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

Section 1 Realization of Restoration and Recovery from the Earthquake Disaster

Numerous efforts to resolve the various issues listed in the Basic Guidelines for Reconstruction, in response to the Great East Japan Earthquake (GEJE) (determined by Reconstruction Headquarters in response to the GEJE on July 29, 2011), show that the policy for recovery and revitalization from the GEJE, that being to promptly rebuild victim's lives and realize a secure and safe society, are being undertaken 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-academic-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 exposed by the earthquake disaster are being resolved by making full use of S&T (science and technology) towards 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.

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 research and development of technology to foster new industries.

MEXT is also implementing the Tohoku Medical Megabank Project, which promotes population-based cohort study (150,000 scale) 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 preventative 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).

The Ministry 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 research and development 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 in order 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 green house 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 assisting demonstrations or performance evaluations of practical technology, conducted jointly by testing and research institutes established by companies, universities or local governments in the disaster areas, as promotional efforts for the commercializing of superior practical technology for meeting needs in the disaster areas. The ministry is also taking measures to promote R&D by industry-academia-government collaboration in growing fields such as medical, information and communications, and renewable energy, in order to create new industries or employment.

In particular, the ministry is assisting in the development and demonstration of medical equipment in collaboration with Monodzukuri companies and medical institutions, in an effort to activate local industries in Fukushima Prefecture. This is also for the improvement project of medical industry base centering on Fukushima Medical University through Recovery Fund concerning Nuclear Emergency Preparedness in Fukushima established for restoration from nuclear hazards.

As one of undertakings to restore the areas suffering from the disaster in Tohoku, as well as the rest of Japan, the Control System Security Center in Tagajo City (Miyagi Prefecture. Established in April 2013) has been conducting research and development, international standardization, infrastructure development for evaluation and certification, human resource development and education with the goal of upgrading the security technology of control systems and evaluating and certifying technologies of control devices.

In addition, in efforts to expand the introduction of renewable energies, METI has implemented the development of R&D centers for renewable energies through industry-academia-government cooperation. This includes an experimental project designed to commercialize the world's top class floating offshore wind power plant, assistance in the construction of a smart community focused on the use of renewable energies for building disaster-resistant communities and others.

(2) Restoration and rehabilitation 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 are 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.

In light of the lessons learned from such communication breakdowns, MIC conducted R&D and empirical experiments into "technology to reinforce communication processing capacity in times of disaster" and "satellite communication networks which work autonomously", in order to eliminate communication bottlenecks when a natural disaster, such as large-scale wind and flood damage, occurs and to implement secure information transmission.

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[1]), 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 is conducting investigation and research into maintaining and recovering city functions with a view to evaluating the margin of safety against building collapse, following shaking-test results in the Special Project for Reducing Vulnerability in Urban Mega Earthquake Disasters.

For the sake of the sustainable functionality of urban structures during and after an earthquake, National Research Institute for Earth Science and Disaster Prevention (NIED) carries out various large-scale shaking tests at the Three-dimensional Full-scale Earthquake Testing Facility (E-Defense) ,and elsewhere in order to investigate failure processes and mechanisms of urban structures, such as buildings and lifeline facilities under large-earthquake ground motions, and to develop effective disaster-mitigation technologies(See Part 2, Chapter 3, Section 1 (1) 1)).

In addition, the National Institute for Materials Science (NIMS) is comprehensively promoting efforts to develop materials which will contribute to the strengthening of Japan with regard to disaster prevention and competitiveness enhancement. It is hoped that this will be achieved by fully mobilizing S&T capacities in the materials field, in which Japan excels, with the aim of promoting the prolongation and enhanced earthquake resistance of the social infrastructure, a current and future threat because of the age progression.

The National Institute for Land and Infrastructure Management (NILIM) is reviewing the validity of technical standards based on understanding and analysis of disaster situations. This includes: the

1 Polarimetric and interferometric synthetic aperture radar system 2

development of methods to allow the quick estimation of the damage to rivers and roads after the occurrence of a large-scale earthquake, the development of liquefaction countermeasure technology for residential lands and a tool to analyze its effects and influences, the establishment of method and criteria for evaluating earthquake-proof safety of nonstructural components of buildings among other measures in order to assist in the design recovery and reconstruction plans for the disaster areas.

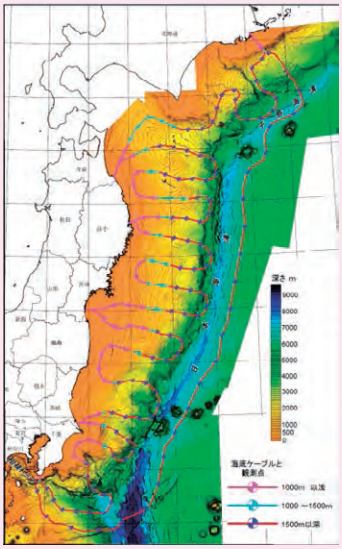
The Public Works Research Institute (PWRI) is conducting research on the characteristics of the resistance behaviors of bridges affected by tsunamis, and on the technologies addressing issues associated with such bridge behaviors. It is also researching the feasibility of a liquefaction determination 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".

(3) Providing safe living in the disaster areas

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

In and around the aftershock area of the Off the Pacific Coast of Tohoku Earthquake, greater seismic activities have been occurring and it is likely that great aftershocks or induced seismicity will occur in the future, so that destructive shaking and a major tsunami may be generated. Taking into account this forecast, efforts to expand and reinforce the survey and observation of earthquakes and tsunamis are being undertaken for the purpose of understanding their generation mechanisms and providing prompt and accurate information on them. 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 measures to mitigate damage from fires caused by earthquakes are being considered.

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



Source: MEXT

In FY2011, 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. In FY2013, the ministry manufactured and installed the necessary equipment with a view to starting full-scale operation in FY2015 (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. A prototype has been developed, test operated and improved in advance of practical

application.

Development of unmanned helicopter technology for reconnaissance and monitoring
Courtesy of National research Institute of Fire and Disaster (NRIFD)

Development of reconnaissance technology and rescue technology
Courtesy of 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, in order to establish technical standards for tsunami countermeasures and a petroleum tank damage estimation system. This makes possible the calculation of spatial variation due to long-period ground motion and cutoff cycle by an empirical prediction method. Furthermore, the agency conducted studies on fire-prevention and fire-extinguishing measures at earthquake debris or scrap metal deposits. A test apparatus was developed that evaluates the risk of thermal ignition of such debris and deposits.

Fire occurred at tsunami debris and deposits in Natori City.
Courtesy of 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 the 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

Fire exposure experiment of a solar cell module
Courtesy of NRIFD

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 beng 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 FY2013, in order 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, confirmation of the results of the monitoring of sea water, seafloor beds and marine life off the coasts of Fukushima Prefecture, Miyagi Prefecture, Ibaraki Prefecture and others, indicated the necessity of further monitoring. The monitoring was made under the cooperation among relevant ministries and local governments in line with the "2013 Marine Area Monitoring Procedure" formulated on April 1, 2013.

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 Implementation System of Each Ministry in Accordance with the Comprehensive Monitoring Strategy

Main monitoring in accordance with the Comprehensive Monitoring Strategy (modified on April 1, 2013)

*** Monitoring implementation system of each ministry in accordance with the Comprehensive Monitoring Strategy**

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 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 water environment, natural parks etc. (MOE, Fukushima Prefecture, municipalities, TEPCO and others)
- Concentration measurement of radioactive substances and measurement of air dose rate in water, sediment and environment samples from rivers, lakes, marshes, water sources, ground waters and coasts in Fukushima Prefecture and neighboring prefectures
- Analysis of concentration measurement of radioactive substance in wild plants and animals
- Concentration measurement of radioactive substances in influent water from refuse incineration plants and measurement of air dose rate on the boundary zones according 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.

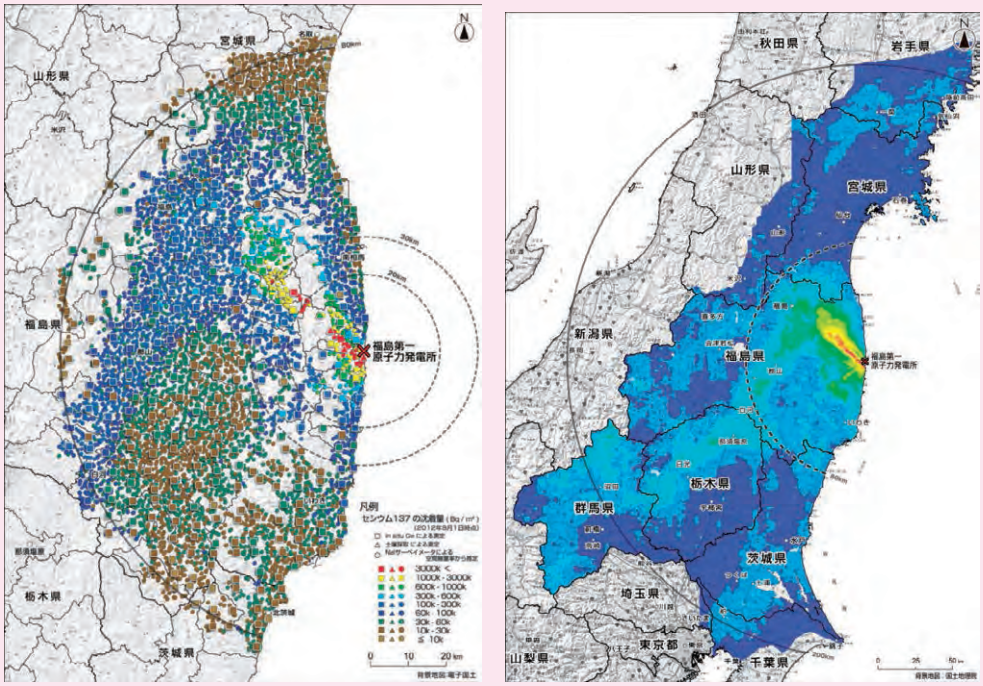
Monitoring of foods (MHLW, MAFF, Fisheries Agency, Fukushima Prefecture and relevant prefectural authorities)
- Concentration measurement of radioactive substances in foods
- Measurement of actual exposure dose due to ingestion of contaminated foods

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

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

Source: Nuclear Regulation Authority

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

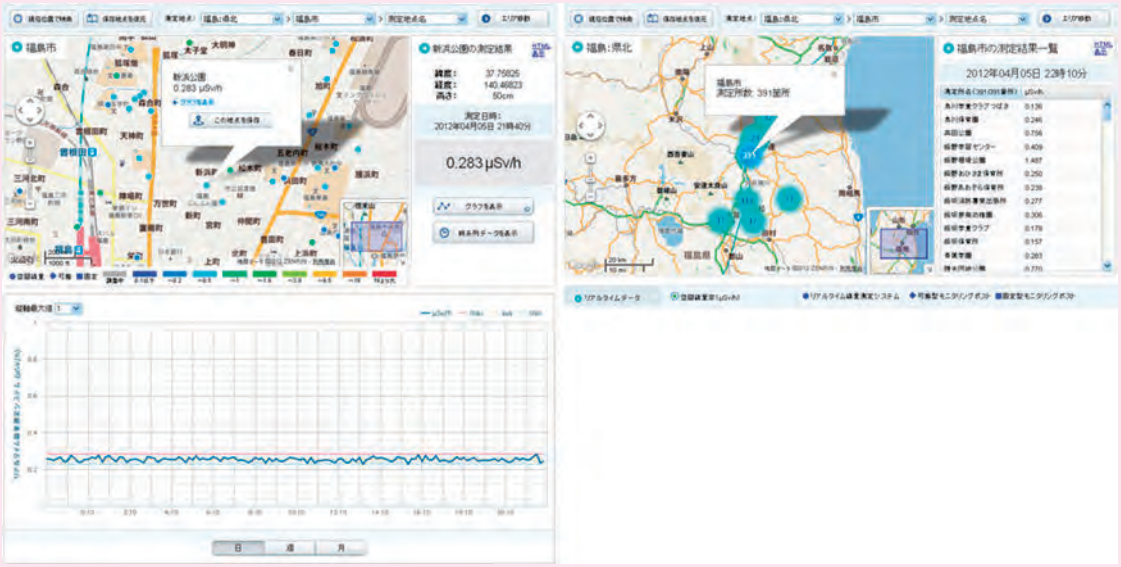


*** Cesium 137 soil concentration map (left)**

*** The spatial dose rate map of Fukushima and neighboring prefectures (As of November 19, 2013: 32 months after the accident) (right)**

Source: Nuclear Regulation Authority

Figure 2-2-4 / Real-time Display System



* The system is under the management of the Nuclear Regulation Authority as of April 2013
Source: 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 the three areas of Fukushima Prefecture and published the results by bringing together the distributions of radiocesium in the forest.

(ii) Efforts toward decontamination

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

The Cabinet Office and Ministry of the Environment (MOE) conducted a decontamination empirical model project for the caution zones in Fukushima Prefecture, those zones defined in the 12 municipalities designated as the planned evacuation zones, in order to obtain knowledge necessary for effective decontamination. They are also publicly calling for contributions to the discovery of superior technologies in the fields of decontamination efficiency, removal reduction and related areas, as well as conducting demonstration tests of decontamination technology in terms of decontamination effects, economic efficiency and safety.

The Japan Atomic Energy Agency (JAEA) is conducting research and development 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 farmland, but also demonstrates the decontamination technologies for farm land and forestry so far developed, in order 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) developed an absorbent by a nanoparticulation process using an inorganic compound called Prussian blue and conducted a verification test of this decontamination technology as an application for plant incineration ash and agricultural water contaminated by radioactive cesium. The outcomes of the verification test provided useful knowledge on the space required for intermediate storage facilities and for simplifying the storage method of radioactive contaminated waste material, as well as for preventing dispersion of radioactive cesium. Also, a detection method was developed for very small amounts of radioactive cesium in environmental bodies of water.

(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 and the MEXT conducted research and development 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 Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4, revised June, 2013.

(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, having recognized the need for TEPCO to take every possible measure for prompt and appropriate compensation for damage, authorized the New Comprehensive Special Business Plan on management rationalization (authorized in January 2014) and is providing assistance to TEPCO through the Nuclear Damage Compensation Facilitation Corporation to facilitate the compensation process.

To address the issue of a deadline of compensation for damages, a special act[1] was enacted in June 2013 to suspend any deadline while the the center works toward settlements. In addition, in December 2013, enactment of another special act[2] extended the deadline for any compensation claim for specified nuclear damage from three years to ten years, with the start of the limitation period for claims arising from tortious acts from "20 years from when the tortious acts were conducted" to "20 years from the time the damage occured" regarding matters subject to Article 724 (Restriction of Period of Right to Demand Compensation for Damages in Tort) of the Civil Code. In June 2013, the government approved the Comprehensive Special Business Plan. The plan clarifies the responsibility of TEPCO to take measures against rejecting the claims of victims due to any deadlines. This responsibility was also included in the New Comprehensive Special Business Plan.

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 / Main Measures for the Prpmotion of Realization of Restoration and Recovery from Earthquake Disaster (FY2013)

Ministry	Research organization	Subject
Reconstruction Agency	Ministry	Tohoku Medical Megabank Project
		Tohoku Ecosystem-Associated Marine Sciences program
		Next-generation Energies for Tohoku Recovery Project
		Tohoku Innovative Materials Technology Initiatives for Reconstruction
		Facility development of national universities
		Development and promotion of the safety evaluation and education center for critical information technology infrastructure, to contribute to the restoration and rehabilitation of Tohoku
		Radiation substance surveys in water and other environments
		Projects implemented under the Act on Special Measures Concerning the Handling of Radioactive Pollution (Technology development and evaluation)
	NIED	Development of an Observation Network for Earthquakes and Tsunamis along the Japan Trench
	AIST	Projects to establish Fukushima as a base for renewable energy R&D
	National Institute for Environmental Studies (NIES)	Studies on radioactive substances, disaster and environment
MIC	MIC	R&D on technology that secures information and communication during a disaster
		R&D on a high resolution synthetic aperture radar to be mounted on a small aircraft
	NICT	R&D on electromagnetic wave sensing basic technology
		R&D for basic network technologies

1 Special Act on Interruption of Prescription of the Nuclear Damage Compensation Dispute (Act No. 32 of the 5th of June 2013)
2 Special Act on Measures to Fulfill Early and Complete Compensation of the Nuclear Damages and on a Special Measure for Prescription of the Right to Demand Nuclear Damages Caused by the Nuclear Power Plant Accidddent Following the Great East Japan Earthquake(Act No. 97 of the 11th of December 2013)

MIC Fire and Disaster Management Agency (FDMA)	NRIFD	R&D of fire extinguishing robots that respond to energy and industrial infrastructure disasters
		R&D on Technology for Ensuring Fire-Fighting Safety
		Improving the safety of petroleum tanks and other hazardous material storage facilities against earthquakes and tsunamis
		Security against diversifying fires
		Information technology to strengthen fire-fighting capabilities during a large-scale disaster
MEXT	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Construction of the Dense Ocean Floor Network for Earthquakes and Tsunamis
	Japan Science and Technology Agency (JST)	Revitalization Promotion Program (Matching Promotion)
MAFF	MAFF	Advanced Technology Deployment Project for the Revitalization of Food Production Areas
		Radioactive Materials Removal and Reduction Technology for Forests and Farmland
		Forest Decontamination Demonstration Project
		Verification project for forestry restoration addressing radioactive material issues
		Agriculture recovery research center project in the Hama District of Fukushima Prefecture
METI	MAFF	Advanced ICT verification research center project in Fukushima Prefecture
	AIST	Implementation of Emergency Geological Survey and Research
		Radioactive cesium decontamination using prussian blue particles
		Passive energy conservation technology
		Development of automated low cost technology for infrastructure inspection
Ministry of Land, Infrastructure, Transport and Tourism (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
		Study on low-cost liquefaction countermeasure in urban areas
		Study on a tsunami inundation prediction system to improve disaster countermeasures
		Research on maintaining stable port and harbor operation when a tsunami disaster occurs
	PWRI	Development of technology for composite measures of riverbanks against large-scale earthquakes and tsunamis
	Japan Meteorological Agency (JMA) Meteorological Research Institute (MRI)	Research on prediction accuracy improvement for earthquake early warning
		Upgrade of the Tsunami Forecast Information and Enhancement of the Tsunami Prevention System

Section 2 Promotion of Green Innovation

It is necessary for Japan to strongly promote green innovation in order 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 in order to realize sustainable growth in Japan. In order 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

In order 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 stability, economy and sustainability 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 towards 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 supports 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.

In order 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 research and development 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 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 is 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 research and development of technologies to produce biofuels from plants, woods and microalgae.

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 and power generation utilizing ocean energy. 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 develop technologies that obtain accurate data on underground thermal resources, that evaluate and control the geothermal resources to ensure a stable power supply and that 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 diseminate 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 developing and verifying technology for hot spring power generation with low environmental load and is conducting R&D into the technology of low cost slope drilling. 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.

MLIT has drafted safety guidelines for floating ocean wind power generation plants to facilitate their safe operation under the harsh natural environmental conditions at sea. The guidelines include detailed requirements to address typical issues of the floating generators; such as their drifting, overturning and sinking, as well as general safety and moorings facilities.

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 a study on infrastructures such as sewage treatment facilities and low carbon houses.

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, JEST has coordinated with METI to start R&D on a basic technology for a next-generation storage battery with performance specifications much higher than those in current use. Development is also hoped for in the use of hydrogen as an energy carrier, utilizing organic hydride, ammonia or other chemical substances for storage and transportation.

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

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

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 2015, the ministry has, since FY2013, been installing about one hundred hydrogen stations in four major metropolitan areas. The technology necessary for this plan has been developed and verified.

The four areas - Yokohama City, Toyota City, Kansai Science City (Keihanna) and Kitakyushu City – are also conducting a large-scale demonstration aimed at the construction of a smart community. This has been ongoing since FY2011 with the participation of local residents, local governments and private companies. For the purpose of utilizing technologies and ideas complementing that demonstration, nine areas throughout the country are conducting demonstrations aimed at solving technological and systematic problems, ultimately leading to the construction of a smart community to promote the development of smart community technology.

MIC is conducting smart grid related research and development 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 (Chapter 3, Section 1, 2, (2)).

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 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 developed a Clean Coal Technology based on R&D to enable low carbon thermal power generation. This is accomplished by a combination of: 1. an Integrated Coal Gasification Combined Cycle (IGCC), 2. an Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC) to generate electricity with high efficiency while reducing carbon dioxide emissions, 3. Carbon Dioxide Capture and Storage (CCS), coupled with the development of a boiler-turbine system which can withstand high temperature and high pressure along with an Advanced Ultra-Super Critical (A-USC) for improving thermal efficiency.

(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 the for demonstration of an

integrated system designed to separate and capture carbon dioxide from large carbon dioxide sources, transporting it to underground storage at depths in excess of 1,000m below the surface. This includes substantial cost reductions and improved safety of the system.

(iv) Innovative petroleum refinery technology

In response to heavy crude oil trends[1], light petroleum product trends[2] and global warming, METI is developing technology to obtain value-added petrochemical raw material from heavy oil. They are also working on innovative petroleum refinery technology to make efficient use of petroleum production residues and to promote efficiency in oil refineries.

(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℃, in order 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 is being done to establish a measurement method for blue carbon. Blue carbon refers to carbon captured by the oceans and coastal ecosystems, which has potential application in and around Japan.

4) R&D into nuclear energy power and fusion

In response to the accident at the TEPCO Fukushima Daiichi Nuclear Power Stations, the Japanese government decided on a new Strategic Energy Plan (Cabinet decision on April 11, 2014).

In FY2013, the government continued efforts to recover from the nuclear power disaster, including R&D for decommissioning the reactor and decontamination of radioactive materials, as well as implementing R&D and nuclear Human Resource Development (HRD) as a base for the use of and safety of atomic energy. Regaeding Monju, the Monju Research Plan (September 2013) was compiled for the Monju Reactor, and the role of Monju was clarified in the Strategic Energy Plan.. 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.

(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

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

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

In order 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.

For the purpose of enriching and enhancing basic and fundamental R&D, MEXT is promoting research at universities, within a competitive environment, on a strategic program set to clarify policy needs according to the "Initiatives for Atomic Energy Basic and Generic Strategic Research."

METI conducts R&D under the "Safety Enhancement for LWRs"Program -"R&D Program for Plant Safety Enhancement" in order 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.

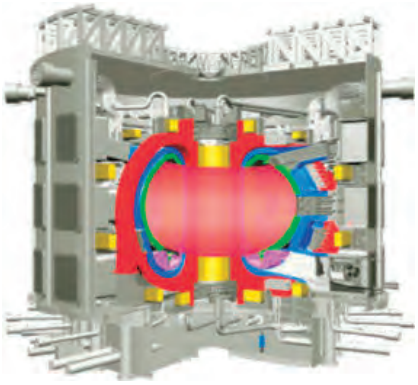
(iii) Fast Breeder Reactor (FBR) cycle technologies

FBR, by producing more fuel than consumed in the process of power generation, can greatly improve the efficiency in utilizing uranium resources. FBR presents the possibility of contributing to a long-term stable supply of energy. It can also reduce the potential radioactive toxicity of high-level radioactive waste through the recycling of minor actinide, contained in spent fuel, to also be used as a fuel. FBR cycle technologies are recognized as key technologies for national security in the 4th "Science and Technology Basic Plan" (hereinafter: the Basic Plan). R&D into FBR will be implemented in accordance with the Strategic Energy Plan.

In October 2012, the Monju Research Plan Working Group was set up under Committee on Atomic Energy Science and Technology of Subdivision on R&D Planning and Evaluation within the Council for Science and Technology (MEXT). After reviewing its past development history, the WG compiled the *Monju Research Plan* in September 2013 to promote effective and efficient research. This plan was also reported to the government as discussion material for the energy policy in October 2013. Through this discussion, the role of Monju was clarified in the 4th Strategic Energy Plan, in April 2014.

Insufficient management of facility maintenance was discovered at the JAEA in November, 2012. In response to this, the Nuclear Regulation Authority issued an order to JAEA in May, 2013 to take the necessary measures for maintenance in accordance with the "Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors" (Act No.166 of 1957) (hereinafter: Nuclear Regulation Act). To underscore the importance of the order, MEXT ordered JAEA to complete the overdue equipment inspections and the revision of the maintenance plan as soon as possible. MEXT also JAEA secure complete safety, and to develop mechanisms and systems to prevent a recurrence of the problem. As the result of a radioactive substance leak at J-PARC in May 2013, MEXT requested that JAEA conduct a thorough and comprehensive safety system inspection of facilities subject to the regulations. MEXT also established a Headquarters (framework, organization) for Reforming JAEA (Chair: Minister of Eduacation, Culture, Sports, Science and Technology) to conduct a comprehensive review of the organization and operation of JAEA, announcing the basic direction of the reform in August. Based on the MEXT's direction, JAEA adopted a concreate reform plan at the end of September and started a one-year intensive reform period in October. In addition, MEXT installed a Headquarters for promoting Monju Reform (Chair: State Minister of Eduacation, Culture, Sports, Science and Technology) in November to strengthen the guidance and supervision over fundamental reform of Monju. During the intensive reform period, concluding at the end of September 2014, a thorough review of the operation and maintenance system will be made in order to regain the trust of the Japanese people.

FBR "Monju" (Tsuruga City, Fukui Pref.)
Courtesy of JAEA



ITER (International Thermonuclear Experimental Reactor)
Courtesy of JAEA/ITER

International Fusion Energy Research Center (Rokkasho Village, Aomori Pref.)
Courtesy of JAEA

(iv) Fusion energy

Fusion energy is expected to serve as the prime energy source in the 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, three types of reactors have been the subject of advanced R&D and have produced world-class results in the fusion field: the Tokamak reactor [JAEA, Break-even Plasma Test Facilities: JT-60, shutdown since August 2008, subsequently dismantled for repair and in the process of assembling high performance fusion experiment system (JT-60SA)], the Helical reactor (National Institute for Fusion Science (NIFS), Large Helical Device (LHD)) and the laser fusion reactor (Institute of Laser Engineering, Osaka University, GEKKO-XII Laser).

In order to meet international agreement, Japan has also been taking part in the International Thermonuclear Experimental Reactor (ITER) Project, which demonstrates the S&T 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 support and complement the ITER Project.

(v) Securing nuclear safety

It is a major premise of R&D and the use of nuclear power to take all possible measures to ensure safety under the strictest of regulations and controls, based on advanced safety research. It is also necessary to prepare disaster countermeasures to minimize the damage to human life and the health of residents in the vicinity of any nuclear power facilities in the event of an accident.

While R&D and the use of nuclear power in Japan has been controlled under the safety regulations set by the government according to the "Nuclear Reactor Regulation Act," Nuclear Regulation Authority was established on September 19, 2012, as an external organ of MOE. This was done in order to remove the negative effects of a vertically integrated administration, to restore trust in the nuclear safety administration and to improve administrative functions in light of the lessons learned from the accident at the TEPCO Fukushima Daiichi Nuclear Power Station.

The Nuclear Regulation Authority, armed with experience gained from the accident at the TEPCO Fukushima Daiichi Nuclear Power Station, is poised to rebuild the nuclear power safety administration and to establish safety conforming to the highest global standards by giving top priority to public safety in order to prevent any similar accidents from ocurring.

(vi) The spread of radiopraxis

Since radiopraxis has been advanced in wide fields of basic and applied research of medical, industrial and agricultural application, it is important to promote R&D.

In the medical field, diagnosis and cancer therapy with radiation has been put to some practical use. Ion-beam cancer therapy has the advantage of reducing stress on patients because surgery with anesthesia or incision is unnecessary. In the agricultural field, irradiation has been applied to pest control or cultivar improvement. Academic research, such as the study of water dynamics and the process of toxic metals accumulation in plants, are also in progress. In the industrial field, radiation has been applied to the production of semiconductor devices, radial tires and other applications. Irradiation has been utilized for the modification and production of various industrial materials, as well as for the sterilization of medical instruments. At the Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) in the Takasaki Advanced Radiation Research Institute, JAEA, the irradiation of semiconductors, the creation of new materials and R&D to create new applications by irradiation have been in progress.

(vii) Disposal of radioactive wastes from research facilities

The radioactive wastes generated from research, industrial and medical facilities (waste from research facilities) are not disposed of but stored in each users' facilities. The disposal of the radioactive wastes is becoming an important issue in advancing R&D and utilization of atomic energy in the future. In response to this issue, JAEA was designated in 2008 to

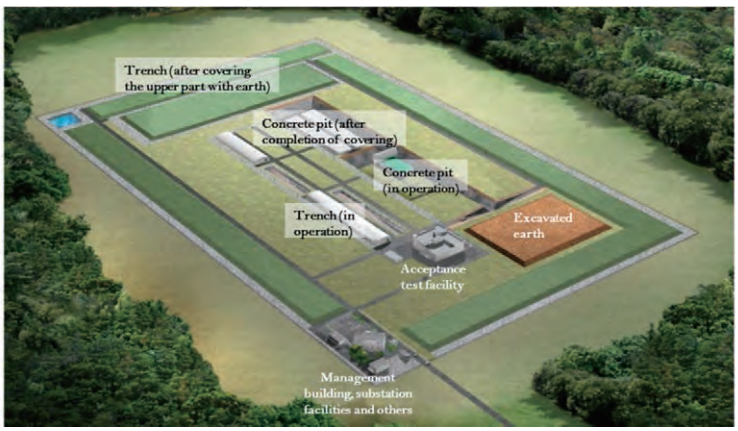


Image of a Disposal Facility
Courtesy of JAEA

conduct disposal according to the revised Japan Atomic Energy Agency Act (Act No. 155 of 2004).

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 approved a revision in March 2014). The aim is to facilitate the disposal of waste from research facilities.

(viii) 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" in order 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 has also been providing financial support for educational programs related to nuclear power and radiation. This includes energy education implemented by prefectural governments and the support of education programs related to radiation at schools through the lending of simple radiation measuring devices.

In order to facilitate the harmonious coexistence of nuclear power research facilities and regions in which such facilities are located, the government is also supporting programs which the regions voluntarily execute with governmental subsidies for the Power Source Siting Laws.

(ix) 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

Towards 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 towards further improving the utilization efficiency of fossil fuels.

The ministry also has been promoting the development of, and 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 towards 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 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, 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 towards 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 been conducting 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 is conducting the following semiconductor research: 1) fundamental evaluation technology necessary for next-generation EUV (extreme ultraviolet radiation[1]) lithography systems that will lead to a 10-nm technology semiconductor manufacturing process, 2) ultra-low-power technology utilizing new materials/structures, and 3) "normally OFF—instantly ON computing," a fundamental technology that consumes electric power only when data processing is required, by embedding nonvolatile elements into the semiconductor. METI also has been conducting R&D on: 1) integration technologies of next-generation semiconductor devices for advanced next-generation automobiles, PCs and servers, and 2) hybrid circuitry consisting of light and electron and the application technology of this system as one of projects under "Future Development Research."

(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[2] 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 FY2012, the National Police Agency has implemented a four year advanced model project of a 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 FY2013, based on this project's results, model projects have also been initiated in Ibaraki and Hyogo Prefectures toward the practical application of further detailed traffic signal controls utilizing probe data.

2) Efforts to create substitute materials for exiting rare resources

In order 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 Project Research Base Formation Oriented", designed to create completely new materials without using scarce elements in order to overcome Japan's resource constraints, as well as to regain lost ground in the internationally competitive materials science field.

Since FY2007, METI has been implementing the "Rare Metal Substitute Materials Development Project", to develop abundantly available resources substitutes for rare metals and to significantly reduce the amount of rare metal use. METI has also supported the rare earth recycling project, which recycles rare earth magnets used in automobile power steering and power window motors. Since FY2012, the ministry, in cooperation with MEXT, has also been implementing the "Development of Magnet Material Technology for a High Efficient Motor for Next Generation Automobiles", as a new long-term measure

1 EUV is ultraviolet radiation with a 13.5 nm wavelength. It is the expected short wavelength light to be used for a next-generation lithography system.
2 Rare earth elements consisting of seventeen metallic elements in the periodic table

aimed at developing a new, more powerful magnetic material which does not use rare earths.

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 light-weight, 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 FY2013 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 wide-scale 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. The Japan Aerospace Exploration Agency (JAXA), to promote earth observation utilizing satellites, has been operating the Advanced Land Observing Satellite "DAICHI" (ALOS, which discontinued operation in May 2011), 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

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.

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.

JAMSTEC has established a global earth observation system to collect data and information on water, thermal and material cycles, not only on regional but also on a global scale. They are also conducting R&D to understand the global change of the water cycle through on-site or satellite observation of air, ocean and land.

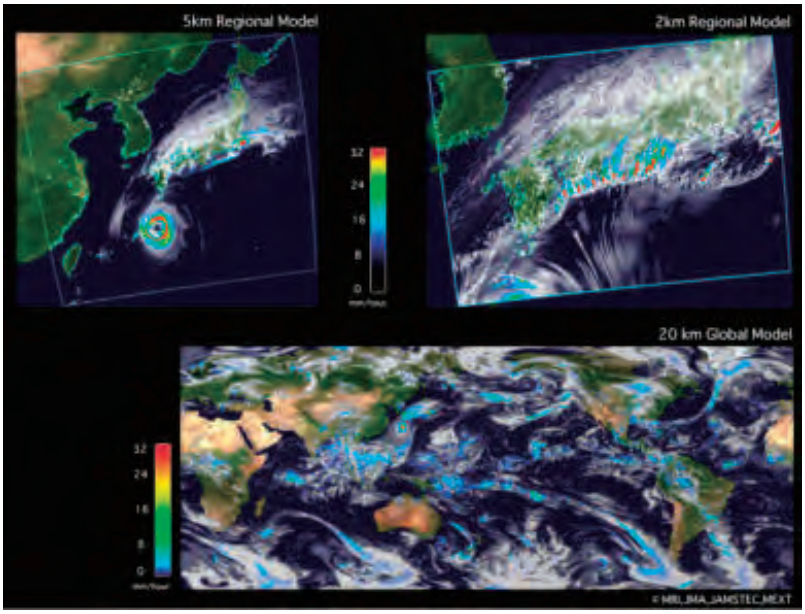
JMA is studying greenhouse gases at three observation points in Japan and at Japan's Showa Station in Antarctica, as well as in oceanic air and seawater in the western North Pacific region by JMA research vessels and high altitude airplanes. The agency has been publishing global warming data obtained 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 the earth observation satellite data.

(ii) Promotion of a climate change projection study

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



Examples of Typhoon simulation
Courtesy of MRI (JMA)

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.

The MRI (JMA) 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 integration and analysis of data

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 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[2]), 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[3] 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 RECCA will be provided as scientific knowledge to local districts for their consideration on adaptation measures for climate change. In addition, RECCA held symposiums in order 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

1 Intergovernmental Panel on Climate Change
2 International Council for Science: It was founded in 1931 as a nongovernmental, nonprofit, international scientific organization intended to promote international activities in the science and applied science fields for the benefit of humanity.
3 Cloud computing environments or services especially-suitable for the processing of large-capacity data for scientific research

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 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 in order to its results widely.

(v) Town development in accord with nature

MRI (JMA) 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.

In order 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 centres* and *L. 1410: Methodology for environmental impact of Information and Communication Technologies (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 FY2013, 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 implementation of such technologies.

Since FY2011, 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 (Part 2, Chapter 2, Section 2, 1, (1)).

The ministry has also reviewed and made efforts to modify the safety regulations of the Electricity Business Act (Act No. 170 of 1964). For example, increasing the range of maintenance work conducted by an outsourced chief electrical engineering license holder for a solar generation system from, "less than 1000 kW", to "2,000 kW." Prior to now, the structural approval of wind power generation was done in accordance with the Electricity Business Act by METI and in accordance with the Building Standards Act (Act No. 201 of 1950) by MLIT. However, it was concluded that combining the inspection under the Building Standard Law with the inspection under the Electricity Business Act allowed the same, or an even higher, safety level. Modifications were made to the relevant regulations in order to start the combined inspections in April 2014.

1 International Telecommunication Union Telecommunication Standardization Sector Study Group 5

Table 2-2-6 / Main Measures for Promotion of Green Innovation (FY2013)

Ministry	Research organization	Subject
National Police Agency	Ibaraki Prefectural Police Hyogo Prefectural Police	The advanced model project for a traffic control system using probe information
MIC	MIC	Establishing fundamental network technology to handle mega data (R&D into High-speed low-power-consumption optical transport technology, network virtualization technologies and related technologies)
	NICT	R&D into Electromagnetic Wave Sensing Infrastructure Technology
		R&D into Fundamental Network Technologies
MEXT	MEXT	Program for Risk Information on Climate Change
		Initiative for Strategic Adaptation to Climate Change
		University-originated Green Innovation Creation Program
		Japanese Antarctic Research Program
		Development of Environmental Technology Using Nanotechnology
		Elements Strategy Project <Focused on Industry-Academia-Government Collaboration >
	NIMS	Promotion of R&D for Advanced Materials Responding to Social Needs
	JAXA	Greenhouse Gases Observing Satellite-2 (GOSAT-2)
		Advanced Land Observing Satellite-2 (ALOS-2)
		R&D of a High Efficiency Aircraft with Low Fuel Consumption and Low Environmental Load
		Climate change observation satellite under Global Change Observation Mission (GCOM-C)
	JAMSTEC	Research on Global Environmental Change
		Promotion of Earth Simulator Project
MAFF	MAFF	Fishery Restoration Project
		Project for production and utilization of renewable energy from local resources
		Technology Development for Circulatory Food Production Systems Responsive to Climate Change
		Project for a basic survey to calculate greenhouse gas emissions from farmland
		Project for supporting acceleration of the introduction of next-generation green house horticulture
		Project for international coordination to respond to climate change
METI	METI	Development of Advanced Handling Technology such as Heavy Oil
		Carbon Dioxide Reduction Technology Demonstration Project Funds
		Japan-U.S. Cooperation on Environmental Technology Research and Standardization Program
		R&D on Advanced Aerodynamic Design
		Creation of Structural Components for Next Generation Aircraft and Development of Processing Technology
		Promotion of Green Sustainable Chemistry
		Development of Magnetic Material Technology for Next Generation Automobile Engines
		Innovative Manufacturing Process Technology Development (Minimal Fab)
		Advanced energy-saving part and material development project
		Innovative new structural component technology development
		Verification project for supporting energy-saving technology to reduce emissions of CFC alternatives
		Highly Functional Genome design Technology development for Realization of Innovative Biomaterials
		Development of renewal energy storage and transportation technology

METI	METI	Dissemination and Promotion Program of Global Warming Countermeasure Technologies
		Project Cost for the development of Carbon Capture and Storage Safety Assessment Technology
		R&D for Innovative Utilization Technology of Wasted Heat Energy
		Verification project on the safety and reliability of next-generation grid
		Verification project of a smart grid using high-temperature superconduction technology
		Measurement standards that support global business industries
	METI Agency for Natural Resources and Energy(ANRE) AIST	Improvement of Efficiency and Reliability of Solar Power Generation
	METI Small and Medium Enterprises Agency AIST	Measurement Standards to Support Green Innovation
	METI AIST	Expanding Biomass Use
		Development of Storage Devices with High Energy Densities for Next-generation Vehicles
		Development of Energy Utilization Technology with High Conversion Efficiency by Fuel Cells
		Safety Evaluation Methods to Support Innovation of Advanced Science and Technology
	METI NEDO	R&D project for technology applying innovative catalysts to the production process of chemical products
	ANRE	Subsidies for Integrated Coal Gasification Fuel Cell Combined Cycle Demonstration Project
		Development of High-Efficiency Hydrogen Production Technology
		Subsidies for International Joint Demonstration Project for Coal Use
		International Cooperation Project on Clean Coal Technology for Climate Change
		Technology development
		Subsidies for Next Generation Energy Social System Demonstration Project
		Subsidies for Next Generation Energy Technology Demonstration Project
		Project for advanced technology addressing surplus power generated by renewable energy
		Subsidies for hydrogen supply facility development project
		Subsidies of demonstration project on advanced comprehensive systems using heat generated by renewal energy sources
		Subsidy for Supporting Commercial Fuel Cell Introduction
		Cost for commissioning for New Energy Equipment Introduction Promotion Project (New Energy Equipment Introduction Promotion Diffusion Project)
		Subsidies for Accelerated Support of Renewable Energy Heat Utilization
		Subsidies for Stand-alone Renewable Energy Power Generation Systems
		Subsidies for Model Project Expenses to Promote the Introduction of Small Hydroelectric Power Generation
		Subsidies for Supporting Operators Streamlining Energy Use (For Private Corporations) (For Natural Gas)
		Concession costs for Streamlining Project of International Energy Use

METI	ANRE	Subsidies for Specific Equipment Introduction Promotion Project for Streamlining Energy Use
		Subsidies for Supporting Operators Streamlining Energy Use
		Foundation fund for project subsiding expenses on consumer-use fuel cell introduction emergency countermeasure
		Subsidies for smart community introduction promotion project
		Fukushima next-generation renewable energy technology development project
		Cost for commissioning for verification research project on ocean floating body wind-farm
		Cost for commissioning for Common Base Development Promotion Project such as New Energies
		Subsidies for technology verification project on regional bio-diesel distribution system
		Subsidies for Energy Conservation Measures Introduction Promotion Project
		Subsidies for smart energy system introduction promotion Project
		Subsidies for High Efficiency Gas Turbine Technology Demonstration Project
		Subsidies for Commercialization Element Technology Development Cost of Advanced Super Critical Thermal Power Generation
		Subsidies for housing and building innovative energy-saving technology introduction project
	AIST	Effective Resources Use and Alternative Technology
		Mass-production Technology and Application of Nanotube, Carbon Materials
		Fabrication Technology of Microelectronic Device System with High Energy-saving Rate
		Technologies to Efficiently Manufacture High-quality Substances Using Bioprocesses
		Development of Power Conversion Electronics
		Promotion of Green Sustainable Chemistry
		Development of Evaluation Technology for Conservation and Utilization of Geosphere Environment
		Fundamental technology development for mega data processing method with high-energy efficiency
	NEDO	Project for international research and development/verification
		Development Project for Promotion Technology for Application of Polymer Electrolyte Fuel Cell
		Strategic Innovation Program for Energy Conservation Technologies
		Development project of promotion technology for application of solid oxide fuel cell
		Next-generation hydrogen technology R&D project
		Nanocarbon material application project
		New energy and environmental technology leading program
		Demonstration Project for Technologies and Systems to improve International Energy Consumption Efficiency
		Next-generation
		Development of Clean Coal Technology
		Rare Metal Substitute Materials Development Project
		Project for the development of fundamental technology for next generation materials evaluation
		Project for the development of laser processing technology for next generation materials

METI	NEDO	Fundamental technology development project for storage battery material evaluation
		Innovative energy-saving chemical process technology development project
		Development of Fundamental Technologies for Next-Generation Printed Electronic Materials and Processes
		Development of Environmentally Friendly Steelmaking Process Technology
		Development of Infrastructure for Normally-off Computing Technology
		Next-Generation Ultra-low Power Consumption Device Development Project
		Expenses for Technology Development of an Ultra-low-power Optoelectronics Implementation System
		Next-generation power electronics technology development project
		Next-generation smart device development project
		Fundamental Technology Development of Next-generation High-efficiency and High-quality Lighting
		Development project for innovative interactive display with ultra-low-power consumption
		Innovative Ultra-light and High-strength Integrated Materials Project toward Achieving a Low-carbon Society
		Development project of sensor systems that address social issues
		Project to Develop Next-generation Technology for Strategic Utilization of Biomass Energy
		Useful element technology development project for biofuel production
		Advanced Science Basic Research Project for Innovative Batteries
		Development Project of Technology for Battery System Compatible with the New Energy System
		Development Project for Cutting-Edge Technology for Practical Use and Application of Lithium Ion Battery
		R&D project for advanced practical application of wind power generation
		R&D of Ocean Energy Technology
		Verification project of measuring technology for use of heat generated by renewable energy
		Development Project for Cutting-Edge Technology for Application of Organic Solar Cells
		Verification project for diversified use of solar power generation
		R&D on Innovative Solar Cells
		Development of Next-generation High-performance Technologies for Photovoltaic Power Generation System
		R&D on Innovative Solar Cells
		Program for New Energy-venture Technology Innovation
		Social Demonstration of Regional Hydrogen Supply Infrastructure Technology
		Project to Develop Innovative Cellulosic Ethanol Production System
	NEDO Japan Oil, Gas and Metals National Corporation	R&D of geothermal power generation technology
METI MLIT	ANRE MLIT	Subsidies for energy-saving logistics promotion project
MLIT	MLIT	R&D on Safety of Floating Offshore Wind Power Facilities
		Safety and environmental measures for promoting active use of ocean energy

MLIT	MLIT	Sewage Innovative Technology Demonstration Project (B-DASH Project)
	NILIM	Research on Technical Potential of Sewage Treatment Plant as Resources and Energy Circulation Base in Local Areas
		Study on the evaluation methods for energy-saving technology that corresponds to regional housing construction technology
	JMA	Development of the next Himawari, geostationary meteorological satellite
	JMA MRI (JMA)	Study on measures against localized, intensive, heavy rainfall (guerrilla heavy rainfall)
	NMRI	Strengthening the foundation for R&D on offshore structures
		Study on Energy-saving Technology Evaluations for Ships
		Study on Development of Maritime Performance and Operation Evaluation Technology
		Study on Development of Carbon Dioxide Emission Reduction Technologies
		Research on Development of Conceptual Design and Regulatory Methods for Ocean and Air Regulations
		Study on Development of Basic Technology Contributing to Reduction of Air Pollutants such as NOX, SOX and PM and Development and Enhancement of Environment Impact Assessment Method Necessary to Advance the Technology
		Study on Building of Assessment Technology for Ecosystem Impact Arising from Ship Operation
		Study on Establishment of Comprehensive Measures against Oil or Harmful Liquid Substances Spills
		Study on Development and Enhancement of Advanced Structural Strength Evaluation Method
		Study on Development of Safety Evaluation Method for New Power System
		Research on Construction of Reasonable Safety Regulation Using Risk-based Safety Evaluation Methods
		Study on Development of Inspection and Diagnosis Technologies for Aging and Thickness Effect on Fatigue Strength
		Study on Improvement of Re-enactment and Analysis Technology for Sea Disasters
		Study on Establishment of Reasonable Safety and Operation Rule Systems Based on Accident Cause Analysis and Human Factors Analysis
		Study on Development and Improvement of Policy-based Evaluation Methods for Streamlining and Optimizing Marine Transport
		Study on Development of Operation Support Technology and Transport System Responding to New Needs for Marine Transport
		Study on Development of Basic Technology for Marine Resource Production System Using Floating Technology and Development and Improvement of Safety Evaluation Method
		Study on Environment Impact Reduction as well as Development of Assessment Method for Environment Impact Arising from Marine Utilization or Development
	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	Strengthening of Ibuki (GOSAT) Observation Systems and Preparation of System for the Development of the Successor for Ibuki
		Contributions to the Institute for Global Environmental Strategies
		Technology development and verification project to induce strengthening of the measures for carbon dioxide reduction
		Waste Energy Introduction and Low Carbon Promotion Project
		Technology innovation project to create desirable future society and lifestyle
		Environment Research and Technology Development Fund
		Global Warming Countermeasure Technology Development Project
		Floating Offshore Wind Turbine Demonstration Project
		Practical application promotion project of technology for tidal current power generation
		Networking project of international experts on building low-carbon society that address climate change issues
	Nuclear Regulation Authority	Radiation hazard prevention measure expenses
		Radiation survey and research expenses
		Detailed Soundness Survey of Light Water Reactor Materials and Fuels
		Survey and research on geological structures at nuclear facilities
		Cost for commissioning on the project for advancing lifetime-extension evaluation technology
		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
		Biodiversity Research Program

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 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 Mega-bank Project" which is a long-term population-based genome cohort study (150,000 scale) in areas affected by the GEJE. The project, which intends to promote

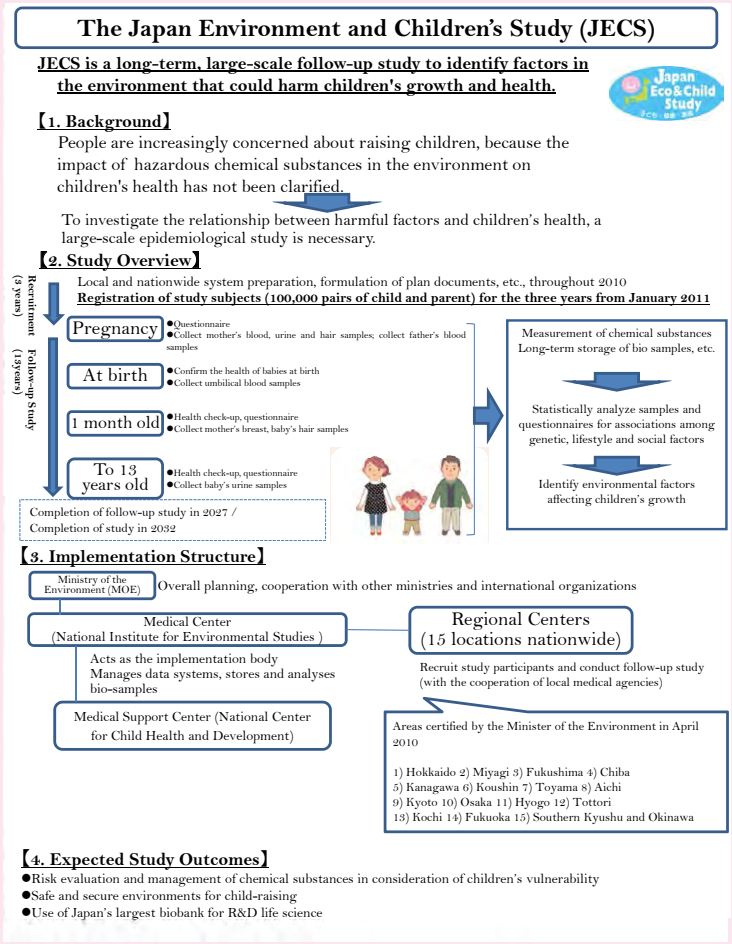
long-term epidemiological research (genomic cohorts) including genomic information, is being implemented for regional medical information sharing. MEXT promotes this project in close collaboration with the regional medical information network supported by MIC and MHLW. This project intends to restore community medical systems in the affected regions and to attain next generation medicine, such as tailor-made preventive medication. MEXT is also addressing "Taylor-made medical treatment with the Biobank Japan Program" (the second term). By utilizing the world's largest Biobank, that controls patients' blood samples and clinical information, MEXT is promoting the program to identify genes of diseases which may greatly affect the nation's health, and to clarify the relationship between adverse drug effects and genetic 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 FY2010, 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: 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 in order 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 Psychological and Neurological Disorders

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

It is crucial to promote the research of brain science strategically and to apply the results of the research to society, and it is with this in mind that the Council for Science and Technology (CST) of MEXT compiled the first report on the *Basic Concept and Promotion Measures for Brain Science Development from a Long-Term Viewpoint* in June 2009. As a result of the report, the ministry has been conducting "the Strategic Research Program for Brain Sciences (SRPBS)" to pass and return the benefits of research results to society as a whole. The program aims at R&D for supporting the independent life of patients and overcoming neuropsychiatric disorders by using Brain Machine Interface (BMI) technology. It also aims to develop methods for early diagnosis, treatment and medication by elucidating the pathological mechanisms of such disorders. In addition, the program promotes a system for creating and disseminating primate model animals, on which brain science research is based. In June 2013, in parallel with the brain research projects of, the Brain Science Committee of the Subdivision on R&D and Evaluation of the CST conducted research and examination into the basic concept of "the Brain Mapping by Integrated Neurotechnologies for Disease Studies". This was an effort for the strategic promotion of brain science study by innovative technology that makes the most of Japan's strengths.

At RIKEN and JST, under the Strategic Basic Research Program, research into brain science is also being promoted in the areas 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 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, gaining attention all over the world; Professor Yamanaka of Kyoto University received a Nobel Prize in Physiology & Medicine in December 2012 for discovering iPS cells. 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 Innovations (Comprehensive STI Strategy) and the Japan Revitalization Strategy, 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 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

1 Positron Emission Tomography

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 and to secure the necessary research funds in order to maintain 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, in order 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 2013, *the Act on the Safety of Regenerative Medicine (Act No. 85 of November 27, 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 safety standard was set for the processing of specific processed cells. It enables the outsourcing of cell processing to a licensed body.

METI is implementing Research and Development 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 FY2011, 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 FY2011). Cancer remains a serious problem for this nation's life and health. Therefore, the government has promoted the development of novel methods of prevention, diagnosis, and treatment of cancer, based on the Third term Comprehensive 10-Year Strategy for Cancer Control (decision of the Minister of Education, Culture, Sports, Science and Technology and the Minister of Health, Labour and Welfare on July 25, 2003), "Cancer-fighting Basic Act" (Act No.98 of 2006), and the "Basic Plan to Promote Cancer Control Programs" (Cabinet decision on June, 2012).

FY2013 is the final year of the Third term Comprehensive 10-Year Strategy for Cancer Control. On March 31, 2014, the new "ten year strategy for cancer control" was established with the confirmation of the ministers of MEXT, MHLW and METI. This study of cancer will proceed comprehensively and strategically in accordance with the strategy.

MEXT is implementing the "Project for Development of Innovative Research on Cancer Therapeutics (P-DIRECT)" in cooperation with MHLW and METI; precisely selecting results of innovative basic

research to establish next-generation medicine; and promoting the development of compounds useful for diagnosis, drug trials and other aspects of cancer treatment. MEXT is also promoting research based on individual genetic information toward taylor-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

MEXT is implementing the Platform Project for Supporting in Drug Discovery and Life Science Researches (Institutional Network in Drug Discovery). This includes: 1. utilizing technology bases for protein structure and function analysis, which were improved through The Protein-3000 Project and The Target Protein Research Program; 2. supporting research for drug commercialization and development and 3. promoting technology bases upgrades.

RIKEN is also utilizing protein production technology, structure and function analysis technology and computational science, in order to upgrade protein structure prediction.

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.

4) Promotion of Genomic science research

Based on complete and accurate human genome decoding and subsequent genome function analysis, MEXT is implementing the Research Program of Innovative Cell Biology by Innovative Technology (Cell Innovation) from FY2009, to decode the complex system of life by targeting cancer cells, through the utilization of innovative analyzing technology such as a next-generation sequencer.

5) Promotion of R&D for radiation therapy equipment

The National Institute of Radiological Sciences 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 National Institute of Radiological Sciences,

Gunma University has installed a small type heavy-ion cancer therapy facility to provide patients with medical treatment.

6) Promotion of Dynamic Approaches to Living System

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

MEXT launched the Platform for Dynamic Approaches to Living System for drug development and related fields in accordance with the 2011 report, "How to Promote Dynamic Approaches to Living System" (The Working Group of CST's Subdivision on R&D Planning and Evaluation, and the Life Science Committee, on July 19, 2011), and started establishing research facilities for the relevant fields. RIKEN and Osaka University are proactively implementing state-of-the-art technology for the measuring, calculating, and modeling of life phenomena to reconstruct cell functions. They are also implementing additional research aimed at the creation of basic technology under the JST Strategic Basic Research Programs.

7) Other efforts for safe and effective treatment

RIKEN is implementing basic research for allergy and immunology diseases. RIKEN and Sagamihara National Hospital have executed a collaborative research agreement to promote combined basic and clinical research efficiently.

In order 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

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.

To make use of clinical applications and life support, MIC, MEXT and MHLW are working to develop a BMI that can decode information in the brain in non-invasive/minimally invasive ways, in order to treat, recover and interpolate 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 *Focused Areas of Robot Technology Use for Care* report in November 2012. In February 2014, "supporting movement in the house", "supporting the taking of a bath" and "in home observation" 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 Robot Care Device Development and Introduction Promotion Project since FY2013. They are supporting R&D into robot technology development by private businesses that address the needs of the elderly and care service personnel.

METI is also working on data collection, analysis, and global standardization of safety verification methods that are essential for life support robots that operate in direct contact with people. In February 2014, a proposal made by Japan was adopted and issued as the international safety standard for life support robots, ISO 13482.

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

To promote medical R&D addressed by all the agencies concerned, the relevant ministries issued a "Healthcare and Medical Innovation Strategy" on June 14, 2013, which was included in the Japan Revitalization Strategy, decided by the Cabinet on the same day. Based on this strategy the Cabinet, on August 2, established the Headquarters for Healthcare and Medical Strategy Promotion as a control center for R&D in all medical fields. The headquarters coordinated the national budget allocation requests for the FY2014 for all medical related R&D. An Experts Panel on R&D in the medical field, held on January 22, 2014, compiled a report, *Comprehensive Strategy of Medical R&D*, which outlined priorities and set achievement targets.

To create a society in which Japanese people can enjoy a healthy lifestyle and live a long life, the Cabinet passed the Act on Promotion of Healthcare Industries and Advancement of Healthcare Technologies (draft) and the Act on Japan Agency for Medical Research and Development (draft) on February 12, 2013, submitting them to the 186th ordinary Diet session. These acts established the Japan Agency for Medical Research and Development (AMED). The objectives of AMED are: 1) the development of a healthcare and medical strategy that promotes all aspects of medical R&D to provide the world highest standard of medical care for the nation and to create new industry that support a society where such medical care can be provided; 2) the organization of the Headquarters for Healthcare and Medical Strategy Promotion to promote the strategy; and 3) the implementation and provision of support for R&D in medicine and the establishment of a R&D promoting environment.

These acts were approved and enacted on May 23 and May 30, 2014, respectively.

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 bridge linking research and clinical studies/trials

Since FY2007, MEXT has been promoting the "Coordination, Support and Training Program for Transitional Research" in cooperation with MHLW and METI to improve the support bases for bridge linking research toward commercialization, by targeting universities that have prospective achievements of basic research. In addition, MEXT initiated the "Translational Research Network Program" in FY2012 to enrich and network support bases. This was done to accelerate and enhance the seed nurturing abilities and to make the bases ongoing.

To produce Japanese innovative medical drugs and equipment, since FY2011, 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 drugs and equipment used for the first time for humans ahead of any other country. Since 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. As well, MHLW is developing and supporting doctor-centered trials in Iwate, Miyagi, and Fukushima prefectures since FY2011 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, stored and accessed 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 IT (information technology).

In May 2009, an database integration task force meeting set up by the "Council for Science and Technology Policy (CSTP) Life Science Project Team" prepared and published a report outlining concepts for the data center: 1. that necessary functions can be constantly provided for users seeking information, 2. the databases can be used for new information input, as well as being maintained and managed 3. useful data/databases collected and prepared by agencies concerned with individual projects can be effectively promoted 4. their scattering can be prevented. Based on this report, MEXT had combined the "Project for Database Integration" and the project of "Bioinformatics Research and Development (BIRD)" into the "Life Science Database Integration Project," conducted by "Bioscience Database Center (NBDC)," and is promoting the R&D necessary for the integration of life science databases made at various research institutes throughout the country. 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 FY2013, an operation committee has established for implementing security and operation guidelines regarding human data.

The ministries decided that October 5th 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

(i) 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.

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).

(ii) 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.

Research into human embryonic stem (ES) cells has the potential to contribute greatly to the development of medicine and biology, but involve bioethical issues because they originate from human embryos. The MEXT has taken proper measures for the derivation, distribution and utilization of human ES cells in research. These are based on, "Guidelines on the Derivation and Distribution of Human Embryonic Stem Cells" (Public Notice of MEXT, No. 156 of 2009) and "Guidelines on the Utilization of Human Embryonic Stem Cells" (Public Notice of MEXT, No. 87 of 2010). 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).

For epidemiological research, MEXT and MHLW issued an interim report on August 2013, and have been looking into revising the Ethical Guidelines for Epidemiological Research (Public Notice of MEXT and MHLW, No. 1 of 2007) and possibly merging the guideline with the Ethical Guidelines for Clinical Research (Public Notice of MHLW, No. 415 of 2008).

(iii) 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. To prevent any adverse influence on biodiversity, necessary restrictions have been put in place against the use of living modified organisms, based on the Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Act No. 97 of 2003). In March 2014, reviews were made on relevant ministerial public notices and enforced in July 2014.

Concerning clinical research of gene therapies, appropriate efforts have been promoted, based on the "Guidelines for Gene Therapy Clinical Research (MEXT/MHLW public notice No. 2 of 2004)."

Table 2-2-8 / Major Policies for Promotion of Life Innovation (FY2013)

Ministry	Research organization	Subject
MIC	MIC	Novel and Innovative R&D Making Use of Brain Structure
	NICT	R&D of future ICT platform technology
MEXT	MEXT	National BioResource Project
		Accelerated Bridging Research Network Program
		Japan Initiative for Global Research Network on Infectious Diseases
		Strategic Research Program for Brain Science / Brain Mapping Utilizing Integrated Neurotechnologies for Disease Studies (Brain/MINDS)
		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
		Platform project for supporting in drug discovery and life science researches (Institutional network in drug discovery)
	National Institute of Radiological Sciences	Program for Development of Fundamental Technologies in Radiation Science and Research Activities
		Research on Heavy-ion Cancer Therapy
		Disease Diagnosis Research Utilizing Molecular Imaging Technology
		Research on Radiation Safety
		Research on Radiation Emergency Medicine
		Research on Radiation Emergency Assessment
	JST	Life Sciences Database Integration Project
		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 Project to support medicine R&D in the developing world
		Project of Early Exploratory Clinical Trial Bases for Specific Research Areas Clinical Research Core Hospital Improvement Project Innovative Drug, Medical Equipment, Regenerative Medical Product Commercialization Promotion Project
		Made in Japan medical equipment creation foundation development project
		Regenerative medicine practical application research base development project
	Prefectural governments	Cost for Commissioning Toxic Gas Disability Person Investigation
	National Institute of Infectious Diseases (NIID)	Expenses for Manufacturing and Testing of Serum and Other Products
	Radiation Effects Research Foundation	Subsidies for Radiation Effects Research Foundation

METI	METI	Program to Formulate Guidelines Designed to Promote Development and Commercialization of Medical Equipment
		Problem-Solving Medical Equipment Development Project
		Next-generation drug discovery fundamental technology development for personalized medicine
		Project to Promote the Industrialization of Regenerative Medicine
		Robotic Devices for Nursing Care Project
		Fundamental technology development for high temperature superconducting coils
		Medical Device Incubation platform promotion project
		Project for R&D into medical equipment and for a future medical care system
	AIST	Healthcare Support Technologies using Cell-Manipulation and Biomaterial Technologies
		Technologies to Characterize and Analyze the Functions of Biomolecules
		Drug Discovery Support Technologies and Diagnostic Techniques through the Amalgamation of Information Processing and Bioanalysis
		Advanced Measurement Technologies of Human Functions and Behaviors
		Assessment Technique of Health Condition based on Biomedical Information
		Development of Technologies to Restore Health and to Achieve a Healthy Life
		Development of National Measurement Standards to Support Life Innovation
	NEDO	Comprehensive R&D into an Early Stage Diagnosis Method and Instruments to Treat Cancer
		Research and Development of Next-generation Regenerative Technology
		Fundamental Technology Development for Promoting the Industrial Application of Stem Cells
		Fundamental Technology Development for Promoting the Industrialization of Stem Cells
		Life Support Robot Commercialization Project
		Project for R&D into medical equipment and a future medical care system
MOE	MOE	Planning and Survey for the Japan Environment and Children's Study (JECS)
	NIES	Japan Environment and Children's Study (JECS)