more efficient and lighter and technologies to reduce noise from the airplane body while taking into account the potential R&D trend for next-generation airplanes and beyond. JAXA will transfer innovative aeronautic technologies developed in R&D to other industries wherever feasible.

The New Energy and Industrial Technology Development Organization (NEDO) implemented the development of innovative energy-saving technology through an open public invitation for proposal which focused on the key technologies listed in the "Strategy for Energy Efficiency Technologies 2011" formulated in March 2011 and partially revised in May 2014, in consideration of the fact that energy-saving technology encompasses many fields and is very wide. Furthermore, aiming at the extensive use of energy and expansion of use application, NEDO has implemented the "R&D Project on Next-generation Heat Pump Systems."

METI launched "R&D of Innovative Utilization Technology of Wasted Heat Energy", toward reducing and utilizing wasted heat energy that has been emitted to the environment without efficient use. Through the advancement and practical application of fundamental technologies, including the storage, insulation and transformation of heat energy, the use of heat pumps and the development of thermal management technologies that combine the aforementioned technologies, the ministry has been working to save energy and to reduce carbon dioxide emissions.

With the aim of halving carbon dioxide emissions in international marine transportation, the MLIT is making integrated efforts for supporting R&D on innovative energy-saving technologies for ships and for forming an international framework to regulate carbon dioxide emissions from ships. The developed

technology is expected to be deployed around the world.

In addition, the ministry is promoting technological development that contributes to the further improvement of environmental performance in railways, such as the development of battery trains that charge their own batteries when they stop at stations in electrified sections and that run by discharging electricity from their own batteries in unelectrified sections.

With an aim of greatly reduce carbon dioxide emissions from ships, the National Maritime Research Institute (NMRI) is conducting studies on fundamental technologies for implementing regulations that contribute both great environmental impact reduction toward zero emissions and feasibility and rationality in the society.

The Building Research Institute is developing effective evaluation method for energy conservation performance based on the clarified energy consumption structure in housing or construction industry and conducting R&D for preparing technical data for diffusion of advanced energy-efficient houses.

3) Improving information and communication technology

MIC has conducted R&D on the practical application of optical transmission technology capable of meeting the expected rapid increase in network traffic to 400 gigabytes per second. NICT is promoting R&D for an all-optical network which combines ultrahigh-speed with low-power consumption over the entire network, while also responding to an exponential increase in communications traffic and power consumption. This is being realized by utilizing information and communication technology (ICT). NICT, with industry-academia-government collaboration, is also promoting R&D on basic technology for a next-generation network to supersede the Internet by 2020.

METI has conducted R&D for technologies for achieving faster and more energy-saving servers, computers and next-generation automobiles, including those for 10 nm level semiconductor micro-fabrication and manufacturing, ultra-low power consumption of semiconductors using new materials and structures, new information processing that consumes electricity only when data processing is required, organic EL sheet display, integration of next-generation semiconductor devices and optical electronics combining optical and electronic circuits. It has also developed basic policies ensuring standardization, generalization, reliability and safety for applying innovative devices in diversified areas.

(3) Greening of social infrastructure

Japan is promoting R&D for construction of a highly efficient transport system for an environmentally-advanced city. They are also making efforts to innovate resource recycling technologies or to create substitute materials for rare earth[1] elements and other projects. In addition, Japan is working to dramatically improve the technologies related to data obtained from Earth observation, projection and integration analysis, which is an important social and public base, as well as to promote the utilization of this information in various fields.

1) R&D for construction of a highly efficient transport system

Since FY 2012, the National Police Agency has implemented a four year advanced model project of a

1 Rare earth elements consisting of seventeen metallic elements in the periodic table

traffic control system using probe data in the Tokyo Metropolitan Area and Kanagawa prefecture, with the purpose of reducing carbon dioxide emissions and traffic jams. In FY 2013, based on this project's results, model projects have been launched toward the practical application of more detailed traffic signal controls utilizing probe data, the results of which were examined in FY 2014.

2) Efforts to create substitute materials for exiting rare resources

To overcome the constraints imposed by scarce elements such as rare earths or rare metals; materials necessary for next-generation cars or wind power generations, MEXT and METI have, since FY2007, been conducting mutual R&D to reduce the use of and to create substitutes for these materials.

MEXT is promoting the "Elements Strategy Initiative" (research center founding type) to create completely new materials without using scarce elements to overcome Japan's resource constraints and improve industrial competitiveness.

METI has launched "Rare Metal Substitute and Energy-Saving Materials Development Project" to investigate demand and supply of rare metals and trends in technological development and support technologies for substituting or reducing rare metals which are indispensable for manufacturing energy-saving products in the private sector. It has also collaborated with MEXT to develop materials having stronger magnetism than usual and without using rare earth such as dysprosium, with highly uneven distribution, through "Magnetic Material Technology for a High. Efficient Motor for Next Generation Automobiles" conducted from FY 2012.

The ministry is also promoting the development of technologies capable of: producing substances which were previously difficult to synthesize, significantly improving production efficiency of useful materials, reducing energy consumption in material production, vastly reducing environmental load and dramatically improving the development efficiency of lightweight, high-performance materials through genetic design and recombinant technologies based on large-scale genome information.

In September 2012, METI and MOE submitted an interim report to a joint council meeting of the Industrial Structure Council and Central Environment Council on the appropriate measures for the economic feasibility of recycling rare metals. The measures include securing quantities of used products and improving recycling efficiency. Based on the interim report, assistance was provided in FY 2014 for demonstration projects and R&D by private businesses, which will contribute to the efficient and economical collection and recycling of used products.

3) Promoting efforts for responding to climate change or large-scale natural disaster

Japan will greatly enhance Earth observation, projection and integration analysis to promote utilizing the information obtained in various fields. Furthermore, Japan is promoting efforts to organize a city and an area that can cope with climate change or wide-scale disaster, to preserve the natural environment and biological diversity, to maintain natural circulation in forests, to mitigate damage caused by natural disasters and to realize sustainable recycling-based food production.

(i) Promotion of Earth observation

Japan is promoting Earth observation by means of satellite, land and ocean observations to contribute to the Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan, agreed upon at

the Earth Observation Summit.

Earth observation utilizing satellites is a useful means by which to continuous collect geoenvironmental information about precipitation, clouds, aerosols[1] and vegetation over a wide range. JAXA, to promote earth observation utilizing satellites, has been operating the Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) and the water cycle observation satellite "SHIZUKU" (GCOM-W, launched in May 2012). It has also been conducting R&D on other satellites, including the "DAICHI-2" (ALOS-2) (Part 2, Chapter 3, Section 1, 3, (1)).

MEXT is promoting research and observation in various research fields related to the Antarctic and North Polar regions, where it is possible to accurately measure global environmental changes. The Antarctic Research Programs are administered by the "Headquarters for Japanese Antarctic Research Expedition" (chief of Headquarters: the minister of Education, Culture, Sports, Science and Technology), in cooperation with the other ministries and research institutions concerned, including the National Institute of Polar Research. They are collaborating with other nations in conducting research and observation in the Antarctica area. "Exploring Global Warming from Antarctica" is the main research topic based on "the 8th Six-Year Antarctic Research Program" (FY2010 to 2015). The ministry, in collaboration with model researchers and observation researchers under the Consortium for Arctic Environmental Research, is conducting the Arctic Climate Change Research Project as part of the "University-originated Green Innovation Creation Program". It is promoting research and observation aimed at strategic goals such as the evaluation of the effects of environmental change in the North Polar Region on Japan and evaluation of the feasibility of the Northern Sea Route.

Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has observed energy-matter exchanges in the ocean and atmosphere, ocean and land and tropical and polar regions that have a decisive impact on meteorological and climatic changes and global warming to understand the processes and actual conditions comprehensively and developed technologies to accurately predict global environmental changes.

Japan Meteorological Agency (JMA) is studying greenhouse gases at three observation points in Japan and at Japan's Showa Station in Antarctica, as well as in oceanic air and seawater in the western North Pacific region by JMA research vessels and high altitude airplanes. The agency has been publishing global warming data obtained from the observations, with analysis of the results. The agency is also conducting observation of the ozone layer and ultraviolet rays at four observation points in the country and at the Showa Station.

In addition, the agency is compiling and disseminating "State of the Ocean Climate," information about the current state of and prospects for, the oceanic fluctuation related to the global environment based on collection and analysis of various observation data obtained from vessels, Argo Floats, satellites and other means.

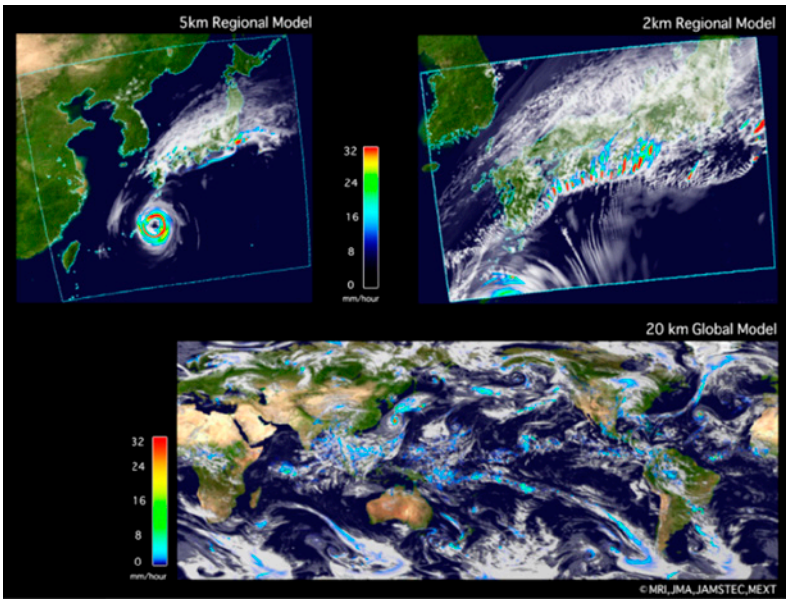
With international cooperation, the Geospatial Information Authority of Japan is promoting earth observation and the Earth Map which is fundamental geospatial information to be used in a variety of fields, such as measures against global warming and developing technologies for data development using

1 Fine solid particles or liquid droplets suspended in the air, including floating substances released from the ground or sea and smoke discharged from industrial facilities, which affect sunlight absorption, sunlight scattering and cloud formation.

the earth observation satellite data.

(ii) Promotion of climate change prediction

MEXT is implementing the "Program for Risk Information on Climate Change", aimed at the sophistication of climate change projection and the generation and provision of fundamental information necessary for the management of various climate change risks such as the intensification of typhoons. In concrete terms, the ministry is promoting R&D in a research system in which projection and diagnosis of the global environmental changes facing the world within a few years or decades, long-term climate change projection associated with research on greenhouse gas emission scenarios, development of probabilistic projection technology of climate change, development of technology for precise impact assessments and other projects are all organically combined using a world-class supercomputer such as the Earth Simulator. The ministry is also implementing a basic study aimed at understanding the mechanisms of environmental change and the projection of these changes by using the advanced computation capacity of Earth Simulator. As well, they are conducting R&D for the technology to increase the speed and accuracy of simulation and for the technology to project global environmental changes using the simulation technology.



Examples of Typhoon simulation
Source: MRI (JMA)

Meteorological Research Institute (MRI) is conducting near future projections of climate changes in the next ten years and a long-term projection based on IPCC[1] emission scenarios. Furthermore, the MRI is conducting a spatially detailed regional warming projection (Part 2, Chapter 3, Section 1, 3, (1)).

(iii) Promotion of data integration and analysis

MEXT has been extending and advancing the Data Integration and Analysis System (DIAS). DIAS is a system to integrate and analyze Earth observation data, results of climate change projections and socioeconomic data gleaned from Earth observation satellites as well as land and ocean observations. Integrated and analyzed results are to be provided to the policy makers and scientists concerned, in the areas of water resource, agricultural produce and fishery resource management. Furthermore, MEXT has implemented the "Green Network of Excellence Program (environment information field)" to build a research network of universities and research institutions using DIAS as the core information platform to

1 Intergovernmental Panel on Climate Change

work on global issues, such as climate change.

NICT has been selected as the host organization of the International Program Office for the building plan of the world's largest scientific data platform. This is in accordance with the World Data System (WDS) plan promoted by the International Council for Science (ICSU) and in cooperation with the Science Council of Japan (SCJ), as well as domestic and related international research institutions, among others. NICT is advancing R&D for phenomenon analysis technology, correlation analysis advancing technology and science cloud[1] technology aimed at creating a world-class science data platform on which analysis of Earth observation data is available.

(iv) Promotion of a climate change adapted society

MEXT is promoting R&D in the following three fields to facilitate provision of the global climate change prediction results to decision makers in local governments: 1) data downscaling methods to provide appropriate, localized, fine-scale data from global climate change projection data; 2) simulation technology to convert data on assessed effects of climate changes and projected future changes into the required scale of data for planning measures on local adaptation to climate change and 3) technology to assimilate observation data into simulation models to reduce simulation result uncertainty. The research results of Research Program on Climate Change Adaptation (RECCA) will be provided as scientific knowledge to local districts for their consideration on adaptation measures for climate change. In addition, RECCA held symposiums to foster a better understanding of climate change adaptation encouraging the broad participation of the public.

MAFF has advanced the development of emission reduction and absorption improvement technology of greenhouse gases. This includes: development of generation and absorption mechanism studies of greenhouse gases, greenhouse gas emission reduction technology, absorption improvement technology for forest or farm soil and development of technology to create new-generation forestry seedling in a short period and new technology for wood use.

As part of the development of a production technology system aimed at the creation of low-input / recycling-based agriculture, the ministry has also advanced: the establishment of chemical fertilizer and pesticide reduction technology with organic resource recycling or microbial utilization, a fertilization system achieving high nutrient use efficiency, a management system making effective use of nutrient accumulated in the soil and development of an insect pest control system making effective use of indigenous natural enemies.

Furthermore, the ministry has clarified resource reserves and current utilization in the tropical forests of Asia by the use of high precision laser metrology and has advanced a land-use change projection model, as part of the development of a support system for measures against deforestation and forest degradation in Asia.

For climate change adaptation technology in agriculture, forestry and fisheries, the ministry has developed a high precision yield and quality prediction model and other means to assess the impact of climate change on agricultural and marine products. They also promoted the development of a production stabilization technology that can cope with the progress of global warming. In addition, the ministry has

1 Cloud computing environments or services especially-suitable for the processing of large-capacity data for scientific research

promoted the development of plant varieties resistant to high temperature or dryness, by making the most of genome information.

MOE is promoting research aimed at realizing a safe and secure society adaptable to climate change. This is being done by supporting the formulation of an adaptation plan for each region by predicting, in detail, the effects of climate warming in Japan and Asia through the environmental research comprehensive fund program "Comprehensive Research on Climate Change Impact Assessment and Adaptation Policies (S-8)." The ministry held a symposium on climate change adaptation in November 2013 to its results widely.

(v) Town development in accord with nature

MRI is addressing the development of real-time observation and monitoring technology to detect unusual meteorological phenomena, such as localized, intensive, heavy rain (referred to as "guerrilla rain"), by means of dual polarization radar and GPS. The institute is also advancing the development of a numerical prediction model, with enough resolution capability to display local heavy rains, to improve the accuracy of weather information, thereby helping to reduce damage due to local meteorological phenomena.

PWRI is implementing technology development contributing to a sustainable society where humans live in harmony with nature. This includes the conservation and restoration of nature, the maintenance of a secure water cycle and the establishment of production bases in Hokkaido for the improvement of food supply capacity. In addition, PWRI has been developing technology for using low-carbon content blended cement to make pavement and conducting R&D into the reuse of heavy-metal containing soil from construction sites as embankment material.

2 System Reforms for Promotion of Green Innovation

Japan is advancing system reforms, such as regulatory or institutional reform, to promote green innovation and to promptly and effectively lead innovation for sustainable growth in Japan and for issue resolutions on a global scale.

To help resolve the environmental problems related to ICT utilization, MIC has been engaged in publishing recommendations through the "Environment and Climate Change" (ITU-T SG5[1]) of International Telecommunication Union such as "L. 1300 Best practices for green data centers" and "L. 1410: Methodology for the assessment of the environmental impact of Information and Communication Technology (ICT) goods, networks and services." Further, "L.1200: Direct current power feed interface up to 400 V at the input to telecommunication and ICT equipment" was recommended in May 2012. In addition, in FY 2013, the Focus Group on Smart Sustainable Cities (FG-SSC) was established under SG5 to study sustainability of urban environments. The focus group is discussing definitions of SCC and KPI. MIC is actively providing its proposals.

Aiming to reform the social system to create a new society that can adapt to climate change, MEXT is developing elemental technologies, such as energy management as a base for climate change adaptation and the field experiment in a social system consisting of such elemental technologies and advancing the social

1 International Telecommunication Union Telecommunication Standardization Sector Study Group 5

implementation of such technologies.

Since FY 2011, METI has been conducting a full-scale demonstration for the construction of a smart community with the participation of residents, local governments and private companies (see Section 2-1 (1), Chapter 2 of Part 2).

■ **Table 2-2-6 / Major Projects to Promote Green Innovation (FY 2014)**

Ministry	Implementation	Project
MIC	MIC	Establishing fundamental network technology to handle big data network (R&D into High-speed low-power-consumption optical transport technology, network virtualization technologies and related technologies)
MEXT	MEXT	Initiative for Strategic Adaptation to Climate Change
		University-originated Green Innovation Creation Program
		Program for Risk Information on Climate Change
		Japanese Antarctic Research Program
		Elements Strategy Initiative
		Initiatives for Atomic Energy Basic and Generic Strategic Research (competitive funds)
		FUTURE - PV Innovation
		Grants for area locating electric power stations
		Grants for promoting the development of power supply regions
		Grants for radiation application and nuclear energy basic technology experiment and research
		Grants for nuclear fuel cycle-related promotion coordination, etc.
		Commissioning expenses for nuclear system R&D (nuclear system R&D project) (competitive funds)
		The Research and Development Program of Clean Energy for Tohoku Recovery
	NIMS	Initiative for Strategic Adaptation to Climate Change
	JST	"Future Earth" initiative promotion
		Advanced Low Carbon Technology Research and Development Program
	JAMSTEC	Marine transport sector costs
MAFF	MAFF	R&D for strengthening production site
		Project for international coordination to respond to climate change
		Project for supporting acceleration of the introduction of next-generation greenhouse horticulture
		Demonstration project of a mass production system for glass eels
METI	METI	R&D on Advanced Aerodynamic Design
		Carbon Dioxide Reduction Technology Demonstration Project Funds
		Carbon capture technology advancement project funds
		Creation of Structural Components for Next-Generation Aircraft and Development of Processing Technology
		Commissioning expenses for Dissemination and Promotion Program of Global Warming Countermeasure Technologies
		Grants for promoting introduction of clean energy automobiles, etc.
		Project Cost for the development of Carbon Capture and Storage Safety Assessment Technology
		Developing magnetic material technology for high-efficiency next-generation automobile motors
		Commissioning expenses for infrastructure development projects such as green contribution certificate systems
		Technological development for innovative new structural materials, etc.
		R&D for Innovative Utilization Technology of Wasted Heat Energy

		Verification project for supporting energy-saving technology to reduce emissions of CFC alternatives
		Advanced energy-saving part and material development project
		Project for international standardization and dissemination of energy-saving, etc.
		Carbon dioxide storage potential investigative project
		Carbon dioxide sequestration and support project to demonstrate the effective use of technology
		Japan-U.S. Cooperation on energy technology development funds
		Next-generation energy-saving material evaluation infrastructure technology development project
		Grants for energy saving recycle process demonstration support project funds
	AMRE	Grants for development of practical use element technology for ultra supercritical pressure thermal power generation
		Commissioning expenses for project to streamline international energy utilization, etc.
		International Cooperation Project on Clean Coal Technology for Climate Change
		Development of advanced processing technology for heavy oil, etc.
		Cost for commissioning for New Energy Equipment Introduction Promotion Project (New Energy Equipment Introduction Promotion Diffusion Project)
		Subsidies for Supporting Operators Streamlining Energy Use
		Subsidies for Accelerated Support of Renewable Energy Heat Utilization
		Subsidies for Accelerated Support of de Utilization
		Subsidies for Next Generation Energy Social System
		Subsidies for Next Generation Energy Technology Demonstration Project
		Subsidies for Stand-alone Renewable Energy Power Generation Systems
		Grants for small hydraulic power generation promotion project
		Cost for commissioning for Common Base Development Promotion Project such as New Energies
		Subsidies for Integrated Coal Gasification Fuel Cell Combined Cycle Demonstration Project
		Subsidies for High Efficiency Gas Turbine Technology Demonstration Project
		Project for enhancing coal extraction and security technology in coal-producing nation
		Subsidies for Supporting Operators Streamlining Energy Use (For Private Corporations) (For Natural Gas)
		Subsidies for housing and building innovative energy-saving technology introduction project
		Project for advanced technology addressing surplus power generated by renewable energy
		Subsidies for technology verification project on regional bio-diesel distribution system
		Subsidies for hydrogen supply facility development project
		Subsidies for renewable energy heat utilization advanced complex system demonstration project
		Subsidy for Supporting Commercial Fuel Cell (ENEFARM) Introduction
		Subsidies for Specific Equipment Introduction Promotion Project for Streamlining Energy Use
		Fukushima next-generation renewable energy technology

		development project
		Emergency response to suspension of renewable energy connection
		Grants for promoting whole-area utilization of local production for local consumption type renewable energy
	Japan Oil, Gas and Metals National Corporation (JOGMEC)	R&D of geothermal power generation technology (For the Coal, Natural gas, Metal and Mineral Resources Agency)
	NEDO	Project for international research and development/verification
		Project for international research and development/verification
		Dissemination and Promotion Program of Global Warming Countermeasure Technologies
		Steelmaking Process Technology
		Development of Next-generation High-performance Technologies for Photovoltaic Power Generation System
		R&D on Innovative Solar Cells
		R&D on floating offshore wind power facilities
		Program for New Energy-venture Technology Innovation
		Advanced Science Basic Research Project for Innovative Batteries
		Project to Develop Next-generation Technology for Strategic Utilization of Biomass Energy
		Development project of promotion technology for application of solid oxide fuel cell
		Development project of promotion technology for application of solid oxide fuel cell
		Demonstration Project for Technologies and Systems to improve International Energy Consumption Efficiency
		Strategic Innovation Program for Energy Conservation Technologies
		Development Project for Cutting-Edge Technology for Practical Use and Application of Lithium Ion Battery
		Development of Clean Coal Technology
		Next-Generation Ultra-low Power Consumption Device Development Project
		Next-Generation Ultra-low Power Consumption Device Development Project
		Development project for innovative interactive display with
		Useful element technology development project for biofuel production
		Useful element technology development project for biofuel production
		R&D project for advanced practical application of wind power generation
		Verification project for diversified use of solar power generation
		R&D of geothermal power generation technology (for NEDO)
		Development project of promotion technology for application of solid oxide fuel cell
		Technology Development of an Ultra-low-power Optoelectronics Implementation System
		Next-generation power electronics technology development project
		Next-generation smart device development project
		Innovative energy-saving chemical process technology development project
		Green device general-purpose application mounting strategy

		Nanocarbon material application project
		New energy and environmental technology leading program
		Energy saving electronic device manufacturing process development with innovative printing technology
		Project to Develop Innovative Cellulosic Ethanol Production System
		Photovoltaic power generation system maintenance and recycling technology development
		Renewable Energy Heat Utilization Development Project
		Distributed energy next-generation grid construction demonstration project
		Power system output fluctuation response technology development project
		Independent regional biomass energy demonstration project
		Renewable energy storage and transport technology development
METI MLIT	ANRE MLIT	Subsidies for energy-saving logistics promotion project
MLIT	MLIT	Sewage Innovative Technology Demonstration Project (B-DASH Project)
		R&D on Safety of Floating Offshore Wind Power Facilities
		Safety and environmental measures for promoting active use of ocean energy
		Comprehensive measures for strategic promotion of marine industry
	JMA	Development of the next HIMAWARI, geostationary meteorological satellite
	NILIM	Study on evaluation method for energy conservation technology for regional housing production technology
	National Maritime Research Institute	Study on the development of actual sea performance and service evaluation technology
		Study on the development of CO_2 emissions reduction technology
	Public Works Research Institute (PWRI)	Promotion of Low-Carbon Social Infrastructure Improvement and Efficient Resources Utilization
	Building Research Institute	Energy Consumption Reduction by Enhancement of Energy-saving Performance Evaluation Method for Houses and Construction
MOE	MOE	Total environmental study promotion costs
		Strengthening of IBUKI (GOSAT) Observation Systems and Preparation of System for the Development of the Successor
		Contributions to the Institute for Global Environmental Strategies
		Networking project of international experts on building low-carbon society that address climate change issues
		Global Warming Countermeasure Technology Development Project
		Technology development and verification project to induce strengthening of the measures for carbon dioxide reduction
		Floating Offshore Wind Turbine Demonstration Project
		Waste Energy Introduction and Low Carbon Promotion Project
		Practical application promotion project of technology for tidal current power generation
		Total environmental study promotion cost (competitive funds) (for general account)
		Total environmental study promotion cost (competitive funds) (for general account)

		MRV related technology advancement for promoting bilateral credit system (JCM)
	NRA	Radiation survey and research expenses
		Detailed Soundness Survey of Light Water Reactor Materials and Fuels
		Cost for commissioning on the project for advancing lifetime-extension evaluation technology
		Cost for commissioning for survey and research on geological structures at nuclear facilities
		Cost for commissioning of survey on level of radioactivity
		Cost for commissioning of comprehensive evaluation of radioactivity in the marine environment
		Cost of survey on the effects of nuclear power plant accident
	NIES	Satellite Observation Cost

Section 3 Promotion of Life Innovation

Life Science is the field of study that elucidates the complicated and elaborate mechanisms of life phenomena for all living creatures. Achievements in this field will lead to great advances in medicine, as well as solutions to food and environmental issues, eventually contributing to an improved nation's life and a developed national economy.

To promote life science, four key issues have been set out in the 4th Science and Technology Basic Plan, with MEXT and the agencies concerned addressing them.

1 Promotion of Measures to Accomplish Critical Issues

(1) Development of innovative disease prevention methods

1) Attaining next-generation medicine

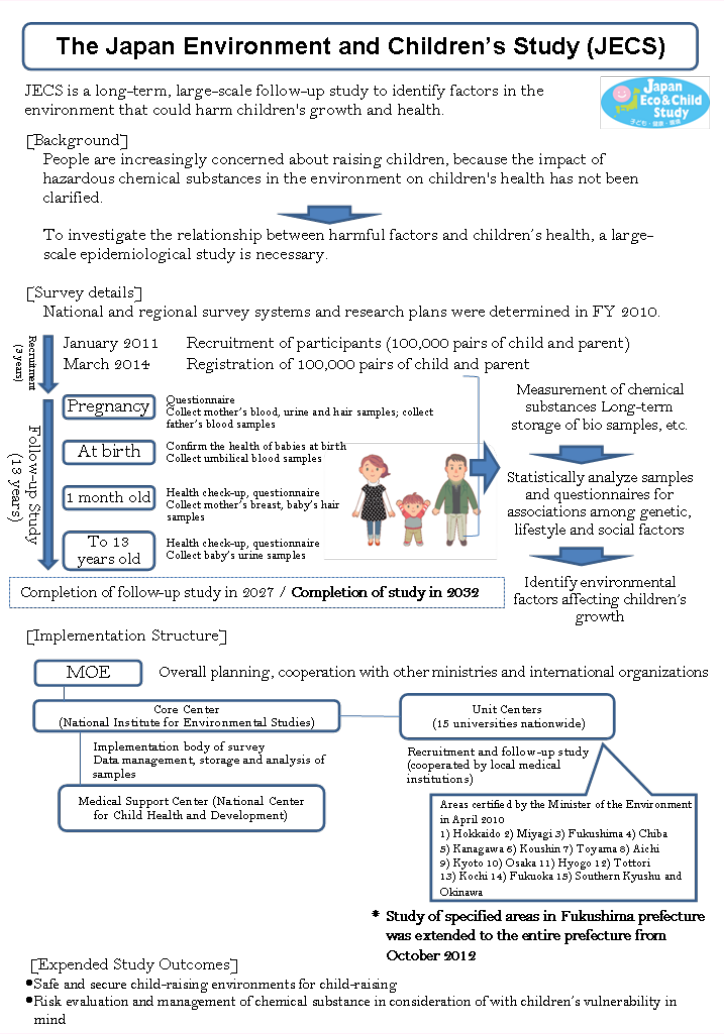
MEXT is promoting "The Tohoku Medical Megabank Project" which is a long-term genome cohort study in areas affected by the GEJE. The project, which intends to promote long-term epidemiological research (genomic cohorts) including genomic information, is being implemented for regional medical information sharing. MEXT promotes this project in close collaboration with the regional medical information network supported by MIC and MHLW. This project intends to restore community medical systems in the affected regions and to attain next-generation medicine, such as personalized prevention. MEXT is also implementing "Taylor-made medical treatment with the Biobank Japan Program" (the 3rd term). By utilizing the world's largest Biobank, that controls patients' DNA, biological samples and clinical information collected from cooperating medical institutions, MEXT is promoting the program to identify and verify genes relating to diseases, which may significantly impact national health and the side effects of medication for individual patients, as well as searching for causal genes for intractable and scarce diseases and promoting a comprehensive study of diagnosis and treatment using genome information. In conjunction with this project, RIKEN is also conducting research to find the causes of diseases.

2) Efforts to clarify environmental risks to children

Recently, the possibility of increased environmental risks to children has become apparent.

In FY 2010, MOE started a large-scale, long-term cohort study, "Japan Environment and Children's Study (JECS)", by engaging 100,000 pairs of parent / children in a study to clarify the influence of environmental chemical agents on children's health (Figure 2-2-7). In this study, initiated at the end of January 2011, participants (pregnant women) were recruited over a three year period. A variety of biological samples, such as blood, umbilical blood, breast milk and other indicators were taken. Follow-up studies will be conducted using questionnaires, until their children reach 13 years of age.

■ **Figure 2-2-7 / JECS on Children's Health and Environment**



Source: Created by MOE

Under JECS, NIES (a core center) is analyzing the samples and data to summarize the results of the research, with the National Center for Child Health and Development (a medical support center) providing medical support. Concurrently, unit centers, publicly recruited and designated universities from 15 districts throughout Japan, have been recruiting participants for the study and conducting the follow-up studies.

Based on the knowledge to be gained from this study and through the improved management of hazardous chemical substances, MOE intends to secure the health and safety of children, as well as ensure a safe child-raising environment. MOE expects that the bank of 100,000 pairs of biological samples and data will contribute to maintaining Japan's international competitiveness in the field of basic research, as a shared infrastructure for medical- and health-related studies.

3) Efforts to Overcome Emerging and Reemerging Infectious Diseases

Recently the world has become acutely aware of newly discovered emerging infectious diseases, as well as infectious diseases that were thought to have been brought under control, but have reemerged. There is a need to investigate these diseases regarding pathogens, infectious routes, infectiousness and underlying mechanisms.

MEXT is working on a program, "Japan Initiative for Global Research Network on Infectious Disease", utilizing 13 research databases in eight countries throughout Asia and Africa to promote R&D that contribute to the fight against these diseases, help accumulate knowledge and to nurture human resources.

MHLW is working on the development of proper diagnostic techniques, treatment strategies and preventive methods that lead to facilitating the necessary administrative responses. With a particular concern for preventive inoculations that are an important means to fight infectious diseases, MHLW is researching the evaluation of medical safety and economic efficiency, helping the vaccination administration. In the field of novel influenza, MHLW is also conducting research into cell culture-based vaccines and intranasal vaccines, so that simpler and more effective vaccines can quickly be provided to people to contain the occurrence of a novel pandemic influenza.

4) Efforts to Overcome Mental and Neurological Disorders

Brain science research is a field that is expected to contribute to the improved quality of life and medicine, as well as the creation of new technology and new industries.

Consequently, the Council for Science and Technology (CST) of MEXT issued its first proposal for the basic concept and method of promoting a long-term study on brain science in June 2009, based on which MEXT launched the "Strategic Research Program for Brain Sciences (SRPBS)", which targeted a contribution to society. The program includes R&D aiming at the support for independence and permanent cure of mental and neurological disorders using Brain Machine Interface (BMI) technology and R&D to clarify the pathogenic mechanisms of mental and neurological disorders, and to develop early diagnosis, treatment and preventive methods. In June 2013, the Brain Science Committee founded under the Subdivision on Science and the Subdivision on R&D Planning and Evaluation of CST examined the basic concept of the "Brain Mapping by Integrated Neurotechnologies for Disease Studies" Based on this examination, MEXT launched the "Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS)" in FY 2014.

At RIKEN and JST, under the Strategic Basic Research Program, research into brain science is also being promoted in the fields of molecular structures, nerve cells, neural networks and other areas.

(2) Development of novel and early diagnostic technology

To protect the nation's health, it is important to develop diagnostic methods for the early detection of disorders. Therefore, the government is promoting the development of highly accurate, early diagnostic technology.

MEXT is implementing the "Japan Advanced Molecular Imaging Program Strategy (J-AMP)," a molecular imaging technology which allows the in vivo molecular behaviors of living creatures to be visualized live. Aiming at the early application of this technology, MEXT has developed a research consortium consisting of the research base for exploring new candidate drugs & the research base for PET[1] Diagnosis; universities; and hospitals, promoting joint R&D toward the demonstration of this technology.

For the early detection of disorders, MHLW is addressing the development of molecular imaging

1 Positron Emission Tomography

technology and image diagnostic equipment that utilizes nanotechnology, promoting toxicity assessment of candidate compounds for drugs in the pre-development stage and searching for proteins useful for the effectiveness assessment. In particular, MHLW is promoting R&D focused on the commercialization of innovative image diagnostic technology that uses novel and cancer-specific biologic indicators which target types of cancers that are otherwise difficult to treat.

METI is implementing "Comprehensive R&D of an Early Stage Diagnosis Method and Instruments to Treat Cancer" in an effort to develop an image diagnostic system able to detect cancer in extremely early stages and to understand the characteristics of cancer correctly.

(3) Achieving safe and effective therapies

1) Promoting the scientific research of cell generation, differentiation and regeneration

Research into cell generation, differentiation and regeneration seeks to clarify the mechanism whereby a single cell differentiates into various tissues and organs to form and maintain the body. This is a basic aspect of regenerative medicine. Recently, the field of regenerative medicine has rapidly advanced since Professor Yamanaka of Kyoto University received a Nobel Prize in Physiology & Medicine in December 2012 for discovering iPS cells. The world's first transplant operation for iPS cell-derived retinal pigment epithelial cells by Masayo Takahashi, RIKEN project leader, in September 2014 has become a global focal point. Aiming at the early realization of regenerative medicine and drug development using stem cells, including iPS cells, the agencies concerned are promoting research in cooperation with each other.

Based on the Comprehensive Strategy on Science, Technology and Innovation 2014 and the "Healthcare Policy[1]," MEXT has been promoting the world's first implementation of regenerative medicine and innovative drug development using iPS cells and related materials to achieve the goal set under the Road Map on iPS Cell Research set by the Stem Cell and Regenerative Medicine Strategy Taskforce under the Life Science Committee of the Research Planning and Evaluation Subdivision, CST, since February 2013. To this end, JST is forming the Research Center Network for the Realization of Regenerative Medicine to construct a nationwide framework by enriching core center functions and networking. In addition, with the Highway Program for Realization of Regenerative Medicine of JST, MEXT is continuously supporting the study of regenerative medicine in cooperation with MHLW and METI. In collaboration with MHLW, research is being conducted into diseases and drug development using patient-derived iPS cells under the Program for Intractable Diseases Research Utilizing Disease-specific iPS Cells. MEXT is conducting basic research under the JST Strategic Basic Research Programs supported by JST and similar research is being conducted at RIKEN. The relevant agencies are working as a whole to improve research systems to secure the necessary research funds, and to establish and manage intellectual properties.

MHLW is seeking to establish a base of technology for safe and effective regenerative medicine that uses human cells, such as iPS cells, to promote research into tumorigenicity, rejection and other areas, which are hurdles for the early clinical application of regenerative medicine. To accelerate the process of drug development, MHLW is also promoting research into making human iPS cells differentiate and be induced into target human cells. They are also promoting research into the basic technology used in the search and selection of candidate compounds for drugs in the pre-development stage. In November 2014, the "Act on

1 Decided by the Cabinet on July 22, 2014

the Safety of Regenerative Medicine" (Act No. 85 of 2013) was established. Toward the swift and safe provision of regenerative medicine, the Act makes the regenerative medicine provider responsible for such provision and establishing a permitting system for the handling of specific processed cells. The Act provides the basis for the swift provision of regenerative medicine and it sets procedures for conventional regenerative medicine provided as medical treatment at the patient's expense (no public insurance coverage) that require pre-treatment application to the national government for safety reasons. Also, a new standard for foreign cell processor was set for the processing of specific processed cells. It enables the outsourcing of cell processing to a licensed body.

METI is implementing R&D of Next-generation Regenerative Technology to develop regenerative devices that stimulate the regeneration of self-tissues within the body. Under the Commercialization and Industrialization of Regenerative Medicine Project, the ministry clarified the evaluation items on safety specific to respective regenerative medicine products and developed an objective evaluation method. In addition, METI is promoting R&D into the safety of drugs that utilize iPS cells. This will make the process of drug development more effective and also, from FY 2011, promote the development of basic technology for the stable mass-production of high-quality stem cells, such as iPS cells, that will be needed in the field of regenerative medicine.

2) Promotion of innovative cancer research

In Japan, one in two people has a possibility of developing cancer. One of three people die from the disease (360,000 persons/year as of FY 2013). Cancer remains a serious problem for the life and health of citizens. Therefore, the government has promoted studies on cancer with a permanent cure and prevention in mind, coexistence with cancer and a joint effort with patients and society, based on the "Comprehensive 10-Year Strategy for Cancer Control" (decision of the Ministers of MEXT, MHLW and METI on March 31, 2014), "Cancer-fighting Basic Act" (Act No.98 of 2006) and the "Basic Plan to Promote Cancer Control Programs" (Cabinet decision in June, 2012).

MEXT launched the "Next-generation Cancer Research Strategy" in cooperation with MHLW and METI for precisely selecting results of innovative basic research to establish next-generation cancer medicine; and promoting the development of "potential seeds" for new compounds useful for innovative diagnosis and drugs. MEXT is also promoting research based on individual genetic information toward tailor-made medicine for cancer by means of pharmacotherapy.

MHLW is continuing prior strategic cancer research and promoting the development of innovative therapies that can restrict and eradicate cancer stem cells, mainly by targeting refractory cancers. Cancer vaccine therapy is rapidly advancing as a fourth therapy following: operation, radiation therapy and chemotherapy. Therefore, MHLW is promoting high-quality, non-clinical trials and international-level doctor-centered clinical trials for drug development, mainly for refractory and/or orphan cancer, by taking advantage of Japan's rich history of such studies. These include: cancer vaccine therapy, molecular target drugs (such as antibody drugs), nucleic acid medicine and cancer peptide vaccine. MHLW is also promoting research into palliative care for cancer patients and their families. This includes: methods for effective cancer pain evaluation, advanced information communication and palliative care quality assessment. The goal is to improve treatment of physical pain, cancer-specific pain, depression and anxiety, psychological and mental pain and social distress, including work and money problems.

METI is implementing "Comprehensive R&D of an Early Stage Diagnosis Method and Instruments to Treat Cancer" to develop an image diagnostic system, enabling the detection of cancer in extremely early stages and to correctly understand the characteristic of cancer.

3) Promotion of drug discovery research

In the "Platform Project for Supporting in Drug Discovery and Life Science Researches," MEXT supports the commercialization of drugs using technology bases for protein structure and functional analysis, improved through the Protein-3000 Project and the Target Protein Research Program and promotes upgrading of technology bases.

RIKEN is also promoting the advancement of structural prediction technology, etc. using protein production technology, structure and function analysis technology and computational science.

To accelerate drug development by utilizing genetic information, METI is implementing R&D into basic technology. For example, the technology to make drug development effective by using the technology to accurately analyze the epigenetics (acquired genomic modification), a factor in cancer and lifestyle diseases.

In its "Development of technology for measuring miRNAs in serum" program, METI aims to achieve early discovery of the markers for 13 cancers, including breast and bowel cancer, as well as dementia and the practical use of less-invasive and highly sensitive diagnosis system technology, based on a tremendous amount of accumulated clinical information and specimens stored in biobanks.

4) Promotion of Genomic science research

MEXT supports life science researchers in their highly advanced epigenome and transcript analyses using the genome/epigenome analysis technology base developed by research programs, including the Innovative Cell Biology by Innovative Technology (Cell Innovation) in the "Platform Project for Supporting in Drug Discovery and Life Science Researches" and enhances related technologies and facilities.

5) Promotion of R&D for radiation therapy equipment

The National Institute of Radiological Sciences (NIRS) is promoting research on heavy-ion cancer therapy, expected to be a breakthrough therapy for refractory cancer. Efforts will be made to propagate its use domestically and abroad. Based on R&D performed by the NIRS, heavy-ion cancer therapy facilities were installed in Hyogo, Gunma and Saga prefectures for medical treatment.

6) Promotion of Study on Dynamic Biological Systems Science

Biological systems are comprised of the spatiotemporal intertwining of multiple factors. Understanding and controlling these systems in "Dynamic Biological Systems Science" are expected to contribute greatly to innovative technologies, including regenerative medicine and pathological prediction.

MEXT launched the "Platform for Dynamic Approaches to Living Systems" project in the Platform Project for Supporting in Drug Discovery and Life Science Researches in January 2013, in accordance with the 2011 report, "How to Promote Dynamic Biological Systems Science" (The Working Group of the Life Science Committee CST's Subdivision on R&D Planning and Evaluation, on July 19, 2011) to establish

research centers for the progress of this scientific field. RIKEN and Osaka University are proactively implementing state-of-the-art technology for the measuring, calculating and modeling of life phenomena and for reconstruction of cell functions. JST also intends to create basic technologies in its Strategic Basic Research Programs. MEXT consolidates these R&D programs.

7) Other efforts for safe and effective treatment

To provide safer treatments for patients, MHLW is promoting the development of test drugs appropriately selected for patients who require drug administration and the development of non-invasive/minimal invasive medical equipment utilizing nanotechnology.

8) Innovations in biomedical structural and synthesis technology

MEXT launched the "Basic Science and Platform Technology Program for Innovative Biological Medicine" in FY 2014 to assist in developing innovative basic technologies in universities for producing Japanese next-generation, innovative biomedical drugs.

To develop medicines with high healing effects and minimal side effects, METI has been establishing basic production technology for next-generation antibody drugs that meet international standards, as well as developing innovative drug discovery processes.

(4) Improving Quality of Life (QOL) for the elderly, disabled and medical patients

Japan has an aging society with a declining birthrate. It is progressing more rapidly than any other country in the world. The government is being pressed to respond to this serious problem, as well as to improve the nation's QOL and welfare.

For the purpose of clinical applications and life support, MIC, MEXT and MHLW are working to develop BMIs that can decode information in the brain in non-invasive or minimally invasive ways, to treat, recover and complement physical functions.

In support of disabled people's independence and participation in society, MHLW has been implementing the "Project for Development and Promotion of Equipment to Support Independence of Persons with Disabilities". They seek to develop convenient support apparatuses that can be used easily by disabled people, as per their needs.

METI is promoting a project to provide support for private business operators who are engaged in R&D of welfare apparatuses. In an effort to prioritize development in needed areas, METI, in consultation with MHLW, issued the "Priority Areas to Which Robot Technology is to be introduced in Nursing Care of the Elderly" report in November 2012. In February 2014, "Mobility aid indoors," "Bathing support" and "Monitoring system for people with senile dementia" were added to the prioritized areas. To facilitate development and practical application of robot care devices in the needed areas, METI has been implementing the "Project to Promote the Development and Introduction of Robotic Devices for Nursing Care" since FY 2013. They are supporting R&D into robot technology development by private businesses that address the needs of the elderly and care service personnel.

2 System Reform for Life Innovation Promotion

To promote life innovation, it is necessary to establish policies concerning critical medical issues and to

improve systems linking the results of research with the prompt commercialization of medical drugs and equipment. MEXT and the other agencies concerned are developing support bases for R&D into medical drugs and equipment and preparing biological resources and databases that will become bases for life science. It is also critical to address proper animal testing, bioethical issues and safety in life science.

(1) Improving systems to translate medical R&D into the commercial sector

The "Act on Promotion of Healthcare policy" (Act No. 48 of 2014)" and Act on the Independent Administrative Agency of Japan Agency for Medical Research and Development" (Act No. 49 of 2014)were approved by the Cabinet on May 23 and publicized on May 30, 2014. Firstly, this is to establish The Healthcare Policy to promote R&D in medical fields, for world-class medical care and establish new industries to underpin a society where citizens remain healthy and live longer in a comprehensive and planned manner. Secondly, to found the Headquarters for Healthcare and Medical Strategy Promotion to promote health and medical care strategies and the Japan Agency for Medical Research and Development (AMED); targeting R&D in medical fields and efforts to develop a suitable environment with subsidies and grants.

The Headquarters for Healthcare Policy was founded on June 10, 2014 with Prime Minister Abe as the general manager and comprising all cabinet members. On July 22, the Headquarters drafted "The Healthcare Policy" to provide long-term and comprehensive policies taken by government for advanced R&D and new industry creation for health and medical care, which were then approved by the cabinet. The same day, the Headquarters also drafted the "The Plan for Promotion of Medical Research and Development" created based on the health and medical care strategies, to promote government policies taken for R&D in medical fields, the development of an environment and dissemination of R&D outcomes in a comprehensive and planned manner.

The "Japan Agency for Medical Research and Development (AMED)" was founded in April 2015 pursuant to these health and medical care laws[1].

AMED integrates the R&D budget for medical fields, which used to be allocated to relevant ministries and uniformly supports all phases of R&D in medical fields from basic research to practical use.

(2) Developing a foundation to support drug discovery and medical technology

To improve drug development and medical technology support bases that link high-quality basic research results with the commercialization of innovative drugs, MEXT is involved in projects to allow industries and universities to share information: 1. developing technological bases, for example, a world-class level radiation facility, a compound library facility and protein production and bioinformatics technology facility, 2. upgrading current technological bases and 3. promoting a "Platform for Drug discovery, Informatics and Structural life science" project.

(3) Improving systems for conducting translational research and clinical studies/trials

Since FY 2007, MEXT has been promoting the "Coordination, Support and Training Program for Translational Research" in cooperation with MHLW and METI to improve the support bases for

1 The Japan Agency for Medical Research and Development was founded on April 1, 2015.

translational research toward commercialization, by targeting universities that have promising achievements of basic research. In addition, MEXT initiated the "Translational Research Network Program" in FY 2012 to take over the former program, improve the translational research support centers and connect these centers in a network for reinforcing capabilities to nurture seeds and establishing permanent centers. Unified with the "C Project for the Improvement of the Clinical Research Quality Assurance System (Clinical Trials Core Hospital Development Projects)" of MHLW in FY 2014, a uniform system to apply basic research outcomes to practical use was established.

To produce Japanese innovative medical drugs and device, since FY 2011, MHLW has been promoting the "Project of Early Exploratory Clinical Trial Bases for Specific Research Areas," and has been improving the trial bases where clinical trials can be conducted for new medical drugs and device used for the first time for humans ahead of any other country. Since FY 2012, MHLW has also been promoting the Clinical Research Core Hospital Development Project to conduct clinical research in accordance with international standards (ICH-GCP) and to provide support for all hospitals from the center hospitals. They are also promoting the "Japan-Centered Global Clinical Research System Development Project" to conduct international joint research, in which planning and adjustment of participating medical institutions can be overseen consistently. In June 2014, the hospitals occupying a central role in international-standard clinical research and doctor-centered clinical trials were defined as "Clinical Research Core Hospitals" in the "Medical Treatment Act" (Act No. 205, 1948). MHLW is developing and supporting doctor-centered trials in Iwate, Miyagi and Fukushima prefectures since FY 2011 to create innovative medical equipment, strength of the Tohoku region. The long-term plan is to invite industries, create jobs and restore the Tohoku regions' local economy.

The Pharmaceuticals and Medical Devices Agency (PMDA) started "the pharmaceutical affairs consultation on R&D strategy" in July 2011 to commercialize academic ventures' excellent seeds. Since October 2013, consultations have been provided at the Kansai Branch of the PDMA.

To promote the development of medical equipment, METI, in cooperation with MHLW, is implementing the "Program to formulate guidelines designed to promote development and commercialization of medical equipment" to clarify the evaluation items on the technological and biological stability of medical equipment for future prospective commercialization.

(4) Improving biological resources

Biological resources are essential to pave the way for new research areas. They are required to be developed, collected, stored and accessed nationally.

Under the "National BioResource Project", MEXT is improving the system so that biological resources, including animals and plants that may become the base of life science and strategically important for the country, can be collected, preserved and distributed in a systematic manner.

METI is actively implementing development of biological genetic resources in Asia by executing bilateral agreements with each of Asian countries under the Convention on Biological Diversity (CBD) and by forming the multilateral collaboration system (Asia Consortium) for the conservation and sustainable use of microbial resources.

(5) Promoting the integration of life science databases

DNA sequencing data, protein conformational data and genetic expression data have recently been produced on a massive scale because of advanced life science studies. To effectively use databases for these items, it is important to develop the integrated database of biological information and to promote bioinformatics research that relate to life science and ICT (Information and Communication Technology).

MEXT founded the National Bioscience Database Center (NBDC) in JST in FY 2011 based on a report[1] specifying the need of the center, created in the (then) Council for Science and Technology Policy on May 2009, for providing permanent features required by users and started the "Life Science Database Integrated Project" to promote R&D required for integrating the life science databases owned by various research institutions. In addition, MEXT, MHLW, MAFF and METI had established a joint portal site to disseminate their policy concerning integrating the life science database and the achievements in life science by the four ministries. Since FY 2013, an operation committee has established for implementing security and operation guidelines regarding human data.

The ministries decided to designate October 5 as "Integration Day," and hold symposiums to discuss database integration-related issues on the day every year.

(6) Issues on system development of life science research

1) Efforts for proper implementation of animal trials

The Act for Welfare and Management of Animals (Act No. 105 of 1973) stipulates the concept of 3R (Replacement, Reduction and Refinement) for animal trials.

Based on this Act, the "Guidelines for the Care and Management of Laboratory Animals and Relief of Pain (Care and Keep Standards)" (Public Notice of MOE, No. 88 of 2006) were enacted for animal experiments. MOE provided a leaflet covering the guidelines to promote suitable feeding and keeping experimental animals, which was then circulated for dissemination.

The Act also defines animal trials and laboratory animals. For laboratory animals, the Minister of the Environment adopted "Guidelines for the Care and Management of Laboratory Animals and Relief of Pain (Care and Keep Standards)" (Public Notice of MOE, No. 88 of 2006). The guideline was modified on August 30, 2013. An administrator is required to make periodic inspections on compliance of the guidelines and to make public announcements. The inspection results are expected to be verified by third party external organizations as much as possible. Booklets and other educational materials have been published and distributed to promote proper care and management of laboratory animals.

Based on these guidelines, MEXT, MHLW and MAFF have implemented similar, basic guidelines for research institutes under their jurisdictions to ensure proper care for animal trials: Basic Guideline for Animal Trials at Research Institutes (Public Notice of MEXT, No. 71 of 2006); Basic Guideline for Animal Trials at Research Institutes Under Jurisdiction of MHLW (Public Notice by the Director of Welfare and Science, MHLW, 2006); and Basic Guideline for Animal Trials at Research Institutes Under Jurisdiction of MAFF (Public Notice of by the Secretary-General of Secretariat of Agriculture, Forestry and Fisheries Research Council, MAFF, 2006).

1 Report from the Life Science PT Integrated Database Task Force

2) Approaches to bioethical issues

Today's rapidly advancing life science is beneficial to people, but raises ethical questions which may threaten human dignity and rights. The relevant ministries and agencies have formulated the necessary regulations.

For medical research involving human subjects, "Ethical Guidelines for Medical and Health Research Involving Human Subjects" (Public Notice of MEXT and MHLW, No. 3 of 2014) was enacted in December 2014 by combining the conventional "Ethical Guidelines for Epidemiological Research" (Public Notice of MEXT and MHLW, No. 1 of 2007) and "Ethical Guidelines for Clinical Studies" (Public Notice of MHLW, No. 415 of 2008) to reflect recent diversification of research and misconduct in clinical research.

For human embryonic stem (ES) cells, which have potential bioethical problems such as development of an embryo, a source of life, by decreasing cells, a guideline was created in 2001 to restrict the study to basic research and ensure adequate handling of these cells. In November 2013, the "Act to Ensure the Safety of Regenerative Medicine, etc." (Act No. 85, 2013) was enacted to provide the legal framework for using human ES cells in medical area. The existing guidelines were reviewed based on this Act and the "Guidelines on the Derivation of Human Embryonic Stem Cells" (Public Notice of MEXT, No. 174 of 2014) and "The Guidelines for Derivation and Utilization of Human Embryonic Stem Cells" (Public Notice of MEXT and MHLW, No. 2 of 2014) were established in November 2014 in light of using human ES cells in medical area. The ministries concerned have also taken appropriate measures for the research concerning utilizing human cloning, based on the "Act on Regulation of Human Cloning Techniques" (Act No. 146 of 2000).

3) Securing safety in life science

Recombinant DNA technology could result in a new combination of genes that do not exist in nature. It has been broadly applied to basic biological research, drug manufacturing and improving agricultural products. At the same time, "Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms" (Act No. 97 of 2003) provides the necessary regulations for ensuring biodiversity. In March 2014, related public notices were reviewed according to results of using genetically modified plants and animals and accumulated scientific knowledge and enforced in July.

■ Table 2-2-8 / Major Policies for Promotion of Life Innovation (FY 2014)

Ministry	Implementation	Policy
MEXT	MEXT	National BioResource Project
		Platform Project for Supporting in Drug Discovery and Life Science Researches
		Accelerated Bridging Research Network Program
		Translational Research Network on Infectious Diseases
		Strategic Research Program for Brain Science / Brain Mapping by Integrated Neurotechnologies for Disease Studies (Brain/MINDS)
		Basic Science and Platform Technology Program for Innovative Biological Medicine
		Japan Advanced Molecular Imaging Program Strategic (J-AMP)
		Project for the Implementation of Personalized Medicine
		Program for Strategic Development of Next-Generation Anti-Cancer Research Seeds
		Human Frontier Science Program
	JST	Research Center Network for the Realization of Regenerative Medicine
MHLW	MHLW	Children's Specific Chronic Disease Treatment Research Expenses Health and Labour Sciences Research Grants Specific Disease Treatment Research Grants
		Innovative Drug, Medical Equipment, Regenerative Medical Product Commercialization Promotion Project
		Project of Early Exploratory Clinical Trial Bases for Specific Research Areas Clinical Research Core Hospital Improvement Project
	Radiation Effects Research Foundation	Subsidies for Radiation Effects Research Foundation
	Prefectural governments	Cost for Commissioning Toxic Gas Disability Person Investigation
METI	METI	Project to Promote the Development and Introduction of Robotic Devices for Nursing Care
		Project focused on developing key technology of discovering and manufacturing drug for next-generation treatment and diagnosis
		Program to Formulate Guidelines Designed to Promote Development and Commercialization of Medical Equipment
		Project for R&D into medical equipment and for a future medical care system
		Medical-engineering collaboration business promotion project
	NEDO	Project for R&D into medical equipment and a future medical care system
		Project focused on developing key technology of discovering and manufacturing drug for next-generation treatment and diagnosis
		Project Focused on Developing Key Evaluation Technology: Evaluation for Industrialization in the Field of Regenerative Medicine
MOE	MOE	Planning and Survey for the Japan Environment and Children's Study (JECS)
	NIES	Japan Environment and Children's Study (JECS)

Section 4 System Reform toward Promotion of Science, Technology and Innovation

1 System Reform toward Promotion of Science, Technology and Innovation

(1) Establishing a strategic council to overcome critical problems

The Council for Science, Technology and Innovation (CSTI) conducted detailed surveys and investigations of missions to expert panels for solving important issues according to the classifications in Chapter 2 of Comprehensive Strategy on Science, Technology and Innovation 2014 at three strategy councils under relevant expert panels, "Energy Strategy Council," "Next-generation Infrastructure Strategy Council" and "Regional Resource Strategy Council," and three working groups, "Environment WG," "Nanotechnology/Material WG" and "ICT WG."

(2) Strengthening industry-academia-government "knowledge" network

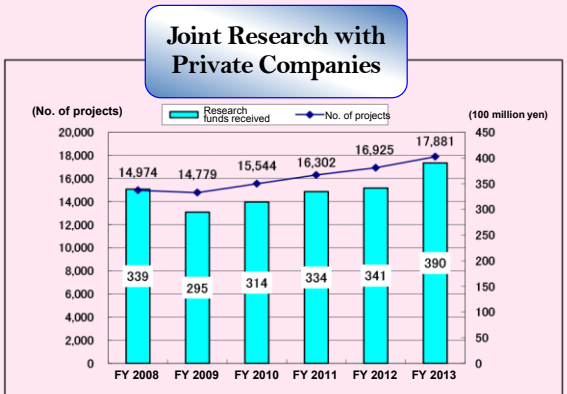
Innovation drives Japan's economic growth. To link high-quality research results of universities and public institutions with innovations, it is necessary to strengthen the industry-academia-government "knowledge" network. The following provides the situation of current industry-academia-government collaboration s and the government's efforts to strengthen that collaboration.

1) Current status of domestic and international industry-academia collaborative activities

(i) Status of industry-academia-government collaboration at universities

Since transformation of national universities into independent administrative agencies in April 2004, cooperative industry-academic-government activities have been increasing. In FY 2013, "the number of the collaborative research activities" between universities and private corporations was 17,881 (a 5.6% increase over the previous year) and "the amount received for joint research from private corporations" was about 3.9 billion yen (a 14.3% increase over the previous year). In contrast to FY 2008, "the number of the cooperative research activities" increased by approximately 1.2 times and "the number of the patent licensing" reached 9,856 (Figure 2-2-9).

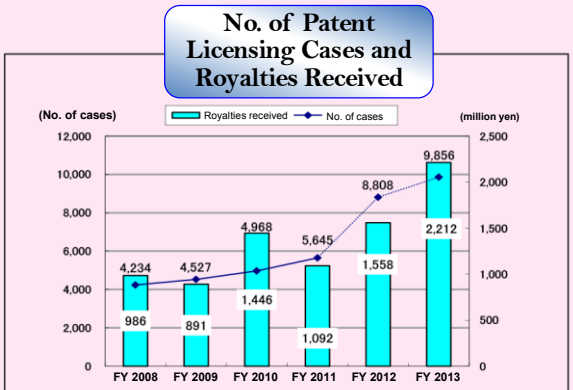
■ **Figure 2-2-9 / Transition in Achievement of Joint Research at Universities**



Research funds received from private companies in joint research projects

(million yen)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
National universities	27,857	24,070	25,468	26,522	27,312	30,557
Public universities	1,585	1,383	1,446	1,637	1,555	1,783
Private universities	4,464	3,998	4,493	5,274	5,281	6,682
Total	33,907	29,451	31,407	33,433	34,148	39,023



Patent licensing royalties

(million yen)

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
National universities	770	638	1,135	885	1,101	1,823
Public universities	21	39	38	39	45	73
Private universities	195	214	272	167	411	316
Total	986	891	1,446	1,092	1,558	2,212

Notes: 1. Subject: National, public and private universities
2. The term "Universities" indicates universities, junior colleges, technical colleges and inter-university research institutes.
3. The number of patent licenses denotes the number of patents which have been licensed or transferred (patent at the stage of "to be received" included).
4. The broken line is used for the FY 2012 survey because the survey renewed the method of counting the number of PTC* licensing applications for those licenses was granted during transition period of relevant counties. *Patent Cooperation Treaty: Licensing an international patent effective in all of the PCT member counties for a patent licensing application that is submitted to one of the member countries.
5. "Total" amount and "total of intermediate total of national, public and private universities" amount may not match because any amount less than 1 million yen

Source: Implementation Status of Industry-Academia-Government Collaborations at Universities (2012), MEXT (as of December 13, 2013)

(ii) Activities of the Technology Licensing Organization (TLO)

TLO (Technology Licensing Organization) is an organization providing enterprises with licenses of patents from research at universities, in exchange for licensing fees from the enterprises and it returns the fee to the university or researcher / inventor as research funding.

As of March 1, 2015, 36 TLOs were approved by MEXT and METI under the "Act on the Promotion of Technology Transfer from Universities to Private Business Operators" (Act No. 52 of 1998). In FY 2013, the number of patent licenses reached 3,596.

2) Effort to expand industry-academia-government collaboration

(i) Development of industry-academia-government collaboration system at universities

MEXT supports open innovation at universities by developing an environment for universities to make autonomous and sustainable efforts for industry-academia-government collaborative activities through interactive workshops (places for creating new ideas through dialog in different fields, industries and areas) and innovation dialog tools.

METI is collaborating with MEXT on verification projects for the evaluation model and the industry-academia-government collaboration centers model. METI is also developing models to reform

systems for promoting; the use of an objective evaluation model of the PDCA cycle for industry-academia collaboration activities, to establish rules for intellectual property rights use between business and university and to increase the mobility of researchers at the industry-academia collaboration centers of leading universities. In addition, METI provides support for industry-academia collaboration activities that are implemented as a verification project for developed models.

The Japan Patent Office (JPO) has sent "university network IP advisors" (university intellectual property management experts) to wide-area networks configured by multiple universities, through the National Center for Industrial Property Information and Training (INPIT), to develop university IP management systems and to enhance IP management function in accordance with the development of industry-academia-government collaboration.

MIC is promoting cooperative industry-academia-government R&D and holding demonstration tests using the New Generation Network Testbed (JGN-X[1]) that has been developed and managed by the NICT (see Section 1-2 (2), Chapter 3 of Part 2).

Through the "Industry-Academia Collaborative Support Project for Accelerating Business Deployment," MAFF has allocated coordinators (agriculture, forestry and fisheries and food industries experts) across the country to collect research seeds and to support matching and research planning.

(ii) Enhancement of R&D through industry-academia-government collaboration

JST is conducting four programs: 1. The Adaptable & Seamless Technology Transfer Program through Target-Driven R&D (A-STEP), which seamlessly covers from the exploration of prospective technological seeds developed in universities and public research institutes through to practical application in industry; 2. The Strategic Promotion of Innovative R&D (S-Innovation), which supports R&D carried out under themes selected among excellent research outputs in academia and aims to create technological the foundations of new industries; 3. The Collaborative Research Based on Industrial Demand, which supports basic research in academia that could resolve technical challenges common in industry .; and 4. JST launched and has conducted the Next-Generation Technology Transfer Program (NexTEP) to support private corporations which are working on practical application of universities' research outputs in the near-to-mid-term. NexTEP aims to ensure that universities' innovative technology can benefit society and to contribute to future innovation.

3) Promoting development of industry-academia-government network

To promote development of industry-academia-government networks, it is essential to raise shared awareness between industries and academia. Japan is bringing together people from private corporations and universities throughout the country and attempting to match them up through forums with open lectures and seminars. To share information, universities are disclosing their achievements by means of workshops, publication of journals and annual reports, presentation of research papers at conferences and in academic journals as well as patent disclosures. Major efforts by the country:

1 JGN-eXtream

(i) The 12th Award of Winners Contributing to Industry-Academia-Government Collaboration (Linking Innovation Award) (FY 2014)

At Innovation Japan 2013 - Universities exhibition of technology and business matching 14 outstanding achievements that contributed greatly to industry-academia-government collaboration were awarded by the Prime Minister and other ministers (Table 2-2-10).

■ Table 2-2-10 / Award Winners for Contribution to Industry-Academia-Government Collaboration

Award	Project	Winner
Prime Minister's Award	Edokko No.1 Development by Industry-University and Financial institution cooperation	Masami Katsuragawa, Small and Medium-sized Business Assist, Customer Support Dept., Tokyo Higashi Shinkin Bank Yukio Sugino, President of Sugino Rubber Chemical Industries Co., Ltd. Shibaura Institute of Technology Tokyo University of Marine Science and Technology, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Minister' Award, Ministry of State for Science and Technology Policy	Development and dissemination of open source-based RTOS	Hiroaki Takada, Professor at Institute Innovation for Future Society, Nagoya University /Nagoya University Graduate School of Information Science, TOPPERS Project
Minister's Award, MIC	Development/standardization/commercialization of global standard wireless transceivers for smart meters	Hiroshi Harada, Head of NICT Social ICT Research Center, Professor at Kyoto University Graduate School of Information Science Fumihide Kojima, Manager of Smart Wireless Lab., Wireless Network Research Institute Mitsuru Kanda, Counselor, Smart Meter System Technology, Grid Solution Promotion Dept., Transmission and Distribution Systems Div., Toshiba Infrastructure System Company, Transmission and
Minister's Award, MEXT	Promotion of "Creation of a health-related bioindustry based on the functionality of characteristic sugars"	Kazutada Yachida, Collaboration Adviser, Kagawa Industry Support Foundation (Project Director, City Area Program) Masaaki Kuwahara, Collaboration Adviser, Kagawa Industry Support Foundation (Chief Scientist, City Area Program)
Minister's Award, MEXT	"Joint Research Chair" academic-industry collaboration research program at Osaka University	Akio Baba, Professor, Director of Office for University-Industry Collaboration , Osaka University Kenji Adachi, Daikin Industries., Ltd. (Invited to Osaka University as Professor) Hiroshi Yoshinada, Komatsu Ltd. (Invited to Osaka University as Professor)
Minister's Award, MHLW	Research and Development of Autologous Cultured Cartilage, JACC®	Mitsuo Ochi, Professor at Department of Orthopaedic Surgery, Integrated Health Science, Institute of Biomedical and Health Sciences, Hiroshima University Katsura Sugawara, Manager, R&D Detp, Japan Tissue Engineering Co., Ltd.
Minister's Award, MAFF	Development of air purifying agent using Japanese cypress branches and leaves	Tatsuro Ohira, Manager, Wood Extractive Lab., Department of Biomass Chemistry, Forestry and Forest Products Research Institute Toshihiko Kaneko, President, Japan Aroma Laboratory

Minister's Award, METI	Development of SBI risk evaluation business from research outcomes at universities	Kazuei Igarashi, President, Amine Pharma Research Institute (Professor Emeritus of Chiba University) Daisuke Katagiri, Senior Managing Director, Amine Pharma Research Institute (Associate Professor of the Center for Academic-Industrial Collaboration and Intellectual Property, Chiba University (concurrent)) Koichi Kamachi, Koichi Kamachi Accounting Office, certified public accountant
Minister's Award, METI	The commercialization of strong synthetic bone grafts	Akira Myoui, Vice Director and Proffesor, Medical Center for Transitional Research, Osaka University Hospital Koichi Imura, Chief, Bio Section, Hatano Facility, Precision & Functional Materials Division, Covalent Materials Corporation Osamu Masaki, Representative Director & President, MMT Co., Ltd.
Minister's Award, MLIT	Development of traffic smoothing at expressway locations such as sag sections	NILIM Takashi Oguchi, Dr. Eng. Professor at. Department of Human and Social Systems, in Institute of Industrial Science (IIS) [Advanced Mobility Research Center (ITS center)] University of Tokyo, Smart Traffic Flow Control System Study Group (Toyota Motor Corp., Nissan Motor Corp., Honda Motor Co., Ltd. ., Mazda Motor Corp., Fuji Heavy Industries Ltd.)
Minister's Award, MLIT	Development technology for the environmentally friendly (eco) terminal system in harbor space	Takeshi Shinoda, Professor, Department of Marine Systems Engineering, Kyushu University Graduate School of Engineering Koki Zen, Specially Appointed Professor, Department of Joint Research for Ocean and Port Disaster Prevention, Kyushu University Graduate School of Engineering Yasuo Kasugai, Rep. Senior Researcher, Port and Airport Research Institute (former Professor of Department of Joint Research for Ocean and Port Disaster Prevention, Kyushu University Graduate School of Engineering) Kazuhiko Egashira, President, Hakata Port Terminal Co., Ltd.
Minister's Award, MOE	Development of a Hybrid Spar Type Offshore Wind Turbine	Tomoaki Utsunomiya, Professor, Department of Joint Research for Marine Energy Resource, Kyushu University Graduate School of Engineering Iku Sato, Assistant Manager, Development Center, Value Creation Promotion Dept., Toda Corp. Takashi Shiraishi, Chief Engineer, Wind Power Generation System Dept., Hitachi Office of Power System Co., Hitachi, Ltd.
President's Award, Japan Economic Federation	Development of "Mahoro" General-purpose Humanoid Robot in biology	Toru Natsume, Director Manger, New Drug Particle Profiling Research Center, AIS Makoto Umeno, Section Manager Assistant, Biomedical Technology Application Sec., Biomedical Project Dept., Robotics Div, Yasukawa Electric Corporation
President's Award, SCJ	Development of Free Cutting Steel without Lead Addition to Replace AISI12L14	Katsunari Oikawa, Professor, Tohoku University Graduate School of Engineering, JFE Bars & Shapes Corporation Kiyohito Ishida, Emeritus Professor, Tohoku University

(ii) Innovation Japan 2014 – Universities, Exhibition of Technology and Business Matching (September 11 - 12, 2014)

MEXT and METI, in cooperation with JST and NEDO, held "Innovation Japan 2014 - Universities

Exhibition of Technology and Business Matching", which was Japan's largest matching forum, with people gathering from universities, public research institutions and private corporations. This forum aims to actively return cutting-edge research achievements from academia to society.

(iii) Agribusiness Creation Fair (November 11 - 14, 2014))

In cooperation with the relevant ministries and institutions, MAFF holds the "Agribusiness Creation Fair" every year. The objective is to exhibit technology seeds from private corporations, universities, public experimental research institutions and independent administrative institutions, and promote collaboration with institutions which are in need of technology. In FY 2014, the exhibition was held next to an exhibition hall of private corporations promoting industrial use of their new technology. At the fair, 147 institutions from all over Japan exhibited their seeds and about 35,000 people participated. Coordinators acted as go-betweens for the industries and universities, consulting visitors and conducting match-up tours for meeting needs of participants and visitors. Local agribusiness creation fairs were also held at two locations in Japan, strengthening the industry-academia-government collaboration network at the local level.

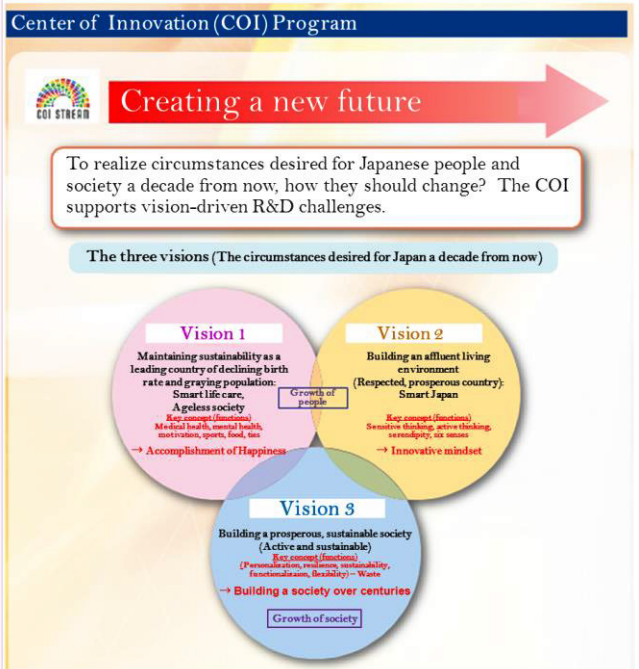
(3) Developing platforms for industry-academia-government collaboration

To promote STI effectively and promptly, it is necessary to develop forums at which industry-academia-government can cooperate with each other.

1) Developing centers for the creation of cutting-edge innovation

MEXT has been implementing the Center of Innovation Science and Technology based Radical Innovation and Entrepreneurship Program (COI STREAM) since 2013. In collaboration with JST, MEXT has been organizing and operating large-scale R&D centers for industry-academia collaboration at which universities, public research institutions and industries can work together to compete with the world. The centers have been concentrating on industry-academia collaborative R&D that focuses on practical application from the basic research phase to achieve cutting-edge innovations and create new industries.

■ **Figure 2-2-11 / Visions of COI**



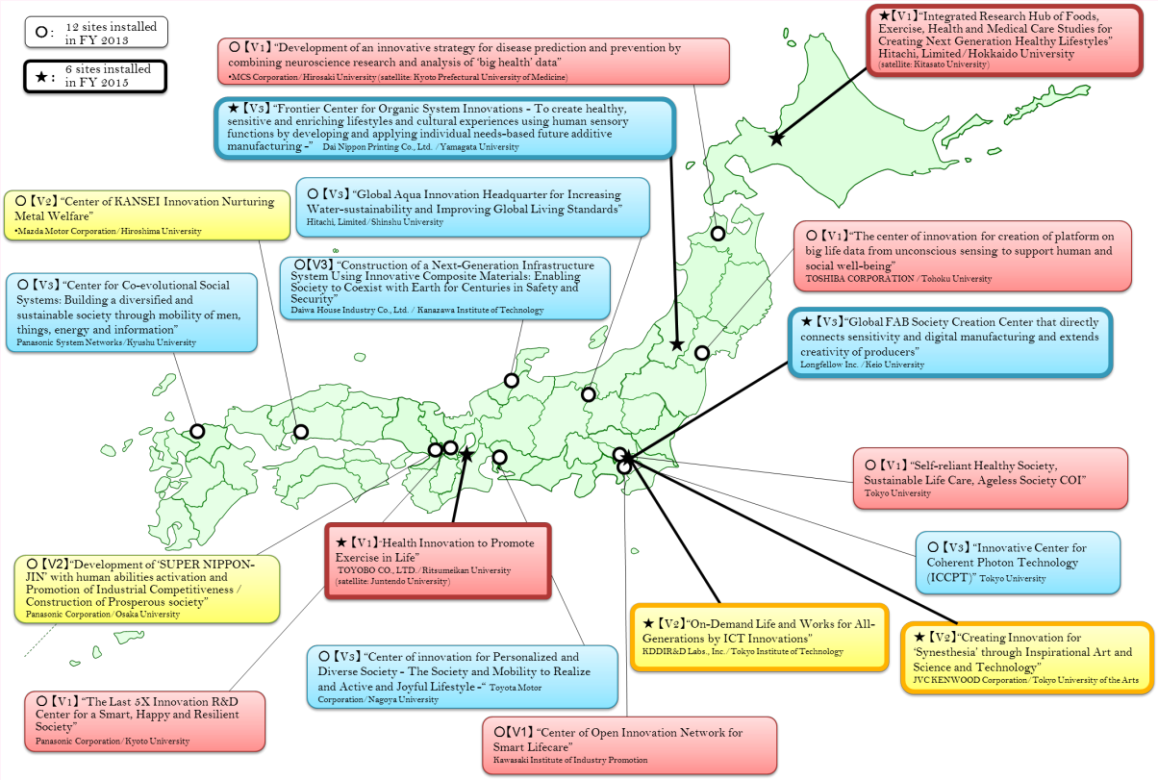
Source: Created by MEXT and JST

COI STREAM has set three visions with the aim of realizing a desirable society and way of life within 10 years. They identify innovative challenges to fulfill the visions at centers called "COI sites." At COI sites, universities and

businesses make utmost efforts, particularly businesses, to take the lead in the practical application of research results. The goal is to build a large-scale R&D center that is world competitive and where concentrated R&D is conducted by universities and businesses seeking the commercialization of research results (Figure 2-2-11).

In FY 2013, MEXT and JST selected 12 COI sites, at which cutting-edge innovate research is conducted by academic-industry collaboration and 14 trial COI sites for examinations of concepts and element technologies to solve R&D challenges as candidates for future COI sites. MEXT and JST evaluated the trial sites in FY 2014, and installed the six new COI sites in FY 2015 (Figure 2-2-12).

■ **Figure 2-2-12 / COI Sites**



Source: Created by MEXT and JST

2) Developing open innovation centers

(i) Infrastructure development for industrial-academic cooperative activities

METI launched the "Program for Promoting Industry-Academia Collaboration Innovation" for promoting full-scale open innovation environment to create innovation efficiently by gathering insight from industries and academies, and revitalize and develop the regions hit by the 2011 Great East Japan Earthquake.

(ii) Enhancement of Functions in Tsukuba Science City and Kansai Science City

The National Spatial Strategy (National Plan) (Cabinet decision of 2008) has stated, "Universities and national and R&D institutions, including those in Tsukuba Science City and Kansai Science City, are

important intellectual/human resources and they are to be utilized to contribute to our nation's development". Based on this statement, Tsukuba Science City and Kansai Science City are working on the following activities.

The Basic Plan has also stated, "International R&D complexes including Tsukuba Science City and Kansai Science City have been improved, but their already accumulated complexes are to be further enhanced functionally."

a) Tsukuba Science City

Tsukuba Science City has been developed to form a center of R&D and education of the highest level in Japan, away from the congestion of Tokyo. The city has more than 300 research institutes, including 32 national experimental research and education institutes and has been promoting many governmental plans, such as research exchange and improvement of functions for international research exchange.

The city has an accumulation of advanced nanotechnology research facilities and human resources. Under the support of the Cabinet Office, MEXT, METI and Japan Business Federation, the three core institutes (NIMS, AIST and Tsukuba University) served as the major force in organizing a world-class nanotechnology research center and the June 2009 launching of the Tsukuba Innovation Arena Nanotechnology (TIA-nano) as the base of industry-academia-government collaboration. In April 2012, the High-Energy Accelerator Research Organization (KEK), that possesses the Photon Factory, joined TIA to become the fourth core institute. TIA-nano is promoting the formation of the center to make the most of increased core research domains and core infrastructure. Public relation undertakings, including the TIA-nano Open Symposium held in September 2014, were made to improve the convenience of TIA-nano for participating companies and to increase the number of participating companies.

The shared facilities system has expanded the available machines and equipment and increased conveniences. Especially since April 2014, the clean room has been operated around-the-clock by the private-sector collaborative research group that has promoted open innovation in the power electronics area.

Aiming to foster next-generation human resources in the field of nanotechnology and to create new industries that will lead Japan in future, the TIA graduate school collaboration project held the Summer Open Festival in 2014 at the TIA Collaboration Building. It attracted 635 young researchers, including under graduate students, graduate student and business researchers from around Japan.

Paralleling these activities as an R&D base open to industry, academia and government, TIA is expanding collaboration networks with private corporations and universities as well as promoting the industrialization of nanotechnology and the development of human resources, by supplying sample materials obtained from projects to user corporations and seeking their feedback for evaluation.

Under the Research and Innovation Promotion Headquarters established in FY 2010 to enhance open innovation hub functions and under the Tsukuba Innovation Arena Headquarters established in FY 2013, AIST is working on industry-academia-government collaboration while determining the various technological needs of industries and society, exploring technological seeds and promoting R&D projects. Specifically, AIST is promoting activities of TIA-nano, an open innovation hub. AIST has participated with 23 technology research associations as part of an undertaking to form a co-creation platform and also carried out 27 large-scale external funding projects. In addition, AIST held the AIST Open Lab, an event

to share the results of its research with business managers, researchers, engineers, universities and public research institutions.

b) Kansai Science City

Kansai Science City is promoting the construction of towns that will play a role as the base for developing the world's culture, science and research and the nation's economy. As of the end of FY 2013, it had about 120 facilities engaged in various research activities.

3) Organizing a co-creation platform under which industry and universities interact through discussions

JST is implementing a program known as the Collaborative Research Based on Industrial Demand. The program is aiming to organize a co-creation platform where dialogs between industries and universities take place in order that universities can identify and engage in basic research for technical issues faced by industries and to accelerate the solution to such issues.

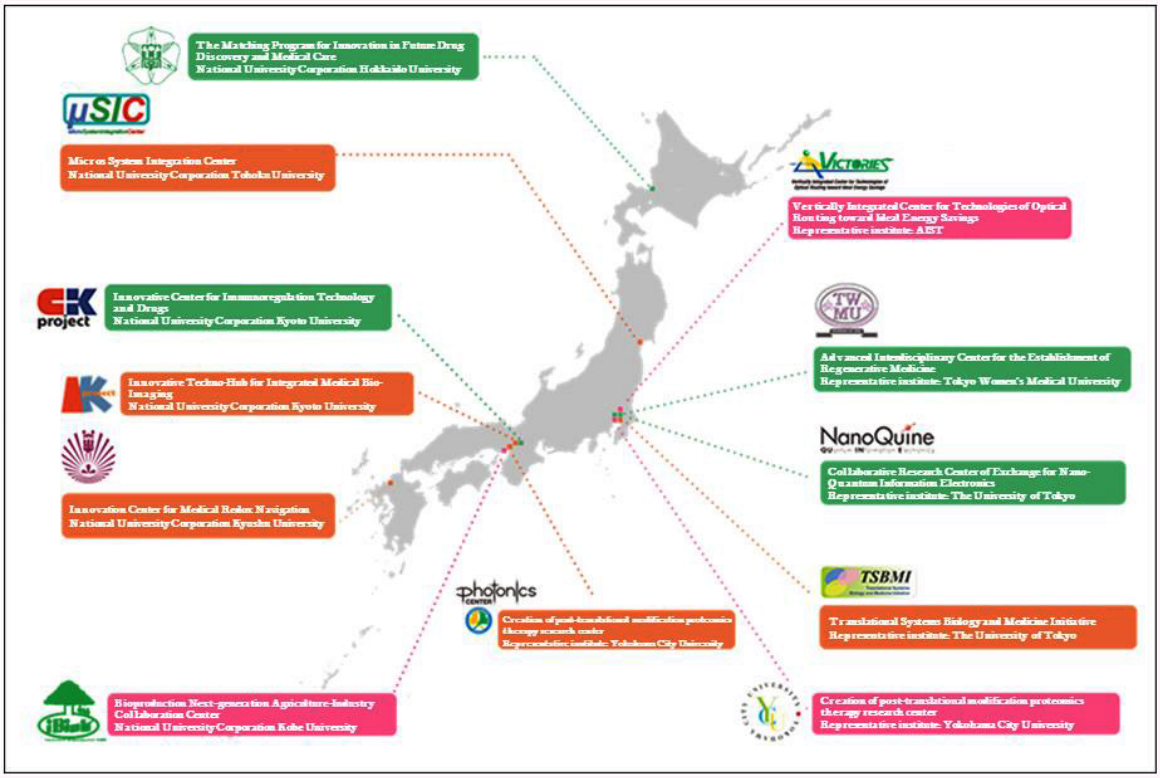
In addition since FY 2012, JST has taken up issues faced by the industries in the Tohoku region to promote the creation of research performance for the recovery of the affected regions, in collaboration with the industry organizations (Tohoku Economic Federation and others) and local governments.

MAFF arranges for coordinators to promote industry-academia co-creative collaboration and hosts local matching forums to support the diffusion of local R&D and technology, so that the people involved in the process, from R&D to its diffusion and industrialization, can work collaboratively toward the same goal.

4) Creation of Innovation Centers for Advanced Interdisciplinary Research Areas

MEXT is promoting the "Creation of Innovation Centers for Advanced Interdisciplinary Research Areas" to support institutions that form the base of R&D, from the first stages to future commercialization under the industry-academia collaboration for advanced interdisciplinary research areas. This is considered important for innovation creation; currently 12 projects have been supported as of FY 2014 (Figure 2-2-13).

■ **Figure 2-2-13 / List of Projects being Implemented under the Creation of Innovation Centers for Advanced Interdisciplinary Research Areas**



Source: MEXT

2 Construction of a New System for Science, Technology and Innovation

(1) Environmental improvement to support industrialization

To create new industries and jobs to vitalize the economy, it is essential to activate start-up businesses utilizing the results of advanced S&T.

By the end of 2008 approximately 2,000 university -launched venture companies across the country as a result of industry-academia-university efforts. However, the number decreased to 52 companies in 2013 compared with 252/year, at the peak of 2004 and 2005. Therefore, MEXT has been promoting an improvement of the environment for start-ups by supporting a seamless process from initial stages of R&D to industrialization.

1) Support for university-launched venture companies

MEXT launched the "Project for Creating STart-ups from Advanced Research and Technology (START)" in FY 2012 and scheduled to be transferred to JST as "Program for Creating Start-ups from Advanced Research and Technology (START)" in FY 2015. START supports creation of university -launched venture companies that can dramatically grow by utilizing the findings such as patent and know-how produced at universities and independent administrative agencies. Under this program, universities and independent administrative agencies conduct R&D for commercializing technologies that have a high risk and a great potential to develop large-scale business by using the commercialization know-how of private-sector experts such as venture capitalists. This program adds new project for

building up a technology and demonstrating its feasibility towards commercialization including robotics.

The "Enhancing Development of Global Entrepreneurs (EDGE)" program, launched in FY 2014 for the development of entrepreneurs and innovation creators, provides the most advanced human resource development for young researchers and graduate students who learn knowledge such as entrepreneurship, start-up know-how and idea creation methods in collaboration with private sectors and overseas institutes including venture capitals and manufacturers.

EDGE program is aiming at cultivating the innovation ecosystem in which innovations based on research outcomes at universities can be created successively by combining the above approaches with the integration and reinforcement of intellectual properties.

In addition, the "Support Program of Capital Contribution to Early-Stage Companies (SUCCESS)" invests in the foundation and capital increases of venture companies which utilize R&D outcome of JST, or offers manpower and technical support to early-stage venture companies to promote commercialization of R&D outcome through their business activities.

MAFF has organized a study group to compile a report on the promotion of interdisciplinary research (August 30, 2013), to proceed with collaborative research with other domains. This is because, in recent years, many cutting-edge technologies that are expected to be applied to the fields of agriculture, forestry and fishery and food have been developed in the medical, information technology and engineering fields.

2) Support for R&D type ventures

MIC has promoted the application of R&D results in ICT area and launched the "ICT Innovation Creation Challenge Program" in FY 2014 to comprehensively support business projects using business know-how of venture capitals and R&D of SMEs and universities to create new businesses. The program invites venture capitals as experts to support business projects and uses their connoisseur capability and management and project development know-how to support the business model verification phase for creating new businesses by SMEs which have innovative technological seeds and ideas as a result of R&D.

RIKEN has established a preferential treatment system for patent licensing to promote the quick diffusion and industrialization of achievements. Venture capitalization is initialized mainly by using RIKEN's research results and certified by RIKEN as useful for diffusion.

In addition, under the "Program for promotion of private-sector commercialization research," NARO has, taking into consideration market needs and costs, been utilizing various resources, ubiquitous in rural areas, to promote the R&D of private corporations that is in the commercialization stage, toward the sextiary industrialization of rural areas.

3) Support by Small Business Innovation Research System (SBIR system)

Under a small business innovation research system (SBIR system[1]) the agencies concerned constantly and jointly support R&D and industrialization in small and medium enterprises that use new technology. To assist R&D for new technology that might produce new small and medium business enterprises, subsidies and commissions have been granted, while several support measures, including reduced patent fees and low-interest loans by the Japan Finance Corporation, have been taken for industrialization. In FY

1 Small Business Innovation Research

2014, seven ministries (MIC, MEXT, MHLW, MAFF, METI, MLIT and MOE) designated 111 special subsidies in all and earmarked about 45.5 billion yen as expenditures for small and medium enterprises.

(2) Regulations and systems to accelerate innovation

R&D activities are sources for the creation of new "knowledge" as well as the creation of new industries and new markets through innovations, thereby strengthening Japan's sustainable development and global competitiveness. Although regulations and systems have been established for the promotion of safe and smooth R&D, they could potentially impede innovation due to excessive strictness. The Japanese government established a system of the National Strategic Special Zones. It is positioned as the breakthrough point for reforming regulations and systems under the Japan Revitalization Strategy. In addition, the conventional Comprehensive Special Zone System and other special zone systems are expected to be increased. These systems are expected to accelerate innovations.

(Undertakings for the National Strategic Districts)

As a means to implement drastic regulatory reforms, the government designated six National Strategic Districts in May 2014. Of these districts, the Tokyo Metropolitan area (nine wards in Tokyo, Kanagawa prefecture and Narita, Chiba prefecture) is based on a political theme as "International Business Innovation Center," and the Kansai area (Osaka, Hyogo and Kyoto prefectures) as "Medical Innovation Center, Support for Challenging Human Resources" using Special Provisions for the Medical Expenses Combined with Treatment Outside Insurance Coverage and "Special Provisions for the Medical Care *Act relating to* regulations on the number of beds" to promote innovation mainly in medical area and further regulatory and institutional reforms.

(Efforts for the Comprehensive Special Zone System)

The government has carried out the first to the fourth designations and selected seven areas for the Comprehensive Special Zones for International Competitiveness to form industrial and functional clusters that will become the engine of Japan's economic growth. It has also selected 41 areas as Comprehensive Special Zones for Local Revitalization to strengthen local power through local vitalization with maximum use of local resources.

Of the areas that were selected as comprehensive special zone for international competitiveness, "Tsukuba" has numerous advanced research centers and Japan's largest international R&D base. However, Tsukuba has problems, such as research results not being directly linked to the creation of new business or new industry and also few instances in which institutions worked together toward the same goals and toward the creation of new projects and industries. To solve these issues and to promote life innovation and green innovation, Tsukuba is planning to utilize the benefits of designation for comprehensive special zone promotion, such as more extensive inter-organizational personnel exchange beyond industry-academia-government barriers.

(3) Development of a regional innovation system

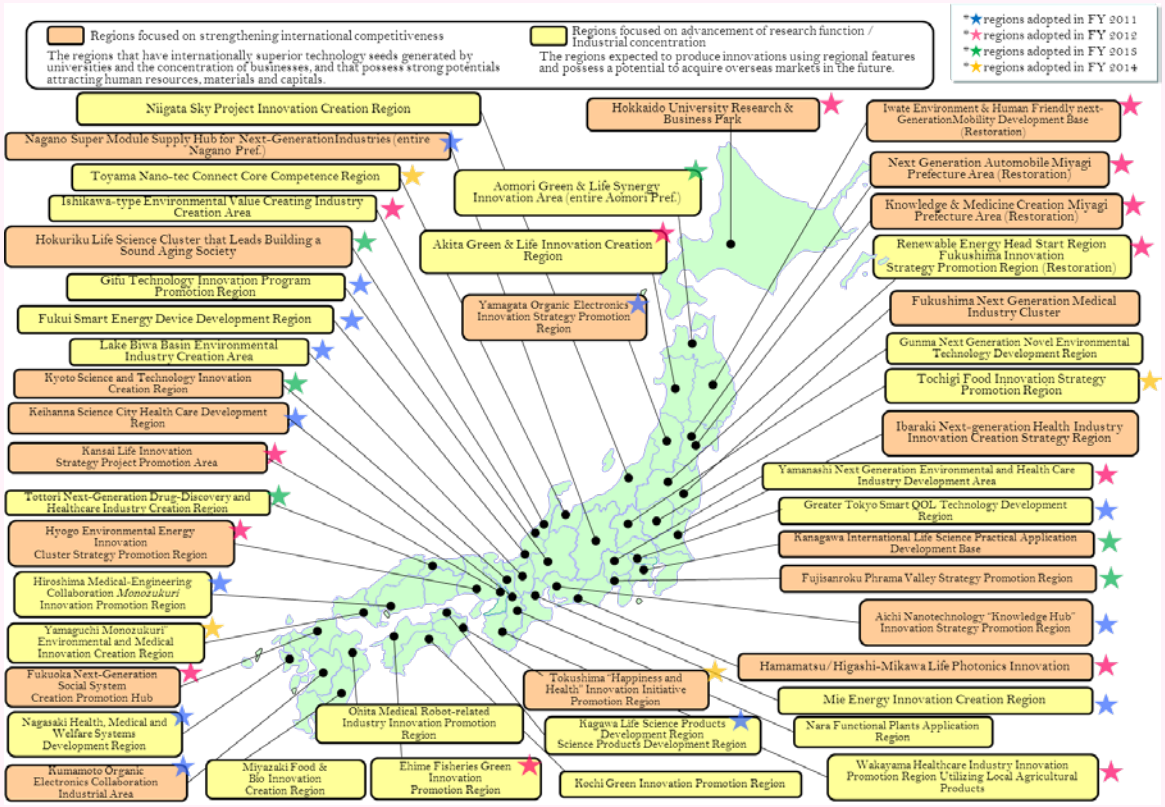
To promote efforts to solve various issues at the local level and to vitalize local areas with S&T power, it is important to utilize the merits, diversity, uniqueness and originality that each area possesses. The

agencies concerned have constructed mechanisms to jointly support local efforts so that each area can utilize its unique merits and characteristics for S&T activities. These efforts are intended to make local areas powerful through local STI and to recover from the GEJE, eventually leading to Japan's upgrade and diversification in S&T and to strengthening of industrial competitiveness.

MEXT, METI, MAFF and MIC established a regional support system to create regional innovations by selecting specific regions that suggest proactive and outstanding ideas as the "Regional Innovation Strategy Promoting Regions," through cooperation or partnership of local governments, universities' research institutes, industries and financial institutions, and assisting the implementation of these ideas continuously from initial research to industrialization stages by mobilizing all policies of the ministries concerned. In particular, the above-mentioned four ministries and Reconstruction Agency select GEJE afflicted areas separately from the selected regions described above, as the "GEJE Recovery Support-type Regional Innovation Strategy Promoting Regions," and support the industries, academies and governments in these regions for achieving proactive and outstanding ideas in the regions for creating regional innovations based on the regional strength and features.

In FY 2014, a total of five regions were selected: two "Regions Focused on International Competitiveness" which contain internationally competitive technological seeds at local universities or results of a company, and have strong potential to attract manpower, goods and money from abroad, and three "Regions Focused on Advancement of Research Function/Industrial Concentration," which are expected to create innovations based on local features, and have potential to capture overseas markets in future (Figure 2-2-14).

■ **Figure 2-2-14 / Regions in which Innovation Promotion Strategies have been supported: List of Regions selected in FY 2013**



Source: Created by MEXT
As of FY 2014, there are 17 Regions Focused on International Competitiveness, 24 Regions Focused on Advancement of Research Function/Industrial Concentration and 45 GEJE Recovery Support-type of Regional Innovation Strategy Promoting Regions.

1) Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Within the Regional Innovation Strategy Promoting Regions, MEXT supports 37 regions which are expected to contribute greatly to the Science, Technology and Innovation Strategy in local area in terms of the development of intellectual property and human resources. Regarding the "GEJE Recovery Support-type of Regional Innovation Strategy Promoting Regions," MEXT has been supporting efforts intended to construct mechanisms for sustainable and developmental innovations

JST provides a comprehensive support for creating regional innovations through seamless R&D from the discovery of prospective technological seeds to commercialization by assistance provided by S&T coordinators under the "Adaptable & Seamless Technology Transfer Program through Target-Driven R&D (A-STEP)."

MEXT also provides a comprehensive support for the recovery from GEJE or in particular, economic recovery of afflicted areas in cooperation with Tohoku Economic Federation and local governments through the assistance for industry-academia collaborative research and desired by the industry in afflicted area by means of the connoisseur system.

2) Ministry of Internal Affairs and Communications (MIC)

For "the promotion of local industries through ICT R&D" under the Strategic Information and Communications Research and Development Promotion Program, MIC is promoting industry-academia collaborative research of ICT that will contribute to the creation of new local industries, promote local industries and vitalize local society.

3) Ministry of Agriculture, Forestry and Fisheries (MAFF)

Under "the program for promotion of science and technology research on agriculture, forestry and fishery and food" MAFF has set research topics that could lead to local vitalization using free ideas and the solution of issues faced by manufacturers, to promote cooperative industry-academia-university R&D led by prefectural experimental research institutions and local universities. It is specifically supporting the research of local innovation strategies. In addition, MAFF has allocated industry-academia-university collaborative coordinators nationwide who are experts of agriculture, forestry and fisheries and food industries, to promote R&D in local industries through support for preparation of research planning.

4) Ministry of Economy, Trade and Industry (METI)

METI supports the discovery of business seeds by providing the place of matching and technological development which may lead to new business by SMEs and small-scale enterprises using technological seeds developed by universities through the "seeds discovery and bridging research project" to accelerate license agreements between SMEs/small-scale enterprises and universities.

AIST designates Tsukuba Center and eight other local centers as the research platform to lead the world with highest level research in response to regional characteristics or needs, or as the collaboration center to bridge technologies to local industries through technological support, joint research and human assistance for SMEs, local universities and public experimental research institutions,, and revitalization of local industries as open innovation hubs. In April 2014, the "Fukushima Renewable Energy Institute" was opened in Koriyama City, Fukushima prefecture for promoting R&D of renewable energy and recovery from the disaster by accumulating new industries.

(4) Promoting an intellectual property strategy and international standardization strategy

It has been a decade since enactment of the Intellectual Property Basic Act in March 2003. The circumstances concerning intellectual properties have greatly changed due to the growth of emerging countries, globalization of business environment and progress in ICT introduction in society.

The cabinet decided the Basic Policy Concerning Intellectual Property Policy in June 2013 to cope with current circumstances. The policy envisions the changes in the coming ten years and has set a goal to become the most advanced nation in the world in the area of intellectual property within that decade. Based on the basic policy, the Intellectual Policy Strategy Headquarters made the Intellectual Property Policy Vision, listing detailed policy issues. To ensure that domestic innovations will lead to a rise in the industrial competitiveness of Japan, the measures include following: 1) reviewing the system for employee inventions under the patent law, 2) protecting trade secrets, 3) improving the patent application review system to become the world fastest and highest quality patent examination system and 4) improving the support system to strengthen the intellectual property strategy of small and medium-sized enterprises

and venture companies.

The measures addressing the issues specified by the vision have been steadily progressed led by the Headquarters.

As corporate activities are more globalized and open innovation is more widely used, the importance of the open and close strategy for maximizing the corporate value by suitably making use of patent rights, trade secret and standardization. Intensified international disputes on intellectual properties and large-scale leaks of trade secret and technologies have largely aroused social concern and the need for improving the quality of intellectual property policy has been understood in light of industrial competitiveness.

Under these circumstances, the Intellectual Property Strategy Headquarters launched the "IP Promotion Plan 2014" in July 2014 for the creation and protection of intellectual property. The plan includes the "drastic re-examination of occupational invention system," "comprehensive reinforcement of business secret protection" and "international standardization and certification" to promote the IP strategy according to the plan in collaboration with ministries and agencies concerned under the supervision of the Intellectual Property Strategy Headquarters.

1) Building up a global intellectual property system to enhance industrial competitiveness

The Japan Revitalization Strategy has determined the necessity to drastically strengthen Japan's standardization strategy through promotion of a "top standard system" and other measures.

METI implemented the "public-private standardization strategy" in May 2014 to promote strategic standardization which may lead to create new markets and strengthen industrial competitiveness and provided specific details for the government and private sector to tackle in close collaboration, including improvements in government-private collaboration, world-class certification infrastructure and cooperation with Asian nations.

For instance, "New Market Creation Standardization System," established in July 2014 comprehensively accelerates the standardization of fused technologies involving multiple organizations and advanced technologies owned by specific companies including SMEs, as a means to reinforce government-private collaboration. In the "Global Certification Infrastructure Development Program" which is provided for developing a certification infrastructure in Japan to reinforce the world-class certification in strategically important areas to encourage Japanese companies to expand their business overseas, construction of large power conditioner and large storage battery evaluation facilities was started. To improve partnership with Asian nations, a bilateral standardization and certification cooperation agreement with Indonesia was signed in September 2014 following Vietnam and India.

The "IEC Convention," the annual convention of the International Electrotechnical Commission (IEC) was held in Tokyo in November 2014. About 2,600 experts gathered to Tokyo from all over the world and joined the general assembly and forums as well as ad hoc committees for developing standards in 53 areas. Japan, as the host nation, set a theme of "Integration toward a Smarter World," and opened various events including technical visits and exhibitions by private companies, symposiums and demonstration experiments, aiming at raising the awareness of participants for the cutting-edge technologies in smart equipment and contribution of Japan to international standardization.

In the International Organization for Standardization (ISO), a proposal for international standardization

by Japan for the vacuum glass for buildings developed by a Japanese manufacturer was approved in July 2014 through the "top standard system" which is the former "new market creation system."

MIC has promoted standardization activities in the ITU[1] and related forums mainly for the prioritized areas of smart grid, digital signage[2] and next-generation browsers according to the report of the Telecommunications Council "Standardization Policies in Telecommunication" (July 2012).

A conference of Study Group 16 (SG16) of ITU-T, the telecommunication standardization section of the International Telecommunication Union, was to be held in Sapporo in June 2014. The task of SG16 is to discuss standardization of image coding and digital signage methods.

Water supply has been included as one of the specific strategic fields for international standardization, so MLIT and MHLW are promoting its strategic international standardization under the IP Promotion Plan to ensure that Japanese corporations launching water supply and sewerage system businesses in the global market can achieve high-competitiveness. Currently, these two ministries are actively participating in the Asset Management Area (ISO/TC224WG6& ISO/PC251) and the Crisis Management Area (ISO/T224WG7) to lay out policies for ISO International Standards.

Establishment of the Project Committee on Wastewater Reuse for Irrigation (ISO/PC282) was led by MLIT as the first ISO committee for Japan to serve as the secretariat in water related fields. The first meeting was held in Tokyo in January 2014. The committee has been working toward ISO standardization as it relates to recycled water and use of recycled water in urban areas.

2) Review of IP systems and improvement of IP activity-related systems

In response to changes in the world innovation environment, the relevant authorities are promoting the following approaches to develop and implement international standardization strategies, review IP systems and improve IP activity-related systems.

(i) Japan Patent Office (JPO)

a) Promotion of global IP initiative

In the midst of growing economic globalization and open innovation, JPO is promoting the Global IP Initiative (laid out by JPO in July 2011) to incrementally improve global IP infrastructures, so that Japanese companies can smoothly engage in business internationally. Currently, JPO is implementing the "patent prosecution highway (PPH[3])"with 30 nations (as of February 2015). This will allow patent applicants, whose patents have first been determined to be patentable, to apply for early examination in other countries. In addition, JPO opened the "Chinese and Korean Document Translation and Search System" in January 2015 for the search of patent documents in Chinese and Korean.

b) Acceleration of examination system

In response to needs from patent applicants for patent right acquisition timing, JPO is implementing an accelerated examination system under certain conditions. Additionally, they have, since August 2011, been

1 International Telecommunication Union
2 A system distributing information in outdoor, stores, public space, transport facilities and various other places using electronic devices such as displays connected to the Internet.
3 Patent Prosecution Highway

implementing the "Accelerated Examination and Accelerated Appeal Examination to Support Recovery from Earthquake Disasters" to speed the examination of patent applications from people and business facilities affected by the GEJE to allow them to utilize intellectual properties for restoration.

The Act for Special Measures Promotion of Research and Development Businesses etc. by Specified Multinational Enterprises (Act for Promotion of Japan as an Asian Business Center) (Act No. 55 of 2012) was enacted to promote activities to attract R&D bases and supervisory bases of global enterprises to Japan. In November 2012, the patents applied as the results of R&D projects approved under the Act were, on a trial basis, included in the subject of the acceleration of patents examination system.

c) Collective examination for IP portfolio supporting business activities

As Japanese enterprises have been developing business overseas, the number of patent applications filed from Japan to overseas patent offices. JPO studied a new examination system to meet the needs of patent applications in response to the Global IP Initiative. In April 2013, JPO started a new initiative, titled "collective examination for IP portfolio supporting business activities," under which it examines applications and grants rights across fields according to the timing of applicants' business development to support applications for comprehensive intellectual properties. The subject to the new initiative is a group of intellectual rights (patents, design and trademarks) that is associated with domestic and overseas projects.

In October 2014, provisions of applications for "the collective examination for IP portfolio supporting business activities" were partially deregulated to allow collective examination of applications when there is a group of applications applicable to this business category even if the applications include those which are not represented by the applicant.

d) Information services concerning licensable patents and research tools

To expedite the use of IPs, JPO provides information of licensable patents and research tool patents in the form of a database through the National Center for Industrial Property Information and Training (INPIT).

e) Implementation and publication of a trend survey in technology

There is a call for coordination between R&D strategy and intellectual property strategy to enable utilizing patent information on R&D. Therefore, JPO has comprehensively analyzed technology trends by analyzing "patent application trends" in light of "R&D trends" and "market trends"; publishing the results.

f) Developing and securing human resources

To disseminate IP knowledge, JPO is supporting high-schools and technical colleges that provide practical IP education, through the National Center for Industrial Property Information and Training (INPIT).

(ii) Japan Science and Technology Agency (JST)

JST is making efforts ranging from the discovery of high-quality research achievement, through support for patent acquisition, to industrialization. Specifically, the Agency is giving full support to the

utilization of intellectual properties through the "Promotion of the Use of Intellectual Property." This includes: supporting the strategic acquisition of foreign patents by universities through use of their research results; collecting and packaging some patent rights scattered in some universities for more efficient use and offering universities' patent information free of charge through the Internet (J-STORE).