Chapter 2 Strategic Priority Setting in Science and Technology

1 Promotion of Basic Research

Basic research, bringing human wisdom and serving as a source of knowledge, is an activity accumulated as a property shared by all human beings. It is realized in the steady, serious pursuit of truth and after much trial and error. The findings and inventions, which do not fall into the existing knowledge framework, will make leaps in knowledge. It is thus important to nurture innovative spirits among researchers. Basic research consists of two types: (1) academic research based on the free ideas of researchers, and (2) basic research that aims at future applications based on policies. It is necessary to understand the purpose of each of these types and should be widely, steadily, and continuously promoted.

To this end, we are promoting basic research at universities and other institutions by securing basic research funds such as government subsidies for national university corporations and financial aid to private educational institutions as well as through competitive funds, such as Grants-in-Aid for Scientific Research for (1) and JST Basic Research Programs for (2).

SCJ made five proposals related to the nature of basic research including the appropriate allocation of resources and financial support for universities and research institutions in its Approach to the Enriching Support for Basic Research to Create the Future of our Country [literal translation] issued on August 1, 2008.

2 Priority Setting in Research and Development for Policy-oriented Subjects

It is essential to strategically prioritize research and development in response to policy challenges in addition to promoting basic research, which is "investment for tomorrow," in order to maximize the effects of governmental R&D expenditures under the Third Science and Technology Basic Plan. The four priority fields in the Second Basic Plan (Life sciences, Information and telecommunications, Environmental sciences, Nanotechnology/Materials) are made into four priority fields to be promoted in the Third Basic Plan, based on the level of contribution to the three ideas, strategic viability, the trends of S&T strategies in the world, and public expectations. Resources are allocated to these fields at a high priority. In addition to the above, the Third Basic Plan also deems the other four areas, including Energy, Monodzukuri technology, Social infrastructure, and Frontiers, as those in which R&D activities emphasize issues that are fundamental for the nation's existence and need to be addressed by the government (hereinafter "four fields to be promoted"), and resource allocation will be made in an appropriate manner. MEXT finalized the Sectoral Promotion Strategy (Decision by the Council for Science and Technology Policy on March 28, 2006) toward selection and concentration of investments as well as achievement of results during the period of the Basic Plan. In the Strategy, 237 tasks were chosen as important R&D tasks that should be worked on by the government. Research targets

and achievement goals are specified for each task. Finally, 62 strategically prioritized S&Ts were chosen as the subject of selective investments. At present, according to the Strategy, R&D projects are being promoted while ensuring thorough selection and concentration of the subjects, including the strategically prioritized S&T for selective investments in each of eight fields after a strict evaluation of R&D work on the Key Technologies of National Importance.

1 Life Sciences

The life sciences aim at elucidating the complex and elaborate mechanisms of biological phenomena produced by living things, and their results contribute greatly to the improvement of people's lives and to development of the national economy, through dramatic advances in medicine, resolutions of food supply and environmental problems, and other areas.

In the Sectoral Promotion Strategy, for the field of life sciences, the following seven strategically prioritized S&T projects are listed as those requiring intense funding for the next five years. MEXT and other ministries promote research and development centered on these projects.

(1) Basic and generic research themes supporting research in life sciences as a whole

1) Science and technology for the reconstruction of complex systems of life

a) Promotion of genome-related research

Based on the completion of detailed sequencing of the human genome, MEXT started promotion of genome function analysis called Genome Network Project and other projects in FY 2004. In addition, research has been steadily promoted in such fields as the analysis of protein structures and functions related to genome-based drug discoveries, etc., and the development of revolutionary medical technologies that make use of individual genome information.

The Ministry of Health, Labour and Welfare (MHLW) promotes R&D for the establishment of methods for the prevention, diagnosis and treatment of disease and the development of revolutionary new drugs by elucidating genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments of the elderly. Moreover, taking into consideration rapid advances in genomic sciences seen in recent years, research and development were carried out since FY 2002 into basic technologies (transcriptome) that allow rapid and effective prediction of the safety (toxicity, side effects, etc.) of compounds that are candidates for medical products.

The Ministry of Economy, Trade and Industry (METI) promotes R&D for the development of tools (informatics and high-sensitivity quantitative analysis technologies) for the analysis of functional RNA and an understanding of its functions, by taking advantage of private-sector contribution through the New Energy and Industrial Technology Development Organization (NEDO).

b) Promotion of protein structural and functional analysis

Proteins are one of the basic molecules that constitute life, and an analysis of protein structure and function is essential for future industrial applications in the medical, pharmaceutical sciences, foods, environment, and other fields.

While utilizing the results and organized infrastructure obtained through the Protein-3000

Project (National Project on Protein Structural and Functional Analyses), MEXT implemented the Targeted Proteins Research Program, which selects protein targets of crucial importance for academic research and industrial applications that present extreme difficult at the current technological level and executes the technological R&D required for analysis of the structures and functions since FY 2007.

c) Promotion of brain sciences research

Brain science is a field that is expected to lead to improvement in the quality of life, improvement in medical sciences, and the creation of new technologies and industries through the results of research.

MEXT promotes the researches at the RIKEN Brain Science Institution and other universities by utilizing the Strategic Research Program for Brain Sciences and other competitive funds for high-priority promotion of brain sciences research at universities. Furthermore, CST made a mid-term wrap-up for the first recommendation concerning fundamental strategies and promotional measures for brain sciences research with a long-range outlook to strategically promote brain sciences research in Japan.

MHLW promotes research toward elucidation of the clinical state and development of treatment methods of nervous and muscular diseases, such as Parkinson's disease, Alzheimer's disease, higher brain dysfunction, and mental diseases, including integration disorder syndrome, and depression.

d) Promotion of immunity and allergy research

MEXT conducts basic research concerning immunity and allergies at the RIKEN Research Center for Allergy and Immunology. The Center and the Sagamihara National Hospital promote efficient research through collaboration between basics and clinical applications under the joint research agreement.

e) Promotion of analysis of the functions of carbohydrate chains

In regard to research on carbohydrate chains, which are believed to play important roles in a vast array of biological functions, MEXT used the competitive funds to promote carbohydrate chain research at universities. The RIKEN Advanced Science Institute implements basic/fundamental research on analysis of the structure and function of glycoprotein for application to the diagnosis and treatment of cancer, infection, lifestyle-related diseases, and brain and muscular degradation.

METI develops methods and tools for analyzing the functions of carbohydrate chains and sugar proteins, utilization of such functions, and carries out R&D toward developing a mass-synthesis technology of carbohydrate chains by taking advantage of the private-sector contribution through NEDO.

(2) Challenges in the field of "better living"

1) Translational research

a) Promoting the establishment of bases for translational research

For the purpose of the steady application of the results of promising fundamental research in medical care for people, MEXT promotes a Coordination, Support and Training Program for Translational Research to support translational research for universities having results for promising fundamental research expected to be used for practical medical care. The program aims to formulate development strategies and establish bases in support of translational research for practical use.

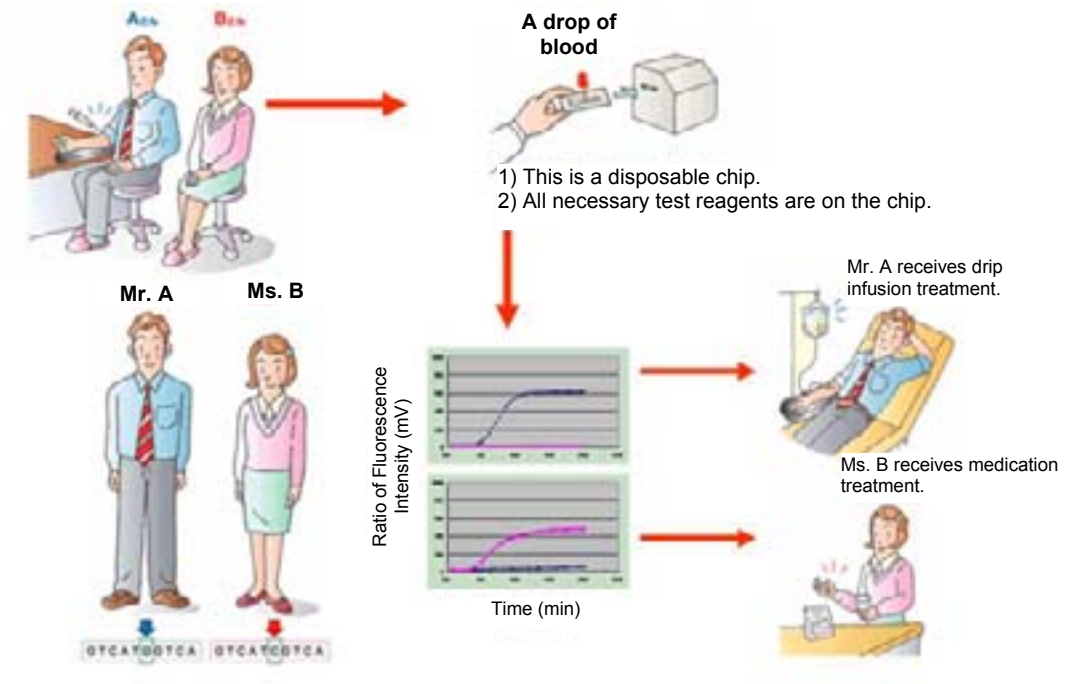
b) Promotion of health science

In order to develop new treatment methods and pharmaceuticals with the results of basic research in the life sciences that lead to improvements in the lives of the public and increased international competition, the Health Research Promotion Conference [literal translation] has been held since FY 2008 with the participation of the Minister of State for Science, Technology and Innovation Policy, the Ministers of MEXT, MHLW, METI, and experts. The related ministries and agencies are promoting health science translational/clinical research cooperatively.

Since FY 2008, the integrated and effective management of research funds and meetings with the officers in charge of regulation from the stage of development have been carried out under the Health Science Promotion Conference [literal translation] to overcome obstacles to the development of innovative technology, and the government promotes the Super Special Consortia for supporting the development of cutting-edge medical care to promote the most advanced regenerative medicine, pharmaceuticals, and medical equipment.

c) Promotion of genetic polymorphism research

For the purpose of serving effective personalized preventative and therapeutical medicine, MEXT established Biobanks by collecting blood serum samples and clinical information from patients and implements the project for realizing medical care according to individual genetic information (the 2nd stage), which aims to elucidate the relationship between genetic information and the diseases which might greatly affect the health of national citizens. In addition, the RIKEN Center for Genomic Medicine promotes research on the elucidation of the causes of diseases, while ensuring cooperation with this project.



Flow of SNPs analysis system in medical activities

Full-automatic SNPs Analysis System (Joint development of Toppan Printing Co., Ltd.). This system is capable of making SNP judgment within 45 minutes from a drop of blood

Source: RIKEN

d) Promotion of research on the development, differentiation, and regenerative science

Research into development, differentiation, and regeneration in biological system aims to elucidate the mechanisms, etc. relating to the process in which one cell differentiates into various tissues or organs to form and maintain an individual. This serves as a basis for regenerative medicine, and the research of this field brings about rapid advances in stem cell research such as iPS cells and establishment of technology for producing Embryonic Stem (ES) cells in recent years.

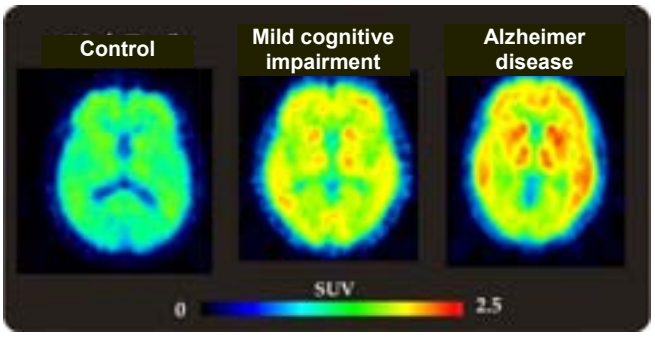
In FY 2003, MEXT launched the Project for Realization of Regenerative Medicine according to its Revised Comprehensive Strategy for Accelerating the iPS Cells Research [literal translation] (Decision: Minister of MEXT in January 2009) to develop the integrated research of iPS and other stem cells. The ministry promotes research for clinical application and conducts fundamental research at the RIKEN Center for Developmental Biology.

Furthermore, following the Promotion of the iPS Cells Research (The 1st Wrap-up) (Decision: CSTP in July 2008), all the related ministries and agencies are taking measures together for the establishment of research system and to secure the necessary research fund and intellectual property.

e) Promotion of molecular imaging research

Molecular imaging is a technique for visualizing quantities and functions of molecules in living organisms.

MEXT has been involved in the Molecular Imaging Research Program, coordinating a central core for innovation in the drug discovery process with the Center for Drug Development Molecular Imaging, and for development of diagnostic technology with the Center for PET Diagnosis, carrying out revolutionary R&D to renovate drug discovery process and improve disease diagnosis at these centers, and promoting developing of human resources and joint research projects.



Investigation photos showing the extent causative substances of Alzheimer disease are accumulated in the brain by using PET (a system to image molecules within the living body).
Much causative substances are accumulated in the portion in red color.

Photo: RIKEN

MHLW promotes the development of medical devices toward noninvasive and minimally invasive treatment through applications of nanotechnology. The ministry also carries out research in innovative imaging diagnosis technology and devices for treatment of cancer and other diseases. Some research projects are supported through matching funds with NEDO.

METI implemented the Project for R&D on Molecule Imaging Equipment since FY 2005. It has been developing a molecular imaging device that can detect cellular function changes with high sensitivity, accuracy, and speed so that tumors can be discovered and the level of malignancy can be diagnosed at early stages.

f) R&D that promotes implementation of research results such as those that facilitate efficiency in the drug development process

METI carries out R&D for building the basic technology that will accelerate genome-based drug discovery for creating new medicines using genetic information. This involves technologies that elucidate disease mechanisms at the genetic level using human full-length cDNA, which is one of the fields where Japan is leading leader, technologies that create medicines based on disease mechanisms analyzed, technologies that efficiently create medicines based on membrane proteins' structure information that plays a crucial role in living organisms, and technology development toward the creation of research model cells for diseases based on human ES cells. Furthermore, METI also develops technologies to create new antibodies that can be used in antibody therapeutics and to efficiently purify the antibodies.

g) Development of new medical technologies and systems through cooperation among private-sector companies and clinical research institutions

METI implements organic cooperation among private-sector companies, such as venture firms and clinical institutions through NEDO to deliver research results in versatile technology fields to medical sites, thus trying to achieve rapid practical applications and dissemination of

medical technologies by developing new medical technologies for achieving a reduction in the incidence by patients and persons involved in medical care.

3) Innovative cancer treatment technologies such as targeted treatment

Based on the Third Term Comprehensive 10-Year Strategy for Cancer Control (Decision by the Minister of MEXT and the Minister of MHLW in July 2003), the Cancer-Fighting Basic Act (Enforcement in April 2007), and the Basic Plan to Promote Cancer Control Programs (Cabinet decision: June 2007), some new understanding of the mechanism of cancer and new methods for prevention, diagnosis, and treatment for cancer, taking advantage of related research results are being elucidated.

MEXT has been carrying out the project Research Promotion for Innovative Therapies against Cancer as research that leads to clinical applications of outstanding results of basic research related to cancer-immunity treatment and molecular target treatment. The National Institute of Radiological Sciences (NIRS) promotes research in heavy-ion cancer therapy, which is expected to be a revolutionary treatment method for types of cancer that are otherwise difficult to treat. In addition, NIRS developed the small-sized heavy ion beam irradiation equipment. Based on the results of this research, Gunma University prepared a heavy-ion beam irradiation facility since FY 2006.

MHLW is involved in research on the mechanism of cancer and translational research that widely applies the research results; multicenter clinical trials for the purpose of establishing standard treatment procedures for cancer treatment; research on palliative care for maintaining and improving quality of life among cancer patients and their families; research on cancer epidemiology and dissemination of cancer information; and research concerning policy challenges such as building a system for promoting equalization of cancer medical services nationwide.

Since FY 2005, METI conducted the Project for R&D on a Next-generation DDS-type Malignant Tumor Therapy System to develop molecular imaging devices that can detect cancer at a very early stage and to treat cancer cells with pinpoint accuracy.

4) S&T for overcoming emerging and reemerging infectious diseases

Currently, the society's fear of infectious diseases, such as new types of influenza whose existence was discovered anew or those that had been assumed to be overcome already, but are raging again (emerging and reemerging infectious diseases), is increasing internationally.

MEXT implements the Program of Founding Research Centers for Emerging and Reemerging Infectious Diseases to promote research on emerging and reemerging infectious diseases at research centers both in and out of the country in order to integrate the basic knowledge and develop human resources.

MHLW sponsors research with an added emphasis on preventive and diagnostic technology for emerging and reemerging infectious diseases, animal-derived infectious diseases and other infectious diseases, on-site studies, and international measures for infectious diseases. The ministry also carries out broad and comprehensive studies on infectious diseases at the National

Institute of Infectious Diseases (NIID).

The Cabinet Office is promoting the Coordination Program of S&T Projects for the emerging and reemerging infectious diseases in cooperation with MEXT, MHLW and MAFF, and the enforcement of the research system.

(3) Challenges in the field of "better eating" and "better lifestyles"

5) S&T for the production and supply of safe foods which improve the nation's international competitiveness

a) Research on microbial/plant and genomes in the food and environment fields

With advances in genome science, the analysis of the structures and functions of the plant genome is also progressing. By controlling the functions of plants based on these results, we anticipate being able to develop plants that will contribute to improved nutrition.

MEXT promotes research to improve plant productivity in terms of both quality and quantity, through the genome sequencing of Arabidopsis thaliana at the RIKEN Plant Science Center.

MAFF is working to accelerate the analysis of gene function, focusing on the resolution of issues relating to food, the environment and energy, launch development of ultra-special high-yielding crops, poor environment-resistant crops, environment cleaning plants, and giant biomass plants using genome sequencing and recombinant technologies, and implement such research strategically and rapidly while committing research funding intensively.

In addition, MAFF is promoting comprehensive genome research to prompt a revolution in the creation of new demand and food production technology, while applying the results of genome research to livestock and insects. More specifically, MAFF implements research focusing on the development of pigs with excellent properties of disease resistance or economic traits, or model pigs for medical research, and enhancement of production of useful substances by using a genetically engineered silkworm genome.

Furthermore, MAFF is working on the development of breed cultivation technology (genome breeding technology) to significantly shorten the breeding period to implement development of innovative breeds that may renovate food production technologies. Besides these projects, there is the continued promotion of development including production technologies of seeding for aquaculture that are difficult to artificially produce. Furthermore, in order to achieve a new target in the food self-sufficiency ratio, the ministry promotes the following projects: 1) development of domestic agricultural goods with unique characteristics in quality or processing compatibility for domestically produced agricultural goods for processing and industrial use where competition with imports is fierce; 2) development of breeding and growing technologies to innovatively improve the productivity or nutritious value of domestic feeds and technologies to produce stockbreeding goods, such as high-quality meats using domestic feeds; and 3) the ministry works on the development of low-cost cultivation techniques using IT, which will achieve dispersion of labor and drastic improvement in productivity, which are important problems for scale expansion.

The Cabinet Office promotes the Coordination Program of S&T Projects for Food and Biological Production Research in cooperation with MEXT, MHLW, MAFF and METI, and plans

measures to promote smooth field cultivation testing through the promotion of national understanding for research on the practical utilization of recombinant crops.

Additionally, the relevant ministries are to promote these projects steadily, based on the Drastic Reform with Effective and Agile Movements for BT innovation in Japan (Dream BT Japan) [Decision by the Public-Private Council on Promotion of Biotechnology (BT) Strategy in December 2008].

b) R&D concerning the guarantee of safe food/food products and consumer trust

With the outbreak of various incidents that threaten food safety and the enactment of the Basic Act on Nutritional Education [literal translation] (Act No. 63 of 2005), people are highly concerned with food or nutrition, and the guarantee of trusted and safe food products has become an important issue to be addressed. Under such circumstances, to expand and enhance food safety measures and to improve the technologies required to control food sanitation, MHLW promotes research on new factors that may cause damage, investigative research to formulate standards and criteria, and research and development for establishing an official method of examination with regard to additives, pollutants, chemical substances, residual pesticides, microorganisms, bovine spongiform encephalopathy (BSE), health products, and products derived from modern biotechnology and which reflects the achievements in risk control measures. Furthermore, the ministry is now working on research for health risk management to prevent food poisoning and food terrorism.

In addition, MAFF is working to develop technology for highly effective epidemic prevention from the zoonotic infection such as bird flu and BSE to reduce potential risk of human transmission of zoonotic infection and the economic loss of stockbreeders. The ministry also works on the development of technology that aimed at reducing the risks of harmful chemicals and microorganisms in the processes of production, distribution, and the treatment of agricultural products. Furthermore, the ministry is now working on the development projects and the technology to prevent tampering with food labels and methods of assessing the functionality of entire foods through nutrigenomics.

6) S&T for the utilization of biological functions for the production of materials and improvement of the environment

MAFF developed the technologies to reduce the use of chemical fertilizers and other agrichemicals by using organism functions. Furthermore, MAFF is involved in the development of methods for assessing characteristics of soil organisms using eDNA (environmental DNA).

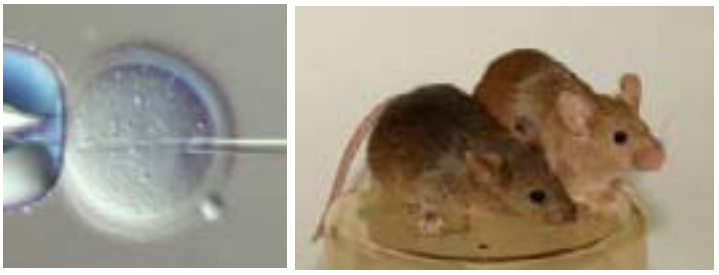
METI develops technologies for producing substances with high add-on value by utilizing plant functions, including highly functional proteins in closed systems; producing useful substances, such as industrial raw materials by utilizing plant functions and microbial functions in projects supported by NEDO; and highly efficient bioprocessing of industry drainage by controlling the microbial community.

(4) Challenges in developing institutional infrastructure of the life sciences

7) Development of life sciences infrastructure that meets the highest international standards

a) Preparation of bioresources

The field of bioresources is not limited to the mere preservation of genetic resources, but also plays an important role in exploring new areas of research. The national interest is served in the development, collection, storage, and provision of bioresources.



Mice (right) **that were born through micro-insemination using sperm from individual organisms refrigerated (-20 degrees) for 15 years**
Photo: RIKEN

MEXT instituted the National BioResource Project for the purpose of establishing a system facilitating the systematic collection, storage, and provision of bioresources for life science research that are of particular strategic importance to the nation.

Since FY 1985, MAFF collected, preserved, and provided biogenetic resources such as native seeds related to the agriculture, forestry, and fisheries industries through the Genebank Project, and the ministry also organized, preserved, and provided rice genome resources including DNA.

Through the National Institute of Technology and Evaluation (NITE), which is a central agency for biogenetic resources (particularly of microbes) in Japan, METI not only does search, collection, and preservation of these biogenetic resources but organizes information concerning the resources (placing them systematically, information on base sequences, information concerning genes, etc.), provides services for R&D and commercialization.

The ministry is also actively involved in coordinating biogenetic resources in Asia through various means such as signing a bilateral agreement with another Asian country based on the Convention on Biological Diversity (CBD) and founding a multi-national cooperative body (Asian Consortium) toward the preservation of microbe resources and their continuously maintained use.

b) Promotion of bioinformatics

Recent advances in life sciences research have produced a massive amount of information like DNA base sequence data, 3D-structure data of proteins, and data concerning the emerging of genes. As a means to use databases containing these data effectively, it is critical to promote bioinformatics, a field created by fusing comprehensive database organization of life information together with life sciences and IT (information technology).

In FY 2006, MEXT began the Integrated Database Project to improve the usability of life sciences relational databases of Japan, encouraging the integration of its databases. MEXT is to integrally manage the database of the Institute for Bioinformatics Research and Development (BIRD) at the Japan Science and Technology Agency (JST), which is actively engaged in the advancement, standardization, and expansion of databases, as well as in the development of genome analysis tools.

MHLW collects and preserves human and animal-derived cultured cells and genes needed for use in research in medical and pharmaceutical fields. The ministry also collects and preserves medical plants and provides them for researchers, while breeding and supplying crab-eating macaques and other animals used for medical testing. In FY 2008, the ministry is increasing experimental disease animal models.

In order to provide information on genomes and genes of agricultural and marine products, including rice, silkworms, and pigs, to researchers at universities and private-sector companies involved in the Agriculture, Forestry and Fisheries-related Genomic Information Integrated Database project, MAFF establishes a database that integrates the above-stated information (see Part 2, Chapter 3, Section 3, 2).

In FY 2008, METI began the Integrated Database Project to integrate data obtained from the research funded by METI and to assure feedback to industries.

CSTP established the Life Science Project Team for Integrated Database Task Force Meeting [literal translation], and initiated the creation of measures to prevent dissipation of useful databases generated or data collected from individual projects to promote utilization of the data and to respond to user requests the input, maintenance and management of new information to be listed in the database, together with relevant ministries, academia and industry.

(Measures for appropriate ways to conduct animal experiments)

In June 2005, the Act on Welfare and Management of Animals was revised as a lawmaker-initiated legislation, and its Article 41 clarified the concept of 3R (Replacement, Reduction, Refinement) concerning animal experiments.

The Act distinguishes experimental animals and animal experiments; for experimental animals, the Minister of the Environment is to determine the standards, which was disclosed as a public notice on April 28, 2006 as Standards Relating to the Care and Management of Laboratory Animals and Relief of Pain (Care and Management Standards). MEXT, MHLW, and MAFF established integrated basic policies for research institutions under their jurisdictions, promoting appropriate ways to conduct animal experiments based on these guidelines. MEXT, MHLW, and MAFF established integrated basic policies for research institutions under their jurisdictions, promoting appropriate ways to conduct animal experiments based on these guidelines.

(Efforts related to bioethical issues)

Rapid development in the life sciences has raised expectations on innovation in medicine and other fields, but may also have brought about new bioethical problems with respect to human dignity and rights, and is regulated by the relevant ministries, if necessary.

MEXT reviewed approximately 60 research proposals for human ES cells under the Guidelines for Derivation and Utilization of Human Embryonic Stem Cells (Public notice by MEXT of No.87, 2007) as of the end of January, 2009 and is now reviewing the procedures for research using human ES cells based on recommendations by the CSTP's Expert Panel on Bioethics. The Bioethics and Biosafety Commission of CST finalized the basic concept concerning the approval of regeneration of reproductive cells from human ES cell, except human embryos

from human ES cells, which is to be inhibited for a while, in February 2009.

Further, preparation and use of human clone embryos was limited to research for the treatment of intractable disease in the Basic Policy on the Handling of Human Embryos (July 2004), CSTP recommendation, and MEXT prepared a draft of the revised guidelines for handling human clone embryos, and submitted it to CSTP for review on October 2008. CSTP is now conducting a review for final commitment. Regarding the handling of fertilized human embryos for research on supplementary reproductive therapy, MEXT and MHLW jointly reviewed the guidelines under CSTP recommendations, and reported in March 2009.

On November 30, 2006, SCJ was requested by the Minister of Justice and the Minister of MHLW to thoroughly discuss issues associated with assisted reproductive medicine, focusing on surrogate conception. SCJ published a report Issues on Assisted Reproductive Medicine Focusing on Surrogate Conception: Towards building a Social Consensus and reported to both ministers on April 16, 2008. The report listed 10 recommendations including the one stating "surrogate conception be regulated by the act to inhibit it to a certain degree." In the areas of human genome and gene sequencing research, epidemiological research, and clinical research, MEXT, MHLW and METI cooperate with each other for the promotion of that research based on the guidelines in order to ensure respect for human dignity and appropriate management of personal information.

(Efforts to ensure safety in the life sciences)

Recombinant DNA technology is used to produce gene combinations that have never existed in the nature, and applied them to a broad range of fields, from basic biological research to the production of pharmaceuticals and the improvement of agricultural crops. The Use of modified living organisms is regulated by the Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Modified Living Organisms (Act No. 97 of 2003) to prevent adverse influences on biodiversity. For clinical research aimed at the establishment of gene therapy, MEXT and MHLW are making efforts for the appropriate promotion of research based on the Guidelines for Gene Therapy Clinical Research (MEXT/MHLW public notice No. 2 of 2004).

The major research issues in the life sciences field in FY 2008 are shown in Table 2-2-1.

Table 2-2-1 Major Research Projects in Life Sciences (FY 2008)

Ministry	Research organization	Subject
Cabinet Office		- Research for evaluation technology of impacts on food and health
Ministry of Finance	National Research Institute of Brewing	- R&D work related to life science
Ministry of Education, Culture,Sports,Science and Technology		- Promotion of genome function analysis, etc. - Target protein research program - Strategic research program for brain sciences (SRPBS) - Program for promotion of bridging research - Project for realization of medical care according to genetic information of individuals - Project for realization of regeneration medicine - Molecular imaging research program - Promotion of research toward development of innovative cancer treatment method - Project for formation of emerging/reemerging infectious disease research centers - National BioResource Project - Integrated database project
	RIKEN	- Project for comprehensive brain science research - Project for plant science research - Project for comprehensive allergy and immunology research - Project for genomic medicine - Project for comprehensive developmental and regenerative science research - Project for molecular imaging research - Bio-resource project - Project for life science fundamental research area [literal translation]
	Japan Science and Technology Agency	- Promotion of Bioinformatics Centers
	National Institute of Radiological Sciences	- Research for upgrading heavy ion cancer therapy - Study on molecular imaging
Ministry of Health, Labour and Welfare		- Infrastructure promotion research project for new drug creation [literal translation] - Research project for third term comprehensive strategy for cancer control [literal translation] - Research project for emerging and reemerging infectious diseases
Ministry of Agriculture, Forestry and Fisheries		- Breeding and integrated research toward enhancing consumption of domestic farm products in food service industry - Integrated research for developing Japanese-style forage feeding system to increase forage self-support ratio - Development of technology for reducing the impact on the environment using biofunction - Development of the seed production technology in the Japanese eel and spiny lobster - Development of technology to analyze the characteristics of soil organisms by understanding of soil microflora - Comprehensive promotion of agricultural genome research - Development of new production systems utilizing IT, etc. which contribute to development of leaders - Creation of an integrated database of genome information on agricultural, forestry, and fisheries products - Research on the implementation and commercialization of agri-bio technology - Development of accurate and effective risk management technology for avian influenza and BSE [literal translation] - Development of the technologies for clarification of the nature of systemic hazardous factors in the processes of production, distribution and processing and technologies for their risk reduction [literal translation] - Development of the infrastructure technology for ensuring reliability in the labeling of foods and agricultural products and for function analysis [literal translation] - Comprehensive promotion of agricultural genome research
	National Institute of Agrobiological Sciences	- Gene bank project

Ministry	Research organization	Subject
Ministry of Economy, Trade and Industry	METI, New Energy and Industrial Technology Development Organization	- Development of technologies to promote bridging of basic research to clinical research - Development of basic bio-technology to support faster creation of genome-based medicines - Development of technology for creating anti-body medicines with new functions - Development of technology to apply sugar-chain functions - Development of diagnostic technologies through fusion with biometric diagnosis toward realization of individualized medical practice - Functional RNA project - Integrated database project - R&D project for intelligent surgical instruments - Developing basic technology for high-quality manufacturing using plant functions - Development of sustainable manufacturing infrastructure utilizing microbial processes
	National Institute of Advanced Industrial Science and Technology	- Prediction and function analysis of the ribonucleic acid for which protein is uncoded [literal translation] - Development and actual operation of a plantation factory [literal translation] - Development of highly effective antibody-specific binding substances for the isolation and purification of antibodies [literal translation]

2 Information and Communications

Information and communications technology are changing a wide range of socio-economic activities in a revolutionary way, not just in the industry but in our daily lives, through means such as the implementation and widespread use of electronic government, working at home, remote medical practice, and distance education. This technology is becoming a critical foundation for the people to live in a safe and secure way. Further, mid- to long-range investment with emphases on those information and communications technologies in which Japan is leading internationally will lead to enhancement in S&T, academic research, and the industrial competitiveness of Japan.

The government's involvement in the general field of information and communications is spelled out in the New IT Reform Strategy (January 2006) and Priority Policy Program 2008 (August 2008) at the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters). The goal is to "realize ubiquitous and universal network society where everyone can enjoy the benefits of IT." The National Information Security Policy Council drafted the Second National Strategy on Information Security: Aiming for Strong “Individual” and “Society” in IT Age (February 2009) to aim at the “establishment of IT environment with security.”

The Ministry of Internal Affairs and Communications (MIC) promotes R&D in an intensive and strategic manner, based on the Strategy on R&D and Standardization of ICT for Enhancing Japan’s International Competitiveness [literal translation] (Telecommunications Council recommendation: June 2008), which specifies concrete measures to promote R&D and standardization, and the sectoral promotion strategy.

Following the strategy in the field of information and communications, MEXT promotes R&D to be implemented with emphasis based on the promotion guidelines for research and technology concerning information S&T, which was finalized in July 2006.

From FY 2008, METI started the Green IT Project aiming at a balance between environment and economy, under the recommendation of the strategy in the field of information and communications.

Below, major guidelines for each ministry and agency are summarized under the seven essential R&D issues in the strategy.

(1) Network domain

In order to construct next-generation network technology which enables us to communicate a massive amount of information instantly and which anyone can use comfortably and conveniently, MIC carries out a variety of research projects, including the following: basic technology R&D necessary for the construction of an all-packet-type, highly functional network; R&D to address the increase in internet traffic and to strengthen the information-communication infrastructure; all-optical networks with both ultra-high speed and extremely low power consumption; technologies for the sharing of multiple wireless systems with the same frequency; technology that will make it easy to construct wireless systems in unused frequency bands; and R&D related to new network architecture beyond the next generation network.

METI conducts R&D on technology to produce highly efficient network devices using electronic/ optical technology.

(2) Ubiquitous network domain

MIC, with the goal of achieving a ubiquitous network society in which access is available "anytime, anywhere, by anything and by anyone" has worked on developing element technology including RFID tags and sensors. Based on these research results, MIC implemented Ubiquitous Platform Technology R&D since FY 2008 which realizes advanced ubiquitous network services utilizing the information from RFID tags and sensors. It includes technology to equip an RFID tag reader/writer that can be applied to a variety of tasks such as monitoring service and health management, in a cellular phone. Moreover, MIC implements the R&D of the technologies to provide safe and secure and also advanced services of the home information appliances which will be used in various manners with the digitalization of home appliances and development of broad bands of networks.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT), to promote the Free Mobility Project, promoted the formulation of public-private rules in data items and service provision required for route guidance intended for practical use, and the ministry implemented demonstration tests at eight locations in the country.

The Cabinet Office promotes collaboration with ministries and agencies according to the above-stated guidelines, focusing on the RFID tag technology as the Ubiquitous Networks of the Coordination Program of Science and Technology Projects. The Office also promotes, through the Science and Technology Promotion Adjustment Expenses, the supplementary projects involving measurement and safety and security using RFID tag.

(3) Device/display domain

MEXT has implemented development of an innovative spin device[1] and basic technologies

1 Spin device utilizes the property of the electric charge of electrons and the property of spin (magnet property) that electrons have.

for large-capacity, high-speed storage required to realize high-function and ultra low-power consumption computing.

In the area of semiconductor technology, METI developed miniaturization technologies for a 45-nanometer or smaller technology node (processing/material technology, exposure system technology, design technology, and masking technology), technology for next-generation memory with a nonvolatile function, and application chip technology that will lead to reduced power consumption in information household appliances. In addition, in FY 2008, METI started R&D related to 3-dimentional integration technology in a semiconductor device, a prototype, and evaluation of a semiconductor device which was produced by private companies using circuit designs developed by universities and ventures. Moreover, as a Green IT Project, METI started R&D on a router to control power consumption by estimating volume of data and an organic EL display for 40 watt, 40-inch full high definition televisions, in addition to R&D on individual devices and equipment.

(4) Security and software domain

Regarding security technology, MIC conducts R&D of technology to prevent information leaks and the technologies for detecting, mitigating, and preventing BGP prefix hijacking. In addition, MIC and METI carry out development and trial operation of a bot trapping / analyzing system. Moreover, METI carries out the development of technology for preventing damage caused by new types of threats to information security, and technology for minimizing the damage in the case where any has occurred. Further, they conduct research for ensuring information security, which is deeply involved with the people's lives and socioeconomic activities, and research on management techniques for developing an environment that enables people to use IT with a sense of security.

Regarding technology to support R&D on software, MEXT implemented R&D on “visualization techniques for software construction status” and “software for system integration and cooperation to realize e-Science” [literal translation]. METI develops voice recognition technologies directly linked to consumer convenience under a project for the Development of Technologies to Use Information Household Appliance Sensors and Human Interface Devices [literal translation], establishes the environment where devices can be interfaced beyond different manufacturers, and then promotes the dissemination of achievements of the development. METI also develops and encourages the broad use of software engineering techniques in order to introduce such techniques to the development of software which is entrusted to the experience of on-site engineers. METI selects the automotive industry as the first field of application, and develops the software for on-board control circuits in cars, while initiating the development of design tools that improve the reliability of integrated systems through the application of engineering methods. In addition, in order to promote utilization of standardized software, the ministry continues improvement of its system to monitor the diffusion, improvement and mutual utilization of the technical guidelines (a technological reference model) for users.

(5) Human interface and content domain

MIC developed the technology for encoding, which is necessary to achieve super-ultra-high-density image broadcasting expected as next generation technology, and implemented development of element technology for future 3-D imaging techniques based on the super-ultra-high-density imaging techniques. In FY 2008, the ministry developed fundamental procedures and created the basic designs for network voice translation technologies, toward realization of voice communication technology that overcomes language barriers, which is one of the Pioneering Projects for Accelerating Social Return. Moreover, monitoring tests were conducted using audiences at the Beijing Olympics Games in order to improve the accuracy of Japanese-Chinese machine translation. The ministry also implements R&D of information analysis technologies (R&D of information believability validation technologies in telecommunications services [literal translation]) to provide reliable information and validate believability of information among various types of information available on networks.

MEXT develops the super-high performance database platform software that enables the management and utilization of huge amounts of data, to respond to an age in which information is exploding. Moreover, the ministry implements R&D on software which enables the seamless use of various computers distributed throughout the country.

METI develops the next-generation technologies for accurate search and analysis of required information from among large amounts of data and infrastructure for futuristic business which can provide the most appropriate information and services depending on the preference and position of the user (Information Grand Voyage Project).

The Cabinet Office promotes a Coordination Program of Science and Technology Projects for the Very Large Information Integration and Application Platform in cooperation with MIC, MEXT and METI, and also promotes the development of technologies for content and knowledge processing in the next-generation information environment [literal translation] through the Special Coordination Funds for Promoting Science and Technology.

(6) Robot domain

MIC is involved in R&D toward creating robots that can provide services like life support and welfare/caretaking support; this is done by linking various types of robots with versatile sensors and devices via a network to further improve the single-function robot.

METI carries out development, with realistic uses in mind, in the fields of next-generation industrial robots, service robots, and special environmental work robots. Furthermore, the ministry develops intelligence technologies that perform different types of work without fail under the rapidly changing environment of production and the living environment, and implements demonstration tests. In addition, METI implements R&D to standardize methods to connect and control various components of robots, including sensors and motors, and to make reusable parts (modules).

RIKEN implements the R&D of life support robots by establishing a cooperation center jointly with Tokai Rubber Industries, Ltd.

Under the above-stated measures, the Cabinet Office promotes one of the Coordination

Program of Science and Technology Projects as the Establishment of Common Platform Technology for Next Generation Robots and conducts some projects, such as the structuring environmental information project funded by the Special Coordination Funds for Promoting Science and Technology as a supplementary project.

(7) R&D platform domain

As a Key Technologies of National Importance (Strategically prioritized S&T: The world's highest level next-generation supercomputer), MEXT promotes the project (Project name: Development and Use of an Advanced, High-Performance, General-Purpose Supercomputer), so that Japan maintains its world-leading positions in a wide range of areas such as science and technology, academic research, industry and medicine. Moreover, the working group set under CST prepared the fundamental rules of utilization [literal translation] (July 2008), and started preparation for a concrete strategy plan for its utilization in December 2008.

(8) Miscellaneous

As a strategically prioritized S&T, MEXT promotes programs such as the Leading IT Specialist Training Promotion Program, toward the formation of a central location where can train human resources who will, as IT personnel with the highest standard in the world, address the changes in social circumstances with flexibility and foresight and play leading roles in companies and other organizations.

Main research topics in the field of information and communications in FY 2008 are shown in Table 2-2-2.

Table 2-2-2 Major Research Projects in Information and Communications (FY 2008)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications		- Research and development concerning next-generation backbones - Research and development on ultra functional network technologies utilizing nanotechnology - Research and development on element technology toward high-level uses of frequencies in mobile communication systems - Research and development on basic technologies toward promoting a transition of wireless systems to unused frequency bands - R&D of the integrated satellite-terrestrial mobile communication systems [literal translation] - R&D of the ubiquitous platform technologies [literal translation] - Research and development on technologies for high-level usage of information household appliances - A trial to stop Cyber Attacks, such as spam, phishing - Research and development on detection, recovery, and prevention of path hijacking - Research and development of technologies for preventing information leaks - Comprehensive research and development into network human interface technologies
	National Institute of Information and Communications Technology	- Research and development on basic technologies for next-generation networks - Research and development on photonic network technologies - R&D of the infrastructure technologies for next generation networks [literal translation] - Research and development concerning information believability validation technology in telecommunication services - R&D on automatic speech translation technologies [literal translation] - R&D on super-high realistic imaging system [literal translation]

Ministry	Research organization	Subject
Ministry of Education, Culture, Sports, Science and Technology		- Development and Use of an Advanced, High-Performance, General-Purpose Supercomputer - R&D on the system-Integrated and collaborative software for realizing e-science [literal translation] - Development of ultra high-performance database core software based on the innovative execution principle - Research and development of device/system core technology for high-function and ultra low power consumption computing - Development and dissemination of visualization technology of software development status - Leading IT Specialist Training Promotion Program
	RIKEN	- Study on biomimetics control
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	- Development of technologies for robot-harvesting fruits and vegetables
Ministry of Economy, Trade and Industry		- Next-Generation Circuit Architecture Technical Development Program - Project for the actualization of Industry-academia collaborative software engineering projects [literal translation] - Developing technologies using information household appliance sensors and human interface devices - Secure platform project - Information grand voyage project (Development of next generation information research/analysis technologies [literal translation] - Infrastructure project for a computer security early-warning system[literal translation] - Project for corporate and personal information security measures[literal translation]
	New Energy and Industrial Technology Development Organization	- GREEN-IT Project - Development of Functionality Innovative Three-dimensional Integrated Circuit (Dream Chip) Technology - MIRAI project - Developing technologies for next-generation process-friendly designing - - Semiconductor application chip project - Spintronics nonvolatile function technology project Spintronics nonvolatile function technology - Development of core technology for the next-generation, large-size, low-power consumption display - Development of the next-generation high-efficiency network device technology - Project for development of the next-generation robot intelligence technology - Project for Open Innovation Promotion by Utilizing Basic Robotic Technology - Project to develop element technologies for strategic, cutting-edge robots
	Information Technology Promotion Agency	- Task of creating an early warning system for computer security - Taking security measures for corporate and private information - (2) central location for industry-academia collaborative software engineering, listed under the coordination of industry-academia collaborative software engineering center - Utilization promotion project for open software [literal translation]
Ministry of Land, Infrastructure, Transport and Tourism		- Promotion of autonomous movement support project [literal translation] - Study on unmanned work, inspection, and diagnosis by using subsea robots

3 Environment Field

The environment field is an essential area of science for preserving the natural environment, including ecological systems with diverse forms of life, for maintaining human health and preserving the living environment, and for maintaining the platforms for the future survival of human beings. The Third Science and Technology Basic Plan places one of the priorities on the environment. In particular, regarding the climate change problem, the Fourth Assessment Report prepared by the Intergovernmental Panel on Climate Change (IPCC) which received a Nobel Peace Prize in 2007 specified that there is a very high possibility that a significant degree of the increased mean global temperatures which have been observed since the middle of the 20th century has been brought about by the observed increase of greenhouse gas concentration of artificial origin. The scientific elucidation of global warming is now progressing. Japan divides the environmental field

into six research area, and is working on the following measures:

(1) Research related to climate change

(Promotion of global environment observation)

In climate change research, the relative ministries focuses on promoting the observation of greenhouse gases and the earth surface environment using satellites as strategically prioritized S&T. Because Earth observation by satellite is a highly effective means for observation that can collect various kinds of information extensively in a repeated and continuous manner, it is being promoted comprehensively under cooperation with related entities in and outside Japan, with the aim of solving environmental problems.

On January 23, 2009, the Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) was launched as a joint project with MOE, Japan Aerospace Exploration Agency (JAXA) and the National Institute for Environmental Studies (NIES). The global observation without deviation which is required to increase the accuracy of the estimation of absorption and emission of greenhouse gases will be advanced for further promotion of the measures against global warming. Furthermore, NIES promoted development of a system to process observational data of GOSAT (preparation of data processing/provision and validation of data quality).

Greenhouse Gases Observing Satellite "IBUKI" (GOSAT)
Source: Japan Aerospace Exploration Agency

JAXA continues to measure global envelopment with the Advanced Land Observing Satellite "DAICHI" (ALOS), and implements demonstration tests for use concerning comprehension of vegetation in cooperation with related institutions. Furthermore, JAXA processes data acquired from Japan's Precipitation Radar (PR) onboard NASA's Tropical Rainfall Measuring Mission (TRMM) satellite and Japan's Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) onboard the Earth Observation Satellite (Aqua) and then provides the data to researchers. In addition, JAXA promotes global observation using the space satellite through R&D on earth observation satellites and sensors which collect and offer various global data related to the global environment, including precipitation, clouds, aerosols, vegetation, etc. for further contributions to the improvement of the accuracy of climate change forecasts.

MEXT promotes global observation under the Global Earth Observation System of Systems

10-Year Implementation Plan, and reinforces observation networks through projects specified in the Japan EOS Promotion Program (JEPP) as: 1) research and S&T for construction of a system to observe atmospheric ingredients in the troposphere changed by trace elements (nitrogen dioxide, ozone, etc.) and aerosols, which are uncertain factors for measures for environmental security and climate forecasts, and 2) clarification of the mechanism of circulation of the substances such as oceanic carbon dioxide, which has a greenhouse effect, and the development of advanced equipment for the observation of carbon dioxide in and on the surface of the ocean for future estimation (for example, a small, durable, and inexpensive drifting buoy).

In addition, MEXT has implemented an environmental observation project under international cooperation in Antarctica where the change of the global environment can be clearly observed. Japanese Antarctic Research Programs are centered at the National Institute of Polar Research, affiliated to the Headquarters for Japanese Antarctic Research Expedition (JARE) (Director: Minister of MEXT), and are operated in cooperation with relevant ministries. In FY 2008, JARE-49 (wintering party) and 50 teams carried out routine observations of weather, ozone, etc. around the Showa Station, and also performed academic monitoring observations, etc., for the purpose of showing environmental changes that have occurred on a global scale. In particular, they performed research on the global environmental system from the viewpoint of reciprocal action of the universe-atmosphere-ocean in the polar area.

Furthermore, MAFF has been working on the development of a carbon cycling model for forests, farmland and marine forests that is conducive to the promotion of countermeasures that aimed at global warming.

(Promotion of R&D necessary for climate change research)

MIC implements development at the National Institute of Information and Communications Technology (NICT) of a differential absorption LIDAR[1,2] for CO_2 remote sensing. Furthermore, the ministry implements R&D on sensing network technology to resolve 3-dimensional structures in the urban atmosphere, which also has a large impact on environmental changes in Asia and the world, and also on the next generation doppler radar necessary for measurement and projections of sudden local hazard risks. In addition, NICT developed a Superconducting Submillimeter-Wave Limb-Emission Sounder[3] onboard the exposed facility of the Japan Experiment Module "KIBO" (JEM) on the International Space Station. NICT also studies technology to enable the measurement of global environmental changes from space.

1 LIDAR (Light Detection and Ranging) is a system to measure the atmospheric status by transmitting laser beams into the atmosphere and observing scattering light from substances floating in the air.

2 Differential Absorption LIDAR (DIAL) measures the concentration of specified atmospheric components by simultaneously transmitting a light beam with a wavelength that is absorbed by specified atmospheric components and a light beam with a wavelength that is not absorbed and then comparing the intensity of the scattered light of the two beams.

3 Superconducting Submillimeter Wave Limb Emission Sounder (SMILES) measures the amount of ozone by directing the antenna to the atmospheric limb and receiving submilimeter waves that are radiated by small amount of molecules in the air through the use of a high-sensitivity, low-noise receiver.

MAFF creates a database of imaging data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS), onboard NASA's global observing satellites Terra and Aqua, and makes it available on the internet.

MOE promotes research studies conducive to preservation of the global environment, such as research on the destruction of the ozone layer and global warming, as well as observation necessary for countermeasures against global warming, from mid- and long-term perspectives.

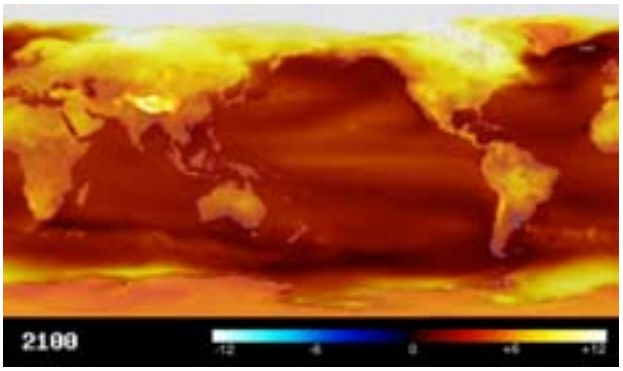
(Promotion of global environment projection research)

In the climate change research, climate change projection in the 21st century using climate model is a strategically prioritized S&T.

MEXT has promoted experiments in climate change projection and R&D on climate models, with the results contributing to the Fourth Assessment Report, prepared by IPCC which received the Nobel Peace Prize in 2007. In preparation for the IPCC Fifth Report, MEXT is promoting experiment on climate change projection and R&D on climate models with high accuracy and high resolution under the Innovative Program of Climate Change Projection for the 21st Century, using the Earth Simulator, one of the world's most powerful supercomputers. Furthermore, in order to adequately cope with issues such as climate change, water resource management, agriculture and other social problems that human society is currently facing, MEXT promotes the establishment of the Data Integration and Analysis System (DIAS), aimed to integrate and analyze various data and results of climate change projections obtained by satellite, terrestrial and ocean observations, and to provide them as useful information for the lives of the Japanese public.

Furthermore, Japan Agency for Marine-Earth Science and Technology (JAMSTEC) implements fundamental research, aiming at clarification of the mechanism of global environment change and achievement of future projections, and R&D for technology to improve the precision and speed of simulation using the Earth Simulator as well as technology to project global environmental changes using such simulation, as a strategically prioritized S&T. In March 2009, the Earth Simulator system was updated to enable a greater contribution to the marine geoscience field.

The Meteorological Research Institute (MRI) of the Japan Meteorological Agency constructed a geographic earth observation system model for the projection of global warming in which analysis of aerosol and ozone was upgraded. For Japan, MRI developed a local climate model with very precise and high resolution that can draw local cloud imaging specific to Japan, and is spatially making detailed regional warming projections.



Global Warming Projection in 2100
Photo: Center for Climate System Research, the University of Tokyo / National Institute for Environmental Studies / Frontier Research for Global Change, Japan Agency for Marine-Earth Science and Technology

(2) Research related to hydrological cycles and solute transport in watersheds

In research related to hydrological cycles and solute transport in watersheds, scenario for the realization of a society existing in harmony with nature and a healthy water cycle has been carried out.

In this area, basin zone observation and environmental information platform on a regional and global scale is promoted as a strategically prioritized S&T. JAMSTEC has established a global earth observation system to observe and collect data and information on water, thermal and material circulation on a regional and global scale and implemented R&D to monitor changes in water circulation on a global scale through in-situ and satellite observation of the atmosphere, oceans and land surfaces.

MEXT establishes, in the Japan EOS Promotion Program, an oceanic research and observation network with international cooperation (including an moored buoy network) and a research and observation network using doppler radars, as well as collecting observation data for atmospheric and oceanic fluctuation phenomena (including the Indian Ocean dipole mode phenomenon) and observational research in order to resolve the mechanism of the hydrological cycle and climate change in the Asian monsoon region.

MEXT and MLIT are working on maintenance of integrated ocean observing system (ARGO Program), which deploys about 3,000 mid-depth floats to observe and report data on water temperatures and salinity by moving through the range from the sea surface to 2,000 meters deep throughout the world under the international cooperation to monitor the status of oceans around the world in real time. The number of the floats in service reached the target of 3,000 pieces in November 2007.

MLIT is working on the development of technologies, including land infrastructure technologies in accord with nature to implement development of reproduction and recovery technologies in the basin zone for comprehensive water circulation management, while taking the entire basin zone into consideration. The ministry is also working on research on elucidation of migratory mechanism of chemical substances in inner-bay deposition and comprehensive monitoring of the environment of inner bays, development of strategic stock management methods for housing and social capital, development of technology to reduce and recycle

construction wastes, formation of waste flow systems to facilitate cyclical usage of resources, and research on collection of biomass energy from sewage sludge and animal manure.

MIC developed the long range ocean radar through NICT, which realizes continuous long-term observation of the flow field of the Kuroshio Current, etc. at the shore and installed the radars at Ishigaki and Yonaguni Islands and observes the flow field of the Kuroshio Current south of the East China Sea.

(3) Research related to ecosystem management

In research related to ecosystem management, the research is being conducted to achieve an exact understanding of the ecosystem and its various organisms in order to assure their maintenance and reproduction.

MAFF implements developments of indicators of biodiversity and evaluation techniques for the effective promotion of related measures while considering biodiversity through environmental conservation-type agriculture. Moreover, the ministry develops methods to clarify the relation between marine resources and large-scale changes, and to manage marine resources continuously through clarification of the influence of climate change on the marine ecosystem.

MOE promotes research into the projection of and countermeasures against the effects of a decrease in biodiversity. Furthermore, the ministry also promotes research in the fields including the field concerning preservation of sound ecological system and engagement with nature and the field concerning the maintenance and reproduction of a sound ecological system.

(4) Research related to chemical risk and safety management

Chemical substances are used in various products, becoming more essential to people's lives. However, in order to sufficiently utilize their benefit, it is necessary to scientifically understand the risk and address it appropriately as well as to develop a society with a good sense of balancing risk and benefit. Survey, R&D as well as the formation of an intellectual foundation is currently being conducted mainly by relevant ministries for the development of risk evaluation/management methods for chemical substances, collection and provision of information on safety, as well as the development of testing/measurement methods necessary for them.

METI has promoted the development of processes and methods for risk reduction related to harmful chemical substances and the establishment of an intellectual platform. METI is also promoting the development of methods for overall risk evaluation and management throughout the life cycles of chemical substances.

MOE promotes the R&D of methods for risk assessment test and measurement methods for chemical substances including the development of an intellectual foundation in order to contribute to countermeasures against environmental risks of chemical substances. MOE conducts surveys and research for related information and possible countermeasures on hazardous metal.

(5) Research related 3R[1] technologies

In the research related to 3R technologies, the achievement of a cycle-based socioeconomic system and solutions to the problem of waste is being promoted.

METI is promoting development of technology considered not only R&D for the downstream sectors of waste recycling, but for 3Rs in the upstream sectors of the design and manufacturing stages of energy-saving products. Concretely, METI has developed innovative structural material using highly strong steel to contribute to lightening building components. Moreover, the ministry develops recycling technology for rare metals indispensable to our advanced manufacturing and implements research for the recovery and appropriate treatment of rare metals collected from discarded small electric appliances.

MOE promoted research that contributes to solving problems related to waste and building a recycle-based society. This research includes research for promoting the 3Rs, promoting the use of waste-derived biomass, social-scientific research for building a recycle-based society, research on waste control technology for safety and security including solution of asbestos problems, and research on a solution to drift wastes.

(6) Research related to biomass utilization technologies

In the research related to biomass utilization technologies, the relative ministries promoted the development of biomass utilization technology suitable to the region that enables the effective retrieval of energy.

MAFF selectively implements the development of technologies related to methods to cultivate resource crops for the use of domestically produced biofuel and methods of low-cost cultivation of such crops, development of highly efficient biofuel production technologies, and the building of biomass-used models for comprehensively using biomass fuel and materials.

MOE developed basic practical-use global warming countermeasure technologies and technology for measures against global warming leading to commercialized products in a short period of time. Such projects include technology to produce methane and hydrogen from leftover food, the demonstration of driving to introduce 10% bioethanol gasoline, and the development of technology to produce bulk methanol from biomass as well as the reuse of recycled byproducts for the production of biodiesel fuel from waste edible oil. Furthermore, the Cabinet Office, the Fire and Disaster Management Agency (FDMA), MAFF, METI, MLIT, and MOE implement demonstration projects where bioethanol is manufactured in Miyakojima, Okinawa, from sugarcane produced on the island where the residents actually use gasoline mixed with 3% ethanol.

(7) Other

MOE conducts research on material cycling mechanisms and oceanic pollution caused by hazardous chemical substances in order to help preserve the global marine environment.

SCJ confirmed agreements based on highly probable scientific findings related to the problem

1 Reduce, Reuse, Recycle

of global warming, and proposed options for realistic actions in its report "Toward the Solution to the Problem of Global Warming - Analysis of Current Findings and Measures: Alternatives for Action" (March 10, 2009). In addition, SCJ reviews the long-term view of global environment through the Subcommittee on Global Environmental Problems of the Japan's Foresight Committee [literal translation].

Major research subjects conducted in the environmental area in FY 2008 are listed in Table 2-2-3.

Table 2-2-3 Major Research Projects in Environmental Sciences (FY 2008)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	Promotion of international information networks for conservation of the Earth's environment	- Research on measurement technology for global environmental changes - Research and development of technologies for the measurement of subtropical Earth environments - Research on sensing network technology
	Fire and Disaster Management Agency	- Ensuring security corresponding to the utilization of new technology/materials
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology, Japan Aerospace Exploration Agency, National Institute for Environmental Studies, universities, etc.	- Earth Observation and Ocean Exploration System - Research on global environment observation - Research on the prediction of global environmental changes - The Innovative Program of Climate Change Projection for the 21st Century - Plan for promoting the establishment of global observation system - Data integration and analysis system (DIAS)
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization, National Institute for Agro-Environmental Sciences, Japan International Research Center for Agricultural Sciences, Forestry and Forest Products Research Institute, Fisheries Research Agency, etc.	- Development of biomass utilization technology for local revitalization - Assessment, mitigation and application technologies for global warming effects on the agriculture, forestry and fisheries sector [literal translation] - Development of technology to predict/control population out break of marine life in relation to environmental change - Development of indicators and assessment technologies of biodiversity useful in agriculture [literal translation]
Ministry of Economy, Trade and Industry		- R&D on architectural structure with new structural system using innovative structural materials - Project for development of alternate rare metal materials - Development of highly efficient recovery system of rare metals
	National Institute of Advanced Industrial Science and Technology	- Resolving the amount of the long-term absorption of carbon dioxide by the Pacific Ocean through data analysis of mid-deep seawater - Development of chemical substances and production technology using biomass as raw material - Preparation of detailed risk evaluation report of typical chemical substances
	New Energy and Industrial Technology Development Organization	- Regional biomass heat usage field test business - Development of methods for brief assessment of the hazardous property of oil refinery substances, etc. - Development of evaluation methods for the properties of nanoparticles - Development of risk trade-off analysis method aiming for optimum control of chemical substances - Development of hazard assessment by structure activity correlation method - Development of alternate technology for high-level lead soldering to promote the recycling of electric and electronic appliances

Ministry	Research organization	Subject
Ministry of Land, Infrastructure, Transport and Tourism	National Institute for Land and Infrastructure Management	- Research into supporting technology for energy conservation with better performance of existing residences - Strategic planning and adaptive management on environment restoration in coastal zone - Research initiative with respect to achieving a more healthy water cycle in consort with regional activities
	Public Works Research Institute	- Development of recycling construction technology for building a material-cycle society - Development of the regional system for the cycling and usage of biomass, based on the joint biogas plant - Development of dam technology to preserve the natural environment - Development of technology to alleviate environmental risks in daily life - Development of technology to preserve/restore water ecosystems - Research on the intensive land use of coastal areas in cold regions - Development of designing technology for river basins and channels that coexists with the environment in the field of rivers in cold regions
	National Maritime Research Institute	- Research conducive to the prevention of marine pollution due to emission and effluence of oil and hazardous liquid from ships - Research conducive to the prevention of air pollution due to gas emission from ships - Research for prevention of environmental contamination caused by salvage work [literal translation]
	Hydrographic and Oceanographic Department, Japan Coast Guard	- As part of activities of Hydrographic and Oceanographic department, geomorphological and geological surveys of sea bottoms for the detection of volcanic eruptions, and observations of water temperatures, ocean currents, waves, and other aspects of the Western Pacific ocean region
	Meteorological Research Institute, Meteorological Agency	- Comprehensive projection of climatic change around Japan due to global warming - Development and improvement of a materials circulation model and research on assessment of the effect on the global environment - Research for observation and modeling of aerosol and its radiation process [literal translation]
	Geographical Survey Institute	- Geodynamics by precise Earth measurement - Development of a correction model for seasonal variations observed in GPS coordinate time-series
	Port and Airport Research Institute	- Sea level rise monitoring by tidal level observation - Research on the changes in the characteristics of the emergence of tidal waves due to global warming - Research on geo-environment design technology for tidal mud flat regeneration - Study on elucidation, impact assessment and measures of migratory mechanism of harmful substances in coastal areas - Research on countermeasure technology against oil spill in coastal areas - Study on comprehensive environment monitoring and environment prediction models of inner bays
	Global Environment Research Fund	- Study on detection of long-term changes in stratospheric processes and uncertainty assessment of prediction on ozone layer fluctuation factors - Multiphase and comprehensive assessment/prediction of mid- to long-term policy options toward society that exists from inducing global warming - Study on vegetation in East Asia regarding risk assessment and impact prediction on agricultural products of ozone concentration rise - Comprehension of behaviors and early detection of settlement of marine organisms which make cross-border transfer through ballast water/adhesion on the body of large ships - Planning of sustainable spontaneous regeneration plans for release of Nipponia Nippon and social procedures thereof - Design of a sustainable metropolitan and industrial system based on an environmental flux assessment of water, substance and energy [literal translation] - Research on countermeasures for geomorphic and water resource changes in small island states consisting of atolls [literal translation] - Research on biotechnology fuel utilization strategy for the sustainable development of Asia Pacific region [literal translation]

Ministry	Research organization	Subject
Ministry of the Environment	Global Environment Research Coordination System	- Development of technologies for assessment of impacts caused by planting under CDM and prediction technologies thereof - Research on the promotion of a long-term ecosystem monitoring and data network for Asian continental carbon cycle observation [literal translation] - Study on early detection and early prediction of global warming by utilizing Tibetan Plateau - Observation of greenhouse gas over Asia-Pacific region utilizing commercial aircraft - Research on assessment of the impact of global warming by monitoring arthropod-borne virus, aqueous bacterial flora, and vectors [literal translation]
	Environmental Technology Development Fund	- Creation of a new highly effective methane fermentation process from palm oil waste fluid (POME) for application of a clean development mechanism [literal translation] - Research on safety assessment, as a guide for consensus building with residents, of the industrial byproducts to be used as the materials for reclamation of the dredging hollow [literal translation] - Development of the multi wave-length and high spectral resolution lidar for a next generation atmospheric monitoring network [literal translation] - Technology and development (T&D) for clarification and treatment of the source of and pollution from organic fluorine [literal translation]
	Environment Waste Management Research Grant	- Research on the control of useful and harmful substances contained in the products produced aiming at proper international resource recycling [literal translation] - T&D of converge mill serial crushing for wood bioethanol production [literal translation] - Construction of an assessment model for a technology system for the realization of a recycling-oriented society vision, and assessment of resource efficacy and eco-efficacy [literal translation] - Research on safe infrared melting processing of asbestos waste [literal translation] - Proposal of systems for recycling of coast driftwoods - Research on the endowment and recovery of rare metals in incineration ash and dust [literal translation]
	Technology Development Business for Global Warming Countermeasures	- Technology development and demonstration business for Academic City East Hiroshima Model related to the introduction of urban biomass energy technology - Development of technology to produce woody biocoke by Pyrocoking technology and system to apply to SOFC power generation - Development of technology concerning biofuel production through integrated/energy-saving enzyme method in southern part of Hyogo Prefecture - Development of technology on production of green methanol for carbon-free BDF and advanced utilization of the byproducts. - Development of technology concerning ultrasonic condensation for reduction in energy cost for bioethanol production - Development of technology concerning application to automotives and distribution of bioethanol-mixed automotive fuels for expanded demand in cold districts - Development of technology concerning bio-hydrogenation/gasification of waste foods - Project for promoting establishment of large-scale bioethanol production centers by using sweet corn for resource-oriented use - Project for demonstration of the global warming prevention initiative in urban renewal/industrial area of coastal areas by using technology for manufacturing high-efficiency, thermally-decomposable bio-oil - T&D on practical application of an urban biomass energy system for the use of dry methane fermentation [literal translation] - Development of cellulase sources for bioethanol production [literal translation] - T&D on new cellulose saccharification with a solid acid catalyst [literal translation] - Development of the effective production technologies to produce bioethanol from the residue of orange juice [literal translation] - T&D on the network construction for the use of bio oil in the middle mountainous regions [literal translation]
	Research Funding for the National Research Institute engaged in Environmental Pollution Research	- Production cost of observational research equipment equipped on satellites
	Survey and Research Funds for the National Organization for Pollution Prevention	- Research on comprehensive management methods conducive to unified preservation of ocean and land

Ministry	Research organization	Subject
	Environmental Management Bureau	- Investigative research on the biological effect of environment nanoparticles
	Environmental Health Department	- Research on the actual state of POPs contamination - Basic research for hazardous heavy metal countermeasure strategy - Provision of information on hazardous property classification, label investigation and label information of chemical substances
	National Institute for Environmental Studies	- Clarification of the regional characteristics and mechanism of long-term changes in the concentration of greenhouse gases [literal translation] - Observation of carbon dioxide using satellites and estimation of global carbon balance distribution [literal translation] - Risk assessment of global warming risk by integrating climate, influence, and land use models [literal translation] - Overall assessment of vision construction and measures for the achievement of a global dewarming community [literal translation] - Design and evaluation of resource recycle system and policy and management techniques in the near future [literal translation] - Planning and evaluation of measures for the recycle management of reusable or toxic substances [literal translation] - Development of Win-Win type resource recycle technologies for waste biomass [literal translation] - Construction of a proper management network and technical system that supports international resource recycling [literal translation] - Exposure level evaluation by integrated analysis of combined factors related to the exposure of chemical substances [literal translation] - Assessment of the impacts of chemical substances on health, focusing on the factors of sensitivity [literal translation] - Assessment of the bio-kinetics of environmental nanoparticles and their impacts on health [literal translation] - Development of assessment techniques for environmental impact from the viewpoint of biodiversity and ecological function [literal translation] - Development of atmospheric environmental evaluation techniques in Asia [literal translation] - Development of a recycle assessment system for water and substances in East Asia [literal translation] - Development of environmental impact evaluation techniques for valley ecosystems [literal translation]

4 Nanotechnology and Materials

The nanotechnology and materials field contributes to the S&T progress and problem solving in fields such as life sciences, information and communications, and environment. It forms important technology seeds that realize the development of industry, affluent lives for people and safe, assuring and comfortable society.

(1) Nanoelectronics

MEXT promotes the development of logic devices that break the limitation of silicon devices, information memory with 100-fold memory density compared to conventional products, and element technologies for the next-generation electron microscopes. Furthermore, the ministry develops information communication materials utilizing nanotechnology at the National Institute for Materials Science (NIMS).

METI develops nanoelectronics technology base on the operating principle of near-field optics to realize optical devices including low-loss and high-function polarization control components.

(2) Bionanotechnology and biomaterial

MEXT establishes nanobiotechnology research bases opened to the world. Furthermore, NIMS develops biomaterials utilizing nanotechnology.

MAFF is working on the development of processing and assessment technologies for developing new food materials by utilizing nanotechnologies.

Since FY 2005, METI has carried out the project for the development of molecular imaging equipment to detect the functional change of cells and to detect cancer at a significantly early stage as well as the equipment to attach cancer cells alone at the pin-point level.

MOE implements the development of technology for the supersensitive and prompt detection of hazardous chemical substances by artificial tissue-nanodevice sensor complex.

(3) Materials

As a strategically prioritized S&T, FDMA develops components to utilize nanotechnology materials for firefighting clothing. The agency also implements research on the evaluation methods of the performance functions such as heat resistance.

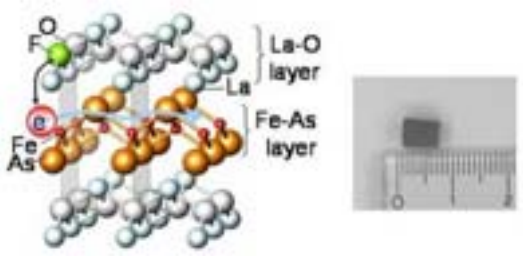
MEXT promotes the Strategy for Rare Elements to develop innovative catalysts with structural design and control at the nano-scale and to develop technologies for scientifically elucidating roles of elements that determine the characteristics and functions of substances and materials for ensuring replacement and reduction in the use of rare elements. Furthermore, the ministry promotes R&D on the sophistication of environmental and energy materials, as well as R&D of materials with high reliability and safety at NIMS.

METI develops fundamental processing technologies related to welding and forging technologies for tissue control at the nano-scale to ensure further reliability, higher strength, and weight saving to take advantage of high-class steel products that are structure-controlled at the nano-levels.

MOE implements the development of environmental technologies that make use of the nanotechnology merits of miniaturization and improved function.

(4) Promotion platform for nanotechnology/material fields

MEXT is preparing in anticipation of its shared use in FY 2011 of X-ray Free Electron Lasers, which enables instant measurement and analysis of ultra-fine structure of a substance at the atom level and ultra high-speed dynamic state and changes in chemical reactions. Furthermore, the ministry promotes commoditizing of state-of-the-art research facilities and equipment owned by research institutions, such as universities and independent administrative institutions, through Nanotechnology Network Project to promote research field integration, thus creating achievements that will lead to innovation.



The conventional copper superconductive material had a limit in applied area because it was weak in the magnetic field. Recently the iron superconductor strong to the magnetic field was discovered, and has been attracted attention as a new material that exceeds the conventional superconductor.
Photo: Tokyo Institute of Technology

METI promotes the project Research and Development of Nano-devices for Practical Utilization of Nanotechnology to strengthen the vertical, collaboration between upstream and

downstream industries and cross-industrial and cross-field collaboration in order to improve technical capacity and international competitiveness of Japanese industries.

(5) Nanoscience/material science

MEXT implements basic/fundamental research at RIKEN regarding control and creation of nano-level physicality and functions, technological renovation of electronic materials by using cross-correlation of electrons, and basic and fundamental research on nano-scale structure observation using light. Moreover, the ministry implements basic research over a wide range of fields at universities and independent administrative institutions.

Major research subjects conducted in FY 2008 in the nanotechnology/materials field are as shown in Table 2-2-4.

Table 2-2-4 Major Research Projects in Nanotechnology/Materials (FY 2008)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology, etc.	- Research and development of ultra functional network technologies utilizing nanotechnology - Research and development related to nano-ICT Ministry of Internal Affairs and Communications
	National Research Institute of Fire and Disaster	- Research on the development of material elements for firefighting clothing using nanotechnology and evaluation methods thereof
Ministry of Education, Culture, Sports, Science and Technology	Promotion of Novel Interdisciplinary Fields Based on Nanotechnology and Materials	- Strategy for Rare Elements - Development of processing device based on non-silicon device materials - Development of memory devices for ultrahigh density information - Founding biotechnology research centers - Development of environmental functional catalyst based on nanotechnology - Development of microstructure-controlled materials
	Research and Development Project for Economic Revitalization (Leading Project))	- Development of nano measurement/processing technologies for practical use (Development of next generation electron microscope element technologies) [literal translation] - Project for creation of innovations for advanced research facilities (Nanotechnology Network)
	National Institute for Material Science	- Development of common fundamental areas in the nanotechnology field - Creation and nanostructure control of nano-scale new materials - Development of information and communication materials utilizing nanotechnology - Development of biomaterials utilizing nanotechnology - R&D for improving environmental/energy materials - R&D on materials ensuring high reliability and safet
	RIKEN	- Research for material function creation [literal translation] - Advanced optical science research [literal translation] - Exotic quantum beam research [literal translation] - Molecule ensemble research - Research on dynamic hydration structures and molecular processes [literal translation] - Material creation research [literal translation] - R&D on an ultimate energy particle observation device [literal translation]
Ministry of Health, Labour and Welfare	Health and Labour Sciences Research Grants (Nano medicine research)	- Research on the application of nano-level imaging in medical area - Research on the development of low invasive and non-invasive medical equipment [literal translation] - Research on the development of a system for the super-rapid diagnosis and treatment of disease [literal translation]
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	- Development of technologies for nano-scale processing/evaluation of food materials

Ministry	Research organization	Subject
Ministry of Land, Infrastructure, Transport and Tourism	Technology Research Division, Minister's secretariat	- Development of performance assessment method of novel structure buildings using innovative structural material such as high-tension steel, etc.
	Policy Bureau	- Research on the reduction of the effects on the environment in the transportation field utilizing nanotechnology
Ministry of Economy, Trade and Industry		- Project for practical development of advanced analyzers (Development of core technologies for advanced components to create new industries) - Development of technologies for new nano-electronics semiconductor materials/new structures – In particular, nano-technologies for new materials and new structures - Project for development of alternate rare metal materials - Development of technologies for new nano-electronics semiconductor materials/new structures
	National Institute of Advanced Industrial Science and Technology	- Development of self-assembly technology - Development of energy-saving building materials [literal translation] - Development of nano simulation technologies [literal translation] - R&D on large-scale synthesis of organic nanotubes and its upgrading [literal translation]
	New Energy and Industrial Technology Development Organization	- Research and development of infrastructure for innovatively higher strength/higher-function ferrous materials - Project for R&D on Next-generation DDS Therapy Systems for Deep Therapy - R&D of Molecule Imaging Equipment - R&D on the practical use of nanotechnology and advanced materials - Project on the development of carbon nanotube capacitor - Spintronics nonvolatile function technology project - Challenges to nanotechnologies achieved through fusion of different field and businesses - Development of technologies for new nano-electronics semiconductor materials/new structures – In particular, development of technologies for substrates/epitaxial growth of nitride-based chemical compounds s - Project for creation of photocatalyst industry for establishing recyclable society - Research and development of infrastructure for innovatively higher-strength/higher-function ferrous materials - Technology for highly-efficient manufacturing of three-dimensional optical device - Forged Magnesium Parts Technological Development Project (Development of Foundation Technology on Advanced Material for the Creation of New Industry) - Development for foundation technology on materials for textiles with new structure with advanced function expression (Development of Foundation Technology on Advanced Material for the Creation of New Industry) - Development of an evaluation basis for the development of next generation advanced material (Development of Foundation Technology on Advanced Material for the Creation of New Industry) - Technology development for ultra-flexible display material (Development of Foundation Technology on Advanced Material for the Creation of New Industry) - Technology development for low-loss optical materials with new functions (Development of Foundation Technology on Advanced Material for the Creation of New Industry - Technology for next-generation electro-optical materials and element synthesis (Development of core technologies for advanced components to create new industries) - Development of technologies for components using innovative micro reaction field (Development of core technologies for advanced components to create new industries) - Development of technologies for innovative components using high-function composite metallic glass
Ministry of the Environment		- Environmental technology development and promotion operations utilizing nanotechnology

5 Energy

Japan stipulated the Basic Energy Plan (Cabinet decision: March 2007) based on the Basic Act on Energy Policy (Act No. 71 of June 2002) and promotes measures concerning supply and demand of energy in a comprehensive and systematic manner on a long-term basis.

(1) Diversification of energy sources

(Promotion of the use of nuclear energy)

Nuclear energy is quasi-domestic energy that contributes to measures for preventing global

warming since it does not discharge CO_2 in power-generating processes with excellent property in supply stability. Today, nuclear power generation accounts for approximately 30% of the total power generation in Japan, and it is planned that nuclear power will be promoted, while being positioned as the core power source in the future.

Research, development, and utilization of atomic energy in Japan have been conducted according to the Atomic Energy Basic Act (Enactment in December 1955), solely for peaceful purposes, based on the premise of ensuring safety, and the government has been steadily promoting the research, development and utilization of nuclear energy based on the Framework for Nuclear Energy Policy (October 2005) and the Basic Energy Plan.

1) Next-generation light water reactors (LWRs)

At present, as for LWRs which is the mainstream of nuclear reactors in Japan, the domestic next-generation LWR has been developed with full cooperation of governmental and private sectors in preparation for the large-scale demand for replacement of the existing nuclear power plants (NPPs) in Japan, which is expected to begin in approximately 2030. In 2008, this development was indicated as innovative technology from which a large reduction effect is expected in the Environmental Energy Technology Innovation Plan prepared by CSTP, and it was determined that it would be implemented strategically.

2) Fast Breeder Reactor (FBR) cycle technology

The Fast Breeder Reactors (FBR) remarkably improves the efficiency of uranium resource use because it generates fuel significantly more fuel than that consumed while generating electricity. Therefore, FBR contributes greatly to stable energy supply in Japan. In addition, it decreases the yield of high-level radioactive waste by reusing minor actinide contained in the used fuel as fuel, and also reduces the burden per generated energy to the environment. Therefore, its development is highly meaningful.

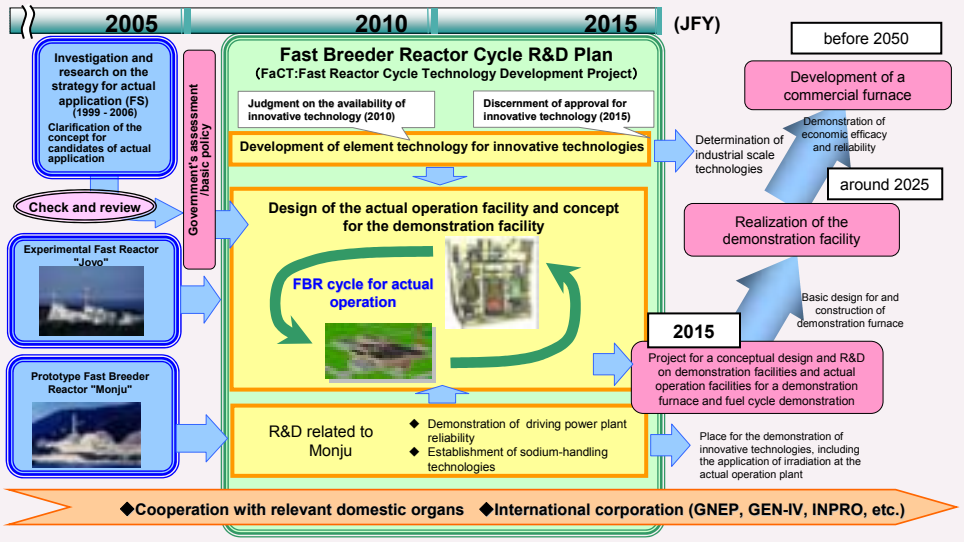
Prototype Fast Breeder Reactor "Monju" (Tsuruga, Fukui)
Photo: Japan Atomic Energy Agency

The FBR cycle technology is positioned as strategically prioritized S&T and the Key Technologies of National Importance in the sectoral promotion strategy (March 2006) under the Third Basic Science and Technology Plan. In the Environmental Energy Technology Innovation Plan (May 2008), it is indicated as innovative technology from which a large reduction effect is expected and was determined that R&D would be promoted strategically. In March 2007, the government states in the Basic Energy Plan that the FBR cycle technology will be promoted as one of the top-priority issues of the nation.

With regard to R&D for the FBR cycle technology, the FBR Cycle Commercialization R&D program is now proceeding in which the innovative technology to be adopted for practical

operation will be determined in 2010 and the concept designs of the actual and demonstration plants will be presented in 2015. Thereafter, construction of the demonstration plant will be completed in about 2025, and the commercialization of a reactor will be started before 2050 (Figure 2-2-5).

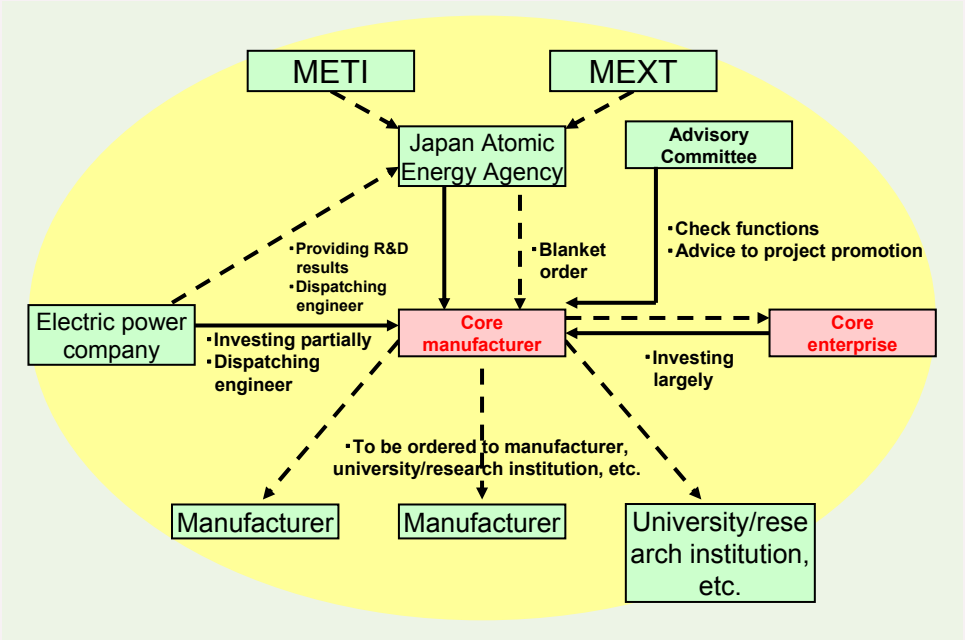
Figure 2-2-5 Fast Breeder Reactor Cycle R&D Plan



The prototype FBR "Monju" is positioned as the core for R&D for FBR cycle technology, and the initial goal of establishing its reliability as a power generation plant as well as the development of sodium handling technologies within the estimated period of about 10 years should be achieved on schedule. Therefore, the Japan Atomic Energy Agency (JAEA) completed modification work in May 2007 and is implementing their work, while placing the ultimate priority on the safety toward resumption of operation, including execution of tests to validate soundness of the entire plant.

In addition, with the recognition that achieving a smooth transition from the R&D phase to demonstration and commercialization via cooperation between the R&D side and the introduction side is important for future practical use, five-way talks including METI, MEXT, electric power utilities, manufacturers, and JAEA started reforming the development system for FBR and preparation for shifting the cycles from light water to fast breeder reactors (Figure 2-2-6).

Figure 2-2-6 R&D System for the Basic Design of Fast Breeder Reactor



3) Uranium enrichment and advanced fuel

Since Japan relies on imports for most of its energy resources, the government is steadily promoting efforts to establish the fuel cycle through effective utilization of the recovered plutonium, etc., from the reprocessing of spent nuclear fuel, in order to secure long-term energy supply stability in view of the future energy supply and demand in the world, and to reduce the load on the environment.

The government strives to ensure the transparency of plutonium use, not only through the rigorous management of nuclear materials, but through clear observation of the principle of never holding plutonium that is not required to implement current programs, so as to avoid arousing international concerns regarding the proliferation of nuclear weapons. The Cabinet Office therefore reports and discloses the use and management status of plutonium in Japan to the Nuclear Energy Council every year (reported on September 9, 2008).

In order to stably secure requirements, from the viewpoint of assuring stable energy supply, for uranium resources and respective processes of nuclear fuel cycle that are required for light-water nuclear reactors in Japan, concerning the enriched uranium used as fuel in nuclear power generation, Japan promotes the development of domestic uranium enrichment projects, while endeavoring to maintain economic efficiency. At present, R&D of an advanced centrifugal machine having higher performance and excellent economic efficiency is in progress with close cooperation of governmental and private sectors, aiming for introduction in the end of FY 2010.

4) Spent fuel reprocessing technology

Tokai reprocessing facilities
Photo: Japan Atomic Energy Agency

In view of the principle that spent fuel should be reprocessed domestically in Japan, construction is underway on a private-sector reprocessing facility (with an annual reprocessing capacity of 800 tons) in Rokkasho-mura, Aomori Prefecture, and testing at the final stage (active testing) is in progress using the spent fuel aiming at the completion of construction in August 2009. Construction and operation of the Rokkasho reprocessing plant is aimed at steady establishment of the reprocessing technology on a commercial scale, as well as the evolution toward establishment of the nuclear fuel cycle.

Furthermore, at present, the Tokai Reprocessing Plant is reprocessing expended uranium fuel used in the Advanced Thermal Reactor "Fugen."

5) Geological disposal of high-level radioactive waste

Geological disposal technology of high-level radioactive waste, one of the strategically prioritized S&T, is essential for Japan to move forward with a disposal project and to support the national safety regulations by continuously implementing R&D for greater improvement of reliability. R&D of this technology is being conducted in close cooperation with the relevant research institutions centered on JAEA. In addition, JAEA develops two underground research laboratory programs in Mizunami, Gifu Prefecture (crystalline rocks) and in Horonobe, Hokkaido Prefecture (sedimentary rocks).

6) Technologies for decommissioning nuclear facilities and treatment/disposal of radioactive waste

It is important that decommissioning of nuclear facilities and treatment/disposal of radioactive waste should be conducted under the responsibility of nuclear facility establishers and radioactive waste generators in a planned and efficient manner. JAEA is developing the technologies needed to achieve safe and reasonable treatment, disposal, and reduction of the generated radioactive wastes as well as the recycling of resources. The Advanced Thermal Reactor "Fugen," which had been undergoing independent development as a nuclear reactor featuring the ability to flexibly and efficiently utilize plutonium, recovered uranium and other fuel, terminated its operation in March 2003. The facility is scheduled for reorganization into the Decommissioning Engineering Center in February 2008 to break up equipment, while executing investigations and research on safety demonstration; the project will be completed by FY 2028.

7) Fusion energy

Fusion energy is expected to be one of the future solutions to energy and global environmental problems at the same time for the following reasons: (1) fuel resources would not be depleted because they can be obtained from seawater, (2) no greenhouse gases are emitted

during the process of electric generation, (3) it generates large amounts of electric power from small quantities of fuel (1g of fuel generates energy equivalent to 8 tons of petroleum). Therefore, fusion energy is expected to be one of the future solutions to energy and global environmental problems at the same time. As for fusion energy, JAEA, the National Institute for Fusion Science (NIFS), universities, and other organizations promote R&D through their mutual cooperation, while efficiently utilizing international cooperation.

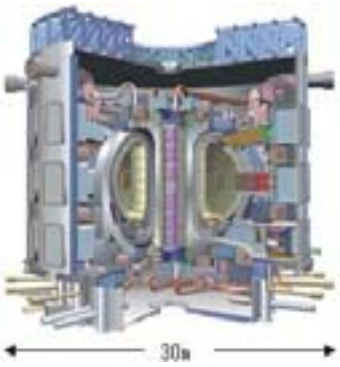
In Japan, R&D have been promoted by using three types of reactors including a tokamak type[1] (critical plasma test equipment JT-60, JAEA; its operation was stopped in August 2008 for replacement to superconductive type); a helical type[2] (large helical device LHD, NIFS); and a laser type[3] (GEKKO XII, Institute of Laser Engineering at Osaka University), and the achievements are leading the world.

Critical plasma test equipment JT-60
Photo: Japan Atomic Energy Agency

Large Helical Device (LHD)
Photo: National Institute for Fusion Science

Implosion Laser "GEKKO XII" (Right)
and Heating Laser "LFEX" (Left)
Photo: Osaka University

Furthermore, Japan takes an active role in participating in the ITER (International Thermonuclear Experiment Reactor) Project[4], which aims for demonstrating S&T feasibility of fusion energy. Japan also implements "broader approach" activities on the advanced R&D project that complements and supports the ITER Project within the country through Japan-Europe cooperation. Production of equipments, Japan is involved in their procurement, and the improvement of Japanese site for ITER Rokkasho is now proceeding steadily.



International Thermonuclear Experiment Reactor (ITER)
Photo: ITER Organization

8) Basic and generic R&D for atomic energy

Basic and generic R&D for atomic energy is important to support utilization and development of atomic energy, such as to maintain the technical basis concerning atomic energy utilization at a high level, as well as to create new knowledge and technologies. JAEA conducts

1 Tokamak type achieves nuclear fusion in the processes to create twisted magnetic fields caused by those generated by coils and plasma current, thus confining heating plasma
2 Helical type achieves nuclear fusion in the processes to twist the coils themselves to create twisted magnetic fields, thus confining heating plasma.
3 Laser type achieves nuclear fusion in the processes to heat the nuclear fusion fuel having ultra high density that is imploded by irradiating laser beams with an ultra high intensity laser.
4 ITER Project is an international joint research and development project which intends to construct and operate a thermonuclear experiment reactor in France, in cooperation with 7 parties; Japan, Europe, the US, Russian Federation, China, the Republic of Korea and India.

basic and generic research projects concerning: nuclear and reactor engineering, fuel and material engineering, environmental and radiation engineering, advanced basic research, and advanced computational science and technologies. In addition, MEXT determined strategic program themes which clarified policy needs for the enhancement and strengthening of basic and generic research, and launched the Initiatives for Atomic Energy Basic and Generic Strategic Research [literal translation] in FY 2008, aiming at the promotion of research conducted in a competitive environment.

9) Nuclear non-proliferation

Japan concluded the full-scope safeguards agreements with IAEA in 1977 in response to the ratification of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1975 and accepted the “safeguards" of IAEA, which is a measure for preventing nuclear materials from being diverted to nuclear weapons and established the domestic safeguards system based on related laws and regulations. Furthermore, Japan implemented physical protection (PP) to prevent theft of nuclear materials or attempts to sabotage nuclear facilities based on the international guidelines. In addition, Japan promotes the development of technologies that are required for implementing the above-stated measures. Regarding the safeguards, after the conclusion of the Agreement, Japan received the conclusion from IAEA that there had been no diversion of the declared nuclear materials into nuclear weapons. Furthermore, in 1999, Japan concluded the additional act for enhancing the safeguards to positively deal with enhancement and promotion of streamlining of the IAEA safeguards. As a result, IAEA first concluded in its Safeguards Statement in 2004 that, concerning the status of Japan as of 2003, no undeclared nuclear materials exited and “all nuclear materials remained in peaceful activities" and the conclusion has been maintained ever since. Based on the conclusion, the Integrated Safeguards have been implemented, making its safeguards more efficient through reduction in the number of inspections. In 2008, the world’s first Site-Level Integrated Safeguards Approach including the facilities handling plutonium were developed in order to progress the Integrated Safeguards with a view to both effect and efficacy, and implemented at the JNC-1 site (JAEA).

At the Rokkasho Reprocessing Plant where full operation is scheduled to start in 2009, the advancement of its integrated safeguards approach and the identification of safeguard equipments’ performance. At the Rokkasho MOX (Uranium-Plutonium Mixed Oxide) fuel fabrication facility which will be constructed in the future, the integrated safeguards approach is being established for the implementation of effective and efficient safeguards. The government started designing system for the purpose of being able to play a proactive role in finding solutions to the safeguards by contributing to realization of effective and efficient international safeguards.

In addition, JAEA actively implements technology development related to safeguards and nuclear nonproliferation. The government also organizes an international training course for the improvement of technologies for nuclear materials accounting. Japan ratifies the Comprehensive Nuclear-Test-Ban Treaty (CTBT) banning any nuclear explosion and makes every effort to improve international monitoring systems concerning radioactive nuclides.

10) Innovative nuclear energy system including a high-temperature gas-cooled reactor

JAEA promotes performance evaluation of the high temperature gas-cooled reactor by means of the test operation of the High Temperature Engineering Test Reactor (HTTR) as well as R&D of the IS process in which hydrogen is produced by pyrolysis of water, in order to establish high temperature gas-cooled reactor technology, which allows for various types of energy supply and heat utilization technologies such as hydrogen production. In FY 2008, JAEA initiated the preparation of a long-run test of HTTR at the rated output of 30 MW and output coolant temperature of 950 degrees centigrade which will be adopted after FY 2009, and also safety verification test at the flow rate of zero in the cooled reactor.

High Temperature Engineering Test Reactor (HTTR) (Oarai R&D Center, Oarai-cho, Ibaraki)
Photo: Japan Atomic Energy Agency

(Ensuring nuclear safety)

Safety is the indispensable prerequisite for the research, development, and utilization of nuclear energy. Enforcement of stringent regulations and safety management as well as execution of safety research, are essential to ensuring safety. Moreover, in recognition of the impossibility of eliminating the occurrence of accidents to 0%, there is also a need to establish countermeasures in the case of an accident to ensure that damage to the lives and health of local residents, etc. can totally be eliminated.

As for research, development and utilization of nuclear energy in Japan, the government imposes stringent safety regulations on nuclear facilities in terms of design, construction and operation stages according to the Nuclear Reactor Regulation Act to levels that are not seen in any other industrial sectors in Japan. In addition, regarding radioactive isotopes and radiation generators used in the medical, agricultural, and industrial sectors, the government implements safety regulations based on the Act Concerning the Prevention from Radiation Hazards due to Radioisotopes and Others to prevent radiation hazards resulting from the use.

As for nuclear emergency countermeasures, efforts to expand and strengthen nuclear disaster measures are now being promoted based on the Act on Special Measures concerning Nuclear Emergency Preparedness, including dispatch of senior specialists for nuclear emergency preparedness, designation of Off-site Emergency Centers and implementation of emergency drills.

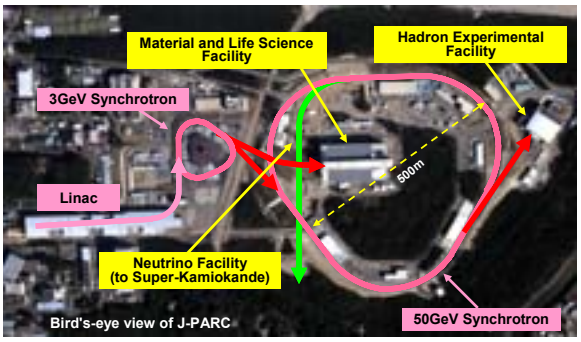
For surveys of environmental radiation, MEXT and other relevant ministries and agencies, prefectural governments and atomic energy utilities continue to conduct radiation surveys in areas surrounding nuclear facilities. In addition, they conduct surveys concerning environmental radioactivity levels in Japan, as well as radiation surveys of nuclear-powered military vessels when they enter ports in Japan. In FY 2007, the Nuclear Safety Commission of Japan conducted an interim assessment on the progress status and utilization of achievements of the Prioritized Nuclear Safety Research Program, and revised the program in June 2008 based on the results.

(Promotion of nuclear S&T, and development of infrastructure for research, development and utilization of nuclear power)

1) Promotion of quantum beam technology

Quantum beam technology using an accelerator and high power laser is applied for a wide variety of purposes, from academic research, such as exploration of the fundamental principles of nature, to use in the industries.

Japan Proton Accelerator Research Complex (J-PARC Project), which is the maximum level proton accelerator facility built jointly by JAEA and the High Energy Accelerator Research Organization (KEK), is expected to contribute to R&D over a variety of fields including life science, material science, nuclear physics and particle physics through the application of secondary particles including the neutron, meson, and neutrino released from the proton accelerator with global maximum level of beam intensity. Neutron beams were added from December 2008. In addition, RIKEN promotes the project of RI Beam Factory (RIBF), an accelerator facility that generates beams of all types of radioactive isotopes (RI), from hydrogen to uranium, with the highest intensities in the world.



Japan Proton Accelerator Research Complex (J-PARC)
(Tokaimura, Ibaraki)
Photo: J-PARC Center

Superconducting Ring Cyclotron in the RI beam factory
Photo: RIKEN Nishina Center for Accelerator-Based Science

2) Dissemination of radiation utilization

Since radiation is used in a wide range of fields from basic and applied research to practical use in medicine, engineering, agriculture, etc. It is important to promote the dissemination of radiation utilization while conducting the research and development.

As for the state of radiation utilization in the respective fields, diagnostic technology using radioactive rays and treatment of cancer were partly put into practical use in the medical field. For example, treatment using particle beams has advantages that it gives less burdens to patients since surgery that accompanies anesthesia or incisions is not required. In the agricultural sector, radiation is used for the extermination of harmful insects and improvement of crop varieties. Academic research, such as studies on the movement of water and the accumulation of harmful metals in plants, has been conducted. In the industrial field, radiation is used for the production of semiconductor devices and radial tires. In addition, radiation is actively used in the reform and manufacture of various types of industrial products, and in the sterilization of medical devices.

3) Fostering and acquiring nuclear technicians

In order to advance R&D and the utilization of nuclear power while securing safety, it is necessary to train and acquire high-talent personnel who can support them. MEXT and METI have implemented the Nuclear Technician Training Program [literal translation] to support the education of the students who wish to become nuclear technicians in universities and colleges of technology. In addition, the training of nuclear technicians has been discussed at the Conference of Nuclear Technician Trainers [literal translation] by industry-academia-government collaboration.

4) Disposal of radioactive waste

At present, radioactive waste that is generated from research institutes and medical facilities is not disposed of but stored by individual entities, however, it is an important subject to realize the disposal of this waste for the smooth promotion of research, development and utilization of nuclear energy in the future.

To this end, the Act on the Japan Atomic Energy Agency was partially revised on June 2008 (Enforcement in September 2008) to establish a system for JAEA, which releases the largest amount of waste and which, therefore, has technical knowledge on waste treatment, to discard waste and the wastes released from other business offices together. Based on the revision, MEXT and METI prepared the Basic Policy on the Underground Waste Disposal Business [literal translation] in December of the same year.

5) Efforts for assuring trust and coexistence with communities

In order to smoothly promote research, development, and utilization of nuclear energy, it is extremely important to obtain public confidence in nuclear power, and nuclear power operators must build up a record of safe operations, and strive to win public trust. To this end, activities to enhance the understanding by the public of nuclear energy are being implemented via two-way and transparent communication with the public through public hearings and public relations programs, as well as through the support of education programs at schools by sponsoring seminars for school teaching personnel concerning nuclear energy and lending out simplified survey meters.

Furthermore, to promote the coexistence of nuclear power research facilities and regions where such facilities are located, voluntarily executed programs in such regions are being supported by utilizing subsidies under the three basic acts related to power source setting and other measures.

6) International nuclear power cooperation

Japan has implemented active international nuclear cooperation under the basic premises of ensuring peaceful use, securing nuclear non-proliferation, nuclear safety, and ensuring nuclear security.

For nuclear cooperation with Asian countries, Japan has implemented projects related to nuclear infrastructure development, including the application of radiation to medicine,

agriculture and industry, and creating a culture of nuclear safety, and radioactive waste, under the framework of FNCA[1], in which Japan plays a leading role,. Japan also promotes cooperation with other countries as seen in the minister-level meeting held in the Philippines in November 2008. In addition, Japan offered technical support, exchange of researchers and training for Asian countries under the framework of RCA[2], and worked to help improve the qualifications of nuclear-involved personnel.

As for R&D for next-generation of nuclear energy systems, Japan actively participated in GIF[3], and signed the memorandum of understanding (MoU) on the sodium-cooled fast reactor, in particular among JAEA, the French Atom Energy Agency (CEA), and the U.S. Department of Energy (DOE), and strengthened partnerships with each other[4]. In addition, Japan participated in GNEP[5] proposed by the US and assumed the position of vice-chairman of the operation group, thus playing the central role in operations. In particular, with the US, Japan drafted the United States – Japan Joint Nuclear Energy Action Plan, and promoted R&D and support for construction of new nuclear power plants under the framework of GNEP vision. Moreover, Japan continues to provide multilateral support through extra-budgetary contribution funding to IAEA and OECD/Nuclear Energy Agency[6].

(Promotion of the use of renewable-energy)

Renewable-energy, including solar energy, biomass and waste energy, and wind energy, have problems, such as instability of power generation and higher cost, however, since they have advantages, including the potential contribution to addressing global warming and relatively limited resource constraint, it is necessary to actively promote technology development in order to solve the above problems, and thereby, to facilitate its introduction and dissemination.

Photovoltaic power generation system installation in test site area ("Pal Town Josai-no-Mori," Ota-shi, Gunma)

Photo: New Energy and Industrial Technology Development Organization

1) Photovoltaic power generation

Photovoltaic power generation has been spreading as its price fell. Nevertheless,

1 Forum for Nuclear Cooperation in Asia: A framework aiming to promote the peaceful and safe utilization of nuclear technologies in Asian countries, thereby promoting their social and economic growth. Ten countries participate in the Forum, including Japan, Australia, Bangladesh, China, Indonesia, Korea, Malaysia, the Philippines, Thailand, and Vietnam.

2 Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology: A framework aiming for promotion and coordination of joint research, development, and training plans concerning nuclear science and technologies intended for developing countries in the Asia-Pacific region through mutual cooperation of the signatory countries and IAEA, as part of the IAEA activities. The signatory countries cover ten countries, including Japan, Australia Bangladesh, China, India, Indonesia, Korea, Malaysia, Mongolian People's Republic, Myanmar, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, and Vietnam.

3 Generation-IV International Forum: Cooperation that is based on the agreement for further promoting research and development of next-generation nuclear systems (the fourth generation) through international cooperation, with twelve participating countries, including Japan, Argentina, Brazil, Canada, China, France, Korea, Republic of South Africa, Switzerland, England, and the US as well as EURATOM.

4 International cooperation for the sodium-cooled fast demonstration reactor among three organization. Three organizations signed MoU on the fast demonstration reactor on January 31, 2008, to strengthen the R&D cooperation on the sodium-cooled fast demonstration reactor. Its MoU was revised to add the utilization of "Monju" data and to strengthen this cooperation further in August of the same year.

5 Global Nuclear Energy Partnership: An initiative for developing and expanding nuclear power generation globally, while ensuring nonproliferation called for by the US. At present, 21 partner countries participate in the initiative including Japan, the US, France, China, and Russia.

6 OECD/NEA: Organization for Economic Cooperation and Development/ Nuclear Energy Agency

development of technologies that further lower costs is essential for the early establishment of a truly independent market. For this purpose, METI promotes the development of technologies that achieve lower costs and higher levels of efficiency, as well as the development of recycling and reuse technologies.

2) Biomass energy

Based on the Biomass Nippon Strategy (Cabinet decision: March 2006), MIC, MEXT, MAFF, METI, MLIT and MOE promote R&D into technologies for the efficient conversion of animal wastes, wood residues, organic sewage, food wastes, and other biomass sources into energy resources.

In particular, regarding biofuel, large-scale demonstration projects toward full-scale introduction of bio-ethanol were conducted in Hokkaido (two locations), Niigata, Osaka, and Okinawa. In addition, development of technologies to effectively produce ethanol from cellulose-based raw materials, such as rice straw and wood, which will not compete with food supply, is being selectively promoted.

(Hydrogen energy/Fuel cells)

It is necessary to promote R&D of a fuel cell system that excels in environmental characteristics, allows for utilization of various energy resources, and has potential energy conservation effect in the civilian and transportation sectors, as well as R&D of production, storage and transportation technologies of hydrogen which is used as fuel of the fuel cell system.

In particular, since fuel cells, which directly generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and do not emit greenhouse gases, they are expected to be key technology for energy and environmental fields. For this reason, METI promotes R&D of elemental technologies of the main unit of the fuel cells, R&D of their utilization technologies in production, transportation and storage of hydrogen fuels, and demonstration of large-scale fuel cell systems for household use, as well as experimental study on fuel-cell-powered vehicles and hydrogen supply system. MLIT supports technology development of energy conservation system with fuel cells to be equipped in residences.

(Promotion of development and utilization of fossil fuels)

1) Petroleum

In response to the requirements for dealing with polymerizatin[1] of crude oil and lightening[2] of the demands of petroleum products, and to promote sophistication of oil factories, METI promotes projects for the development of innovative oil refining technologies and a technology to produce petrochemical feedstock of high value from heavy-gravity crude oils.

In addition, it becomes important to develop technologies that allows for promotion of energy conservation and resource saving by means of the advancement and improved efficiency

1 Polymerization: Increase of the ratio of heavy crude oil with heavy gravity.
2 Lightening: Increase of a relative percent of the light petroleum products such as gasoline and kerosene compared with heavy gravity petroleum products such as heavy fuel oil in domestic demand.

of petroleum refineries as well as cooperation with various industries in petrochemical complexes. For this purpose, METI develops technologies, including promotion of process streamlining in oil factories, and effective utilization of by-products that are produced in petrochemical complexes.

2) Coal

Coal offers excellent supply stability compared to petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, R&D is needed to reduce its burden on the environment. For this purpose, METI promotes the development of clean coal technologies for the Integrated coal Gasification Combined Cycle (IGCC) and the Integrated coal Gasification Fuel cell Combined Cycle (IGFC) which are highly efficient power generation systems capable of reducing carbon dioxide emissions.

In addition, R&D of Carbon Dioxide Capture and Storage (CCS) technologies is being conducted from medium- and long-term viewpoints.

3) Natural gas, etc.

Because natural gas has lower carbon dioxide emission and less environmental burden than other fossil fuels, promotion of R&D into its utilization is therefore of importance. Consequently, METI promotes research into technologies for the manufacture and utilization of liquid fuels (GTL, or Gas-to-Liquid) and dimethyl ethyl (DME), obtained by converting natural gas into liquid fuel, which should lead to the expansion of natural gas use. The ministry also promotes the R&D of new exploitation technologies for the utilization of methane hydrates, believed to be available as an energy source in relatively large quantities from the seas around Japan.

(2) Promotion of countermeasures for energy conservation

From the viewpoint of preventing global warming, effectively utilization of limited energy resources, it is important to carry out R&D to improve efficiency in specific individual devices and element technologies and to promote R&D for improving energy supply and utilization efficiency of energy systems throughout social systems through the use of unused energy. It is also necessary to promote R&D from the viewpoint of reducing all energy (life cycle energy) that is directly or indirectly consumed in the process of the production, use, re-use, and disposal of various products.

For this purpose, METI established a strategy for the development of energy conservation technologies aiming, from discovery to commercialization of a new technology, and thereby to enhance the effectiveness of energy conservation technology development. The ministry promotes strategic research and development.

(3) Other

Issues concerning energy and environment are synthesizing issues that require research from aspects of both natural science and social science. Table 2-2-7 shows major research topics in the energy sector (excluding nuclear power) implemented during FY 2008.

Table 2-2-7 Major Research Projects in Non-nuclear Energy (FY 2008)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	- Assurance of safety measures that respond to new technologies and new materials
Ministry of Education, Culture, Sports, Science and Technology	National universities and other institutions	- New energy and energy efficiency R&D - The Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes - Development of fuel cells featuring higher performance and lower cost than conventional type
	National Institute for Materials Science	- Development of new heat-resistant materials that resist long-hour use at ultra high temperatures - Development of ultra-light and high-intensity structural materials featuring excellent workability that contribute to efficient use of energy
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	- Development of biomass utilization technology for local revitalization
Ministry of Economy, Trade and Industry		- Experimental study on fuel cell systems - Development of solar photovoltaic technology for energy-saving and reduced environmental burden - Development of innovative technologies including those for petroleum refining that respond to heavier-gravity crude oil - Development of technologies that fuses advanced functions of petroleum refining within industrial complexes - Development of hydrogen energy technologies - Development of technologies related to GTL fuel and dimethyl ether fuel - Development of methane hydrate technologies - Research and development into clean coal technologies - Development of energy conservation technologies/energy-saving technologies – Research and development for CO_2 heat pump water heater with higher efficiency and reduced size – Development of element technologies for practical use of high-efficiency gas turbine – Development of high-efficiency lighting equipment using organic electro-luminescence (organic EL) – Development of electric double-layer condenser using carbon nanotube – Study on carbon-fiber reinforced composite materials for weight saving of automotives – Development of core technology concerning next-generation low power consumption semiconductors – Development of core technologies of inverter by using high-performance power device (power element - Development of technology for distributed energy network systems - Development of technologies for sequestration and effective use of carbon dioxide
	Advanced Industrial Science and Technology	- Technologies for distributed energy network systems - Development of new fuel technologies including clean diesel engines - Development of technologies for manufacturing ethanol from wood-derived biomass
	New Energy and Industrial Technology Development Organization	- Development of technologies of small-output fuel cells that could be compact mobile power sources - Development of technologies for new use pattern of fuel cells - Development of technologies for practical use of fuel cells (polymer electrolyte fuel cells) that use ion-exchange membrane as electrolyte - Maintenance project for building common infrastructure of hydrogen society - Development of technologies concerning hydrogen manufacturing through gasification of coal and coal - Basic research project for advanced hydrogen science - Research and development of new energy technologies - Development of technologies for practical use of next-generation battery systems - Development of technologies including stabilizing of electric power systems of wind-power generation - Large-scale demonstration concerning dissemination of mixed with 3% ethanol - Research and development of basic technologies for application of superconductivity - Strategic development of technology for streamlined energy use
	Japan Oil, Gas and Metals National Corporation	- Promotion of development and utilization of oil and natural gas

Ministry	Research organization	Subject
Ministry of Land, Infrastructure, Transport and Tourism	Housing Bureau	- Development of technologies for an energy conservative system that uses fuel cells equipped in buildings or houses [literal translation]
	National Maritime Research Institute	- Research contributing to the prevention of global warming derived from CO_2 emission from ships [literal translation] - Research for the creation of an estimation technique for CO_2 emission from foreign shipping, which is an international issue [literal translation]
	Port and Airport Research Institute	- Research on understandings of coastal and offshore wind condition characteristics as well as utilization of wind energy

6 Monodzukuri Technology

The Monodzukuri (manufacturing) industry is the field with the highest international competitiveness among all industries, and is a lifeline for Japan. It also has a large ripple effect on other industries and serves as a driving force for economic growth.

Under the Third Science and Technology Basic Plan, Monodzukuri technology is being promoted in order to clearly show the viewpoint that it strengths the ability of value-creating Monodzukuri, which aims for the development of S&T that raises the value of "things (mono)" by stepping out of the conventional development framework of manufacturing technology.

(1) Promotion of Monodzukuri technology with a common basis

As strategically prioritized S&T, MEXT promotes the development of the "only one, number one" measurement analysis technology and devices that are able to respond to the needs of advanced researchers and on-site manufacturing. Moreover, MEXT has developed close industry-academia collaboration systems, and promotes R&D on high-performance, state-of-the-art, advanced, complicated, and large-scale simulation software in the area of Monodzukuri.

METI promotes the development of technology for manufacturing highly integrated complex Micro Electro Mechanical Systems (MEMS), which features compact and high-precision and excellent energy saving characteristics in versatile sectors, including automobile, telecommunications, safety and security, environment, and healthcare. In addition, METI implements the development of manufacturing technologies of the different-fields cooperating in the Bio Electoro-mechanical Autonomous Nano Systems (BEANS) that integrate MEMS technology, biotechnology, and nanotechnology. Further, METI promotes the development of robot technologies that are utilized in the manufacturing sector. With these projects, the ministry supports creation of innovation in Monodzukuri.

(Support for the advancement of core monodzukuri technology at SMEs)

The wellspring of international competitiveness of Japan's SMEs, whose excellent technologies play key roles in production, including casting, forging, and plating, lies in the point that SMEs are working closely on details with downstream companies in the course of developing and manufacturing products and parts.

Those SMEs are, however, facing various difficulties, including greater risks caused by sophistication and specialization in their technologies. To this end, METI deployed supports to R&D concerning core manufacturing technologies and implemented promotion of information

sharing between upstream and downstream industries as a means to establish the environment for solving the problems.

1) Support for R&D by manufacturing SMEs

Among the technologies specified in the Guidelines for Advancement of Specific Core Manufacturing Technology [literal translation] under the Act on Technology Advancement of SMEs (Act No. 33 of 2006), the guidelines for the technologies related to embedded software, metal molds, the mounting of electronic parts and devices, polymer processing, powder metallurgy, forging, molding, metal pressing, and heat treatment, were revised.

In addition, the government also approved and supported plans of specific R&D prepared by SMEs based on the guidelines.

Furthermore, efforts by SMEs to undertake innovative, high-risk R&D, R&D to realize innovation in production processes were supported. Expenses for patent application of achievements obtained through the plans of specific R&D by SMEs were mitigated, low-interest financing by Japan Finance Corporation, and other projects were implemented.

2) Enhancement of the environment for the advancement of core manufacturing technology

Support was provided for activities to create “opportunities of meeting" of SMEs and downstream companies, including allocation of personnel who coordinate and fine-tune cooperation between SMEs which play key roles in core technologies and industries, establishment of opportunities for information exchange between them.

Furthermore, very versatile software that digitizes, systemizes, and accumulates tacit knowledge, including design and processing know-how of experienced technicians owned by manufacturing SMEs, was developed. At the same time, in order for SME manufacturers without experience in designing software to create business software (production management, quality control, shipment management, etc.) and utilize accumulated know-how, etc., in their production activities, tools to support creation of such software were developed and provided to SMEs. In this way, continuation of core technologies owned by SMEs was supported.

Serving as "shelters" for SMEs with problems involving intellectual property, societies of commerce and industry and chambers of commerce and industry across the country served as one-stop access points for advice and consultation. Seminars on prevailing corporate activities focused on intellectual property also were staged in various places around the country.

(2) Promotion of Monodzukuri technology with groundbreaking, dramatic development expected

METI implements the Project for Strategic Development of Advanced Robotics Elemental Technologies, which executes development of state-of-the-art technologies (for industrial, service and special environment use) toward realization of mission-oriented competitive advanced robot within the scope of the Strategic Technology Roadmap.

Such projects are expected to lead to innovative and dramatic development of manufacturing

processes, thus making significant contributions to the enhancement of industrial and international competitiveness.

(3) Development, fostering competent persons, and the inheritance and deepening of skills among them

Monodzukuri is the field that can be referred to as the lifeline of our country, but shortage in the aspects of both quality and quantity of competent persons who support Monodzukuri is assuming serious proportions.

To solve this problem, MEXT is working on establishment of systems concerning development of competent persons and other versatile creative measures, covering the elementary, lower secondary education, upper secondary education, and even lifelong learning stages.

In elementary, lower secondary education, education concerning Monodzukuri in related subjects is provided from the elementary school stage based on the National Curriculum Standards. In particular, at specialized upper secondary schools, the Project to Foster Competent Persons for Local Industries [literal translation], which aims to develop specialist business workers matching the specific characteristics of each region is being carried out in cooperation with local industries.

For upper secondary stages, under the Project to Foster Practical Competent Persons by Industry-Academia Collaboration: Towards Fostering Monodzukuri Engineers [literal translation], Monodzukuri engineers with advanced knowledge and technologies who are capable of innovating manufacturing are being developed at universities, through the development and implementation of the educational programs organically combined with experiments, practical training and lectures in cooperation with regional communities and industries. In particular, colleges of technology aim to become an attractive option, by conveying their appeal to manufacturing through approaches such as Robot Contest. They also sponsor public lectures to provide manufacturing technologies to local communities.

In the area of lifelong learning, opportunities for career improvement are being amplified through the acceptance of working people at universities and other schools and providing practical training program. It is also intended to foster competent persons for manufacturing by providing children opportunities to experience and learn manufacturing in each region, through approaches such as utilizing citizens' public halls and museums or opening classes in educational institutes to the public. Furthermore, this area also has an aspect to allow senior people to find worthwhile lives and enrich their life after retirement by passing knowledge and experiences of the baby-boomers onto the next generation through related measures.

The major research topics in FY 2008 for the Monodzukuri technology field are as shown on Table 2-2-8.

Table 2-2-8 Major Research Projects in Monodzukuri Technology (FY 2008)

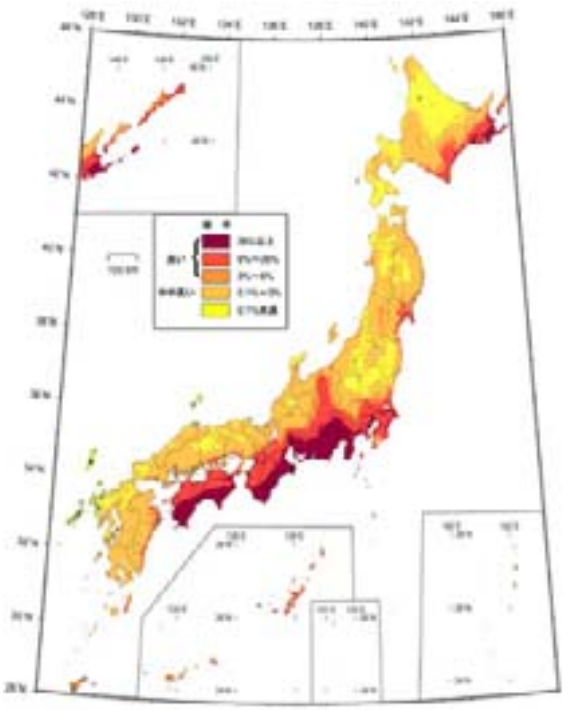
Ministry	Research organization	Subject
Ministry of Education, Culture, Sports, Science and Technology		- R&D on simulation software that becomes the base of innovation creation [literal translation]
	Japan Science and Technology Agency	- Project for the development of advanced measurement analysis technology and device
	RIKEN	- Research on the establishment of technology information integration system in advanced IT
Ministry of Economy, Trade and Industry		- Development of production technologies of different fields-cooperated next generation devices [literal translation]
	New Energy and Industrial Technology Development Organization	- Highly Integrated, Complex MEMS Project - Research and development on ultra-flexible display members - Technology for highly efficient manufacturing of three-dimensional optical device - Project to develop element technologies for strategic, cutting-edge robots

7 Social Infrastructure

Social infrastructure field is a basic one that supports people's lives. In order to achieve a prosperous, secure, safe society, R&D is being promoted so as to contribute to reducing the risks inherent in society and to improving public conveniences.

(Disaster prevention)

Natural disasters bringing enormous damage occurred inside and outside Japan in 2008, including the Iwate-Miyagi Nairiku Earthquake in 2008, earthquake occurred in the northern coastal area of Iwate Prefecture, the torrential rains from July through August, and the Great Sichuan Earthquake in China. These disasters make it extremely important to promote the earthquake-volcano forecasting research and disaster-prevention technologies, aiming at reducing the damage caused by these natural disasters.



Distribution map of probability of ground motions equal to or larger than seismic intensity 6 lower, occurring within 30 years from the present

Source: Headquarters for Earthquake Research Promotion

Earthquake research in Japan is promoted with the collaboration and cooperation among related administrative agencies under policies for the promotion of earthquake research (April 1999) that are stipulated by the Headquarters for Earthquake Research Promotion (Director: Minister of MEXT; hereinafter referred to as the "Earthquake Headquarters") established under the Act on Special Measures concerning the Earthquake Disaster Prevention (Act No. 111 of 1995). The Earthquake Headquarters compiled a final report in April 2009 for preparing a new 10-year plan starting from FY 2009 the New Earthquake Research Promotion [literal translation]. This new plan notes research on

ocean-trench earthquake and the active fault are promoted integrally and strategically within at least the first 10 years while considering the coming 30 years, and their results are applied effectively to the countermeasures for disaster-prevention and disaster-reduction, aiming at establishing circumstances that minimize seismic damage.

Regarding research on seismic/volcanic eruption prediction, the recommendation Promotion of the Observation and Research Plan for the Prediction of Earthquakes and Volcanic Eruptions, which is the first proposal integrating earthquake and volcanic activity, was proposed at CST in July 2008. The new 10-year plan also emphasized the importance of the basic research based on the recommendation and the research will be promoted at universities from FY 2009.

Under the policy of the Earthquake Headquarters, MEXT officially announced the revised edition of the National Seismic Hazard Maps for Japan, which generalized achievements of past earthquake research based on information including evaluation results of major fault zones in Japan in April 2008. MEXT implemented investigations into active fault zones of Itoigawa-Shizuoka geotectonic line, the investigation and observation of the ocean-trench earthquake offshore Miyagi Prefecture, the special project for hazard prevention/ reduction of metropolitan epicentral earthquake for the reduction of metropolitan epicentral earthquake damage, and technology development for a submarine network system known as the Earthquake and Tsunami Observation System [literal translation] equipped with seismographs and water pressure gauges on predicted seismogenic zones of the Tonankai Earthquake. In addition, in FY 2008, MEXT started the multidisciplinary research project on the zones of high strain rate aiming at clarifying the mechanism of earthquake occurring at the strain concentration zones on the East coast of the Japan Sea where earthquake damage has recently increased, and research to evaluate the relationship among the Tokai, Tonankai, and Nankai Earthquakes which are investigated through the wide-area observation of marine earthquakes and simulations to reduce damage caused from potential Tokai, Tonankai, and Nankai Earthquakes.

After the Iwate-Miyagi Nairiku Earthquake in 2008 and the Great Sichuan Earthquake in China, the ministry urgently conducted research under the Grants-in-Aid for Scientific Research and obtained important data concerning these earthquakes.

MEXT promoted the R&D of disaster prevention S&T based on the Research and Development Policy on Disaster Prevention [literal translation] formulated in July 2006 by CST's Subdivision on R&D Planning and Evaluation. In FY 2008, MEXT launched the Program for the Promotion of Disaster Prevention Education Support [literal translation] aiming to conduct projects on disaster education using the results of disaster prevention research and disseminate them throughout the country. MEXT also conducts R&D on the information system for use in time of disaster under the Project on Science and Technology for a Safe and Secure Society.

To acquire and accumulate data on breaking processes of bridge structures, the National Research Institute for Earth Science and Disaster Prevention (NIED) implements R&D using experiments and research on earthquake resistance with a 3-D Full-Scale Earthquake Testing Facility (E-Defense) that contributes to reduction in seismic damage. In addition, NIED conducts

research for the reduction of damage from natural disasters, which includes the highly accurate prediction of rainfall with next-generation high-performance radar (MP radar)[1], the prediction of landslides, windstorms and flood disasters, and the prediction of volcanic eruptions and volcanic disaster. In addition, in FY 2008, as part of the Pioneering Projects for Accelerating Social Return specified in Long-term Strategic Guidelines "Innovation 25" (Cabinet decision: June 1, 2007), NIED initiated research related to the development of the Disaster Risk Information Platform, a system for the collection and distribution of information on various natural disasters in order to deliver detailed disaster information to the public.

JAXA operates the Advanced Land Observing Satellite "DAICHI" (ALOS), which was launched in January 2006, and which observes large scale natural disaster areas and provides imaging to the related disaster prevention facilities. In addition, JAXA implements R&D on highly accurate positioning measurement technology using a quasi-zenith satellite. These technologies are developed and operated as technologies comprising the Key Technologies of National Importance, Earth Observation and Ocean Exploration System, aiming for domestic and international contribution by establishing a global observation and monitoring system using satellites, which is essential for the overall security of Japan.

FDMA promotes R&D on fire prevention, led by the National Research Institute of Fire and Disaster, concerning the assurance of safety of facilities handling hazardous materials in the event of earthquakes, technology to reduce damages of disaster, and research on technologies for disaster countermeasures.

The National Institute of Advanced Industrial Science and Technology (AIST) has promoted the seamless construction of a geological information system which integrates information on sea and land obtained through geological and active fault investigation in the coastal zone in addition to the installation and operation of the integrated groundwater observation stations

Under the Basic Plan for the Ministry of Land, Infrastructure and Transport Technology [literal translation] (MLIT, April 2008), MLIT promotes R&D on technologies aimed at realizing advanced social communities for disaster prevention, which is perfect for precautions against disaster.

The Geographical Survey Institute (GSI) conducts continuous GPS observation by using Electronic Reference Stations[2], observation of crustal deformation and plate motion by using state-of-the-art technologies, including a Very Long Baseline Interferometry (VLBI) and an interferometric SAR, and further analysis of the data obtained from the above-stated observations.

The Japan Meteorological Agency (JMA) establishes and operates observation facilities, and provides centrally integrated information including observation data from relevant institutions. JMA also works together with NIED to conduct R&D toward further advancement of the emergency earthquake alert service.

MRI developed a laser displacement meter in order to increase the accuracy of prediction for the Tokai earthquake, identified the specified accuracy, and succeeded in the observation of

1 MP (Multi-Parameter) Radar: A meteorological radar that uses two horizontal and vertical polarized waves. Compared with conventional radars, accurate estimation of rainfall and distinction of rain and snow are available.
2 As of the end of March 2009, 1,240 stations were established.

displacement due to the slip of the deep fault. In addition, MRI developed the numerical simulation model demonstrating that the initial patterns of earthquakes along with the Nankai Trough agreed with those of past cases.

The Japan Coast Guard (JCG) promotes the geodetic in the sea and investigation of submarine topography and active faults.

(Antiterrorism and public safety measures)

In recent social conditions where international terrorism acts are aggravated, and deterioration of public safety is pointed out, to realize safe society with less crime is one of the most important and urgent needs of the general public. Therefore, it is quite important to further enhance approaches utilizing the most advanced S&T for antiterrorism and public safety measures.

Regarding antiterrorism, to promptly detect hazardous and dangerous materials in advance, MEXT implements R&D by the Science and Technology Promotion Adjustment Expenses and under the Science and Technology for Safe and Secure Society, on systems for the detection of explosive materials, biological agents and chemical agents, and methods for the treatment of dangerous materials in a safe manner, which are based on the excellent original technologies of our country.

In addition, regarding crime-fighting measures, intensive promotion of the development of technologies and systems that can be used at the site of crime prevention, investigation support, and identification is required in order to reduce crime using limited human resources. Therefore, the National Police Agency (NPA) implements the development of technologies to address crimes that use the anonymity of the internet, personal forensic investigation using three-dimensional facial imagery, DNA type analysis research, R&D on equipment to support on-site activities for the treatment of explosives and radioactive materials, substance identification technology for the identification of toxic substances and appraisal of trace evidence, technologies for appraisal and examination that apply the most recent information-processing technology, the technologies for crime prevention, support of investigation based on behavioral science, and R&D related to the technology of appraisal of traffic accidents. JST's Research Institute of Science and Technology for Society (RISTEX) promotes R&D to secure children's safety against crimes.

(Transportation and transit systems)

There is an urgent need to restore the safety and reliability of the means of transportation, which are transportation devices necessary for everyday life of the general public. It is necessary to intensively promote the utilization of new technology to thoroughly prevent accidents and ensure safety by considering the expected demand increase in air transportation in the future as well as human factors such as operators at transportation facilities, and "finding," "decision" and "operation" of car drivers.

NPA, MIC and MLIT implement R&D in relation to a system to support safe driving through coordination with infrastructure, and information processing capacity relevant to safe driving.

In addition, they are working with advanced R&D towards the realization of more safe and

comfortable transportation and transit systems in the future, and upgrade of the information and telecommunications system.

MLIT provides subsidies to the Railway Technical Research Institute in order to promote R&D for the practical use of the superconducting magnetically-elevated train, which is targeted for high speed transportation in the future.

In addition, as for air transportation system, it is expected not only to support the maintenance and improvement of safety and environmental compatibility, but to have ripple effects on a wide range of areas including information and telecommunication, nanotechnology and materials.

MEXT promotes advanced and infrastructural R&D related to aeronautical science technologies corresponding to the social needs of environmental compatibility and security, in light of the Promotion Policy for Research and Development concerning Aeronautical Science and Technology [literal translation] (July 2006) and the Promotion of Research and Development for Silent Supersonic Aircraft Technologies (July 2007) formulated by CST's Subdivision on R&D Planning and Evaluation. Specifically, MEXT works on R&D for technologies to increase the performance of the passenger airliners made in Japan, the technologies to develop a clean engine and a silent supersonic aircraft, and the technologies for all-weather and high-density operations, through JAXA. In addition, the ministry cooperates in air accident investigation carried out by MLIT's Japan Transport Safety Board, using the results of past R&D.

METI promotes R&D on the elemental technologies of aerodynamic design, carbon fiber composit materials, and advanced control systems, aiming at an upgrade of the entire manufacturing industry, including the aircraft industries in Japan, and the streamlined use of energy. Furthermore, in R&D projects of engines for environmentally friendly small passenger aircraft, the ministry implements the development of technologies for practical use of engines in small passenger aircraft in the 50-seat class in which the properties of energy efficiency and silence are dramatically improved. Furthermore, the ministry implements the creation and development of manufacturing and processing technologies for structural components for next-generation aircraft, thereby achieving energy saving and reduction in CO_2 emissions through drastic weight saving of aircraft. Based on the achievements obtained through such projects, the ministry promotes joint research between Japanese and French industries. In addition, the ministry implements surveys concerning technologies that are required for the development of an aircraft which can cruise at high speeds exceeding Mach 0.8 or 0.9 which is the cruising speed of ordinary aircraft with the cooperation of relevant institutions in cooperation with the French Ministry of Ecology, Energy, Sustainable Development, and the Sea. Furthermore, the ministry also implements the development of fundamental technologies for advanced systems that contribute to improved safety and reduced operation costs of aircraft and surveys aiming for pursuing feasibility of the cargo aircraft-X (C-X), the rescue flying-boat (US-2) and other aircraft of the Ministry of Defense to private use.

The Electronic Navigation Research Institute selectively implements R&D on effective utilization of airspace and capacity expansion of flight routes, R&D on capacity expansion of congested airports, R&D of improved safety and efficiency achieved by preventive safety, and

technologies for ensuring security and smoothness of air traffic.

The major research topics in FY 2008 for infrastructure are shown on Table 2-2-9.

Table 2-2-9 Major Research Projects in Infrastructure (FY 2008)

Ministry	Research organization	Subject
National Police Agency	National Research Institute of Police Science	- Research on the improvement of individual identification utilizing three-dimensional facial imaging - Development of methods for identification from biological samples through the single nucleotide polymorphisms (SNPs) analysis - R&D on RN material detection technologies for R (Radiological) terrorism and equipment to support on-site activities [literal translation] - Study on on-site treatment technologies of explosive substances - Research on the sophistication of microphyte samples [literal translation] - Research on speaker recognition techniques adequate for new speech communication methods - Study on case link analysis on enhancement of serial incidents and assumption of profile of criminal - Cognitive science study on information processing ability of drivers - Development of advanced traffic accident analysis technologies
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	- Expenses required for R&D system of fire safety and disaster preparedness technologies
	National Research Institute of Fire and Disaster	- Information system for supporting dramatic improvement in on-site fire-fighting/rescue activities and disaster prevention activities - Reduction in damage of dangerous facilities during large-scale earthquake - Perception of fire behaviors in buildings and facilities designed for various purposes
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	- Special Project for Earthquake Disaster Mitigation in Urban Areas - Assessment of the synchronization of Tokai, Tonankai, and Nankai Earthquakes [literal translation] - Development of Dense Ocean-floor Network System for Earthquakes and Tsunamis - Prioritized observation and research at the distortion-concentrated belt [literal translation] - Promotion of seismic investigation and research (priority investigation and observation) - Promotion of centralization of observed data
	Science and Technology Policy Bureau	- Safe and Secure Science and Technology Project
	Japan Science and Technology Agency	- Advanced integrated sensing technology
	National Research Institute for Earth Science and Disaster Prevention	- Earthquake engineering research utilizing the Three-Dimensional Full Scale Earthquake Testing Facility (E-Defense) - Maintenance, Inspection, etc. of the three-dimensional full scale earthquake testing facility - Renewal of the middle deep layer earthquake observation facilities [literal translation] - Disaster Risk Information Platform
	Japan Agency for Marine-Earth Science and Technology	- Long-period monitoring system of drilling hole
	Japan Aerospace Exploration Agency	- Operation of the Advanced Land Observing Satellite "DAICHI" (ALOS) - High-precision positioning, navigation and timing experimental technology using a quasi-zenith satellite system - R&D on advanced land-observing satellites [literal translation] - Research and development of technologies for higher performance domestic passenger aircraft - R&D on clean engine technologies [literal translation] - Research and development of silent supersonic demonstrator air craft - R&D on all-weather and high-density service technologies [literal translation]
	Special Coordination Funds for Promoting Science and Technology	- Research and development of detection system for nuclear substance concealed in hand-carried baggage
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization	- R&D on an engine for environmentally-compatible small aircrafts
	National Institute of Advanced Industrial Science and Technology	- Maintenance technologies for land-sea integrated, seamless geological information [literal translation]

Ministry	Research organization	Subject
Ministry of Land, Infrastructure, Transport and Tourism	Technology and Safety Division, Policy Bureau	- Development of emergency/alternative transportation support system
	Engineering Affairs Division, Minister's Secretariat	- Development of land monitoring technology aimed at disaster reduction by means of advanced image processing - Development of technology for housing land development and ultra-long-term durable house construction for multi generations
	Road Bureau	- Technologies for executing provision of information, reminder, warning, etc. of traffic events in the range that is not visible directly from drivers
	Ports and Harbours Bureau	- Damage reducing technologies, including enhancement of quake-resistant performance of structures for large-scale earthquakes - Prediction/simulation technologies of local phenomena caused by Tsunami - Technologies dealing with ultra external force generated by great earthquake - National land conservation and sediment budget - Development of drift sand balance control technologies - Evaluation/prediction technologies for inspection/diagnosis and soundness level of structures - Technology for reducing life cycle costs including social capital
	Civil Aviation Bureau	- Technologies for air traffic control/operation support by utilizing IT technologies
	National Institute for Land and Infrastructure Management	- Research on water management method utilizing precipitation prediction information - Research on the method for evaluating the level of social infrastructure development - Research on adequate management method of sewage pipes and drains
	Geographical Survey Institute	- Enhancement and improvement in prediction accuracy of crustal movement monitoring/modeling for reduction of damage caused by earthquake, volcanic eruption, etc.
	Public Works Research Institute	- Technologies for perception of planar analysis information of precipitation by utilizing satellite information, etc. - Technologies for reducing damages, including quake-resistant design of structures for large-scale earthquake - Development of technologies for predicting the danger of landslide disaster caused by heavy rain and earthquake and alleviating damages thereof - Technology for the qualitative improvement of river levees for improving flood control safety - National land conservation and sediment budget - Enhancement of management of social capital, etc., and reduction in life cycle costs
	Building Research Institute	- Development of popular-type of quake-resistant refurbishment technologies - Development of reorganization of cities and buildings that deal with reduced population and aging society with a falling birthrate - Development of technologies for reproducing/utilizing existing stock - Development of technologies for accident risk assessment and improvement in safety and security in residences/buildings
	Japan Meteorological Agency	- Earthquake observation network, earthquake and tsunami monitoring system, etc.

8 Frontier Science

Frontier science is an area to explore and probe the unknown in space and the oceans, and to promote R&D for the development and use as a new area for utilization. In the Third Science and Technology Basic Plan, frontier science is positioned as an area where R&D should be promoted, focusing on R&D issues that must be addressed by the nation. This area aims to contribute to improvement in the safety and security of people's lives, the quality of people's lives, development of economic society, the overall security of Japan, and sustainable development of human beings, by using communication satellites and positioning, navigation and timing systems, earth observation and monitoring systems, and the oceans which have abundant resources.

(1) Space development and utilization

Space development and utilization have deeply infiltrated into the life of the public as seen in the services of weather and communication/broadcast satellites which have become essential for us. The Space Basic Law was enacted in May 2008, and the system for government promotion of space development and utilization in a unified manner was established under the Strategic

Headquarters for Space Policy, chaired by the Prime Minister. In 2009, the Basic Plan for Space Development and Utilization [literal translation] will be formulated based on the Act as the national strategy of our country.

R&D on space increases universal knowledge and findings regarding the origin of space and various phenomena of the earth, and results contribute to the improvement of security, the betterment of people's lives, industrial promotion, the development of society, and the improvement of the Japan's international position. It is extremely important to advance the policy, weighed on the utilization of space, while improving technological development in the future.

The future major satellite launching plans of Japan are as shown on Table 2-2-10.

Table 2-2-10 Japan's Major Satellites Launch Schedule

Satellite	Weight (kg)	Orbital altitude (km)	Launch vehicle	Launch date	Major objectives
Japan Experiment Module (JEM) "KIBO"	approx. 26,800	approx. 400	U.S. Space Shuttle	The extravehicular experiment platform will be launched in FY 2009 (The intravehicular storage and experiment rooms were already launched)	Contributes to the maintenance and improvement of the nation's international position as a space-advanced country, accumulation of the technologies for manned space activities, promotion of utilization of the space environment that will be developed for new industrial activities, and acquisition of new scientific findings.
H-II Transfer Vehicle (HTV)	Maximum supply weight: approx. 6,000		H-IIB	In FY 2009 (technology experiment satellite)	To supply materials to the International Space Station by the Japanese transport system
Space Environment Reliability Verification Integrated System-2 (SERVIS-2)	740	1200	Rockot (Russia)	In FY 2009	The durability of commercial off-the-shelf device/technology in space is demonstrated.
Quasi-Zenith Satellite (QZS)	approx. 1,800	Quasi-zenith orbit (Long radius of the orbit: approx. 42,000)	H-IIA	In FY 2010	To demonstrate the fundamental technology of positioning, navigation and timing systems using satellites, which reinforces the global positioning system
Venus Climate Orbiter (PLANET-C)	approx. 480	Orbit around Venus (approx.300-80,000))	H-IIA	In FY 2010	To explore Venusian atmosphere, and solve riddles in the basic principles of planetary weather and the evolution of atmosphere
Global Change Observation Mission-Water (GCOM-W)	approx. 1,900	Sun synchronous sub-recurrent orbit (approx. 700)	H-IIA	In FY 2011	Precipitation and water temperature on the surface of the sea are observed on a global scale to contribute to clarification of the global water recycle mechanism.
Advanced Satellite with New system Architecture for Observation (ASNARO)	approx. 450	Sun synchronous orbit approx. 450	(Under review)	In FY 2011	A sophisticated small satellite with the functions comparable to a large satellite, low cost, and short development period, has been developed.
Radio-Astronomical Satellite (ASTRO-G)	approx. 1,200	Highly elliptical orbit (approx.100-20,000)	H-IIA	In FY 2012	The Milky Way and the core of the star-generating will be drawn with the highest resolution in history, and their physical conditions will be clarified.
Advanced Land Observing Satellite-2 (ALOS-2)	approx. 2,000	Sun synchronous sub-recurrent orbit (approx. 630)	H-IIA	After FY2013	Global forests and geography are observed for application of the data to meet needs under normal circumstances, including land and resource management in addition to the objective to understand the situation in disaster situations.

Satellite	Weight (kg)	Orbital altitude (km)	Launch vehicle	Launch date	Major objectives
Global Precipitation Measurement /Dual-frequency Precipitation Radar (GPM/DPR)	approx. 3,500 (GPM Satellite)	Sun-asynchronous orbit (approx. 400)	H-IIA	After FY2013	Observes the three-dimensional distribution of precipitation and snow using the dual frequency precipitation radar (DPR) installed in the main satellite for international global precipitation measurement (GPM) project.
Mercury Exploration Project (BepiColombo)	approx. 220 (MMO)	Elliptical polar orbit around Mercury (approx. 400～12,000) (MMO)	Soyuz Fregat 2B	After FY2013	To observe the magnetic field, magnetosphere, the inside and the surface of mercury from many angles through international cooperation with the European Space Agency. Japan is in charge of the Mercury Magnetospheric Orbiter (MMO).
Earth Clouds, Aerosols and Radiation Explorer/Cloud Profiling Radar (EarthCARE /CPR)	approx. 1,200 (EarthCARE Satellite)	Sun synchronous sub-recurrent orbit	Under review (Europe)	After FY2013	The three-dimensional distribution of the cloud/aerosol in the atmosphere is observed in the global scale with a cloud profiling radar mounted on the Europen Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) Satellite.
Global Change Observation Mission - Climate (GCOM-C)	approx. 2,000	Sun synchronous sub-recurrent orbit (approx. 800)	H-IIA	After FY2013	Vegetation and cloud/aerosol are observed at the global scale to contribute to the clarification of the mechanism of global climate change.
X-ray Astronomy Satellite "ASTRO-H"	approx. 2,400	Circular orbit (approx. 550km)	H-IIA	After FY2013	The growth of galactic clusters is directly observed and huge black holes are observed by means of X-rays for clarification of the large-scale structure of space and its development, and to understand the extreme situation of space.

(Space transportation system technology)

In order to maintain Japan's overall security and autonomy in space activity, it is important to have the ability to transport necessary satellites to a given place in space by the nation itself. Also, because space transportation system is an advanced system technology, the activities themselves for improving technical capabilities sophisticate the industry and develop the social economy. Therefore, Space Transportation System is selected as an essential R&D issue. In particular, the development, manufacturing and launch of H-IIA launch vehicles, H-IIB launch vehicles (an upgraded version of the H-IIA launch vehicle), H-II transfer vehicles (HTV) and GX launch vehicles, implemented by JAXA, are positioned as one of the strategically prioritized S&T, named highly reliable space transportation system. As for the H-IIA launch vehicle, which is Japan's central rocket that can launch a large-size satellite, transportation service for launching rockets by private sector was implemented starting in FY 2007. In FY 2008, the Greenhouse Gases Observing Satellite “IBUKI” (GOSAT) was launched by using the 15th H-IIA. As a result, the success launching rate of H-IIA rockets has achieved 90% or over, which far exceeds the world level in the initial operation phase. Also, in order to secure HTV, which should be involved in transportation of materials such as food, consumables, and experimental appliances to the International Space Station (ISS) and should constitute contribution means to Japan's ISS Project, as well as to secure measures of launching HTV, Japan promotes the development aiming for launching of a technology-demonstration vehicle and test vehicle of H-IIB rocket to transport an eight-ton class satellite to the geostationary transfer orbit in FY 2009. Development, manufacturing, and launch

of these H-IIA launch vehicles, H-IIB launch vehicles, and HTV are positioned as technologies configuring the Key Technologies of National Importance, the Space Transportation System Technology, which is being promoted under the national long-term strategy in the Third Basic Plan. Furthermore, as for the GX launch vehicles, which were developed in cooperation with the government and private sectors, METI implements R&D concerning avionics that the control the flight of rockets, and the JAXA develops propulsion systems with liquefied natural gas (LNG) that is filled in the second booster. Regarding this launch vehicle, it has been shown that it will reach the start of real development around the summer of 2009 in the Measures for Space Development and Utilization in FY 2009 [literal translation] (Decision by the Space Development Strategy Headquarters [literal translation] on December 2, 2008). JAXA is advancing the experiments necessary to obtain the technical prospect of an LNG propulsion system according to this decision.

(Telecommunication satellites systems, positioning, navigation and timing satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellite)

Utilization of satellites for communications, broadcasting, and other purposes offer a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc.

To this end, the telecommunication satellites systems, positioning, navigation and timing (PNT) satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellites are selected as essential R&D issues.

Regarding the telecommunications satellite system, an Engineering Test Satellite-VIII "KIKU No.8" (ETS-VIII) was launched in December 2008 in corporation with MEXT and MIC to develop and demonstrate large-scale satellite bus technologies, large deployable antenna technologies, and satellite mobile communication technologies. In February 2008, the Wideband InterNetworking engineering test and Demonstration Satellite "KIZUNA" (WINDS) was launched to develop and demonstrate gigabit-class satellite internet communication technologies, and experiments have been implemented. As for the PNT satellite system, MIC, MEXT, METI and MLIT are jointly promoting the development of the quasi-zenith satellite (QZS) that makes high-precision positioning, navigation and timing possible without being affected by mountain valleys or tall buildings under the Basic Plan for the Advancement of Utilizing Geospatial Information (Cabinet decision: April 15, 2008) and the Action Plan for the Advancement of Utilizing Geospatial Information (G-Spatial Action Plan) (Committee for the Advancement of Utilizing Geospatial Information, August 2008) based on the Basic Act on the Advancement of Utilizing Geospatial Information, and will launch it in FY 2010. Explanation of the satellite observation and monitoring system is included in Part 2, Chapter 2, Section 2, 3 (1) and 7.

As for the R&D regarding satellite sensor technology and fundamental technology of satellites, the Program to Improve Reliability (in relation to satellites) is selected as strategically prioritized S&T, and JAXA works to improve the reliability of satellite bus technology and components. In Research and Development of a Small-sized Advanced Space System which was newly selected as strategically prioritized S&T, METI promotes R&D of the small-sized high

performance satellites to realize functions equivalent to large-sized satellites, low cost, and short delivery time.

(Acquisition of technologies for manned space activities based on the International Space Station project)

The International Space Station (ISS) project is an international cooperation project in which five pole countries of Japan, US, Europe, Canada, and Russia participate to jointly construct a space station in earth orbit. Japan participates in the project, aiming to maintain and improve the international position as a space-advanced country, and accumulate technologies for manned space activities through development and operation of the Japan Experiment Module (JEM) "KIBO" and the H-II Transfer Vehicle (HTV) for space station. In June 2008, a stowage module of "KIBO" was attached to ISS, and scientific experiment in the stowage module was started from August. Moreover, in March 2001, Astronaut Wakata, started his long stay in ISS, to last for approximately three months, as a first Japanese. As for HTV, which will play a role of material transportation to ISS, Japan is steadily developing it aiming for launch of a technical demonstration vehicle in FY 2009.

(Solar system exploration and space astronomical observation)

JAXA serves as the center of space science in Japan by launching science-mission satellites and conducting R&D with the participation of researchers from various universities or academic institutes nationwide, and has made world-class achievements.

"Full Earth-rise" High-resolution photo-shot from the lunar explorer satellite "KAGUYA" (SELENE)
Photo: Japan Aerospace Exploration Agency / Japan Broadcasting Corporation

Japan is promoting the scientific satellite project as one of the important R&D projects. The lunar orbiting satellite "KAGUYA" (SELENE) launched in September 2007 has been deployed more than one year since its routine observation started, and its scientific results have been covered in various magazines, including the cover of special issue of *Science*. Further results will be expected in the future. In addition, the beautiful pictures of "Full Earth-rise" and "Full Earth-set" taken by the installed high-resolution camera raised great interest in space. The Solar Observatory HINODE also was launched in September 2006. It provided solar observation data for at least 2 years, and contributed to scientific research on the sun. In addition, Japan continuously promotes the development of the projects including the Venus Climate Orbiter (PLANET-C), the Radio-Astronomical Satellite (ASTRO-G), and the Mercury Exploration satellite (Bepi Colombo) under international cooperation with the European Space Agency.

(Promotion of international cooperation/collaboration)

In accordance with global-scale problems that gradually become serious such as environmental changes and large-scale natural disasters, the necessity of earth observation satellite technology and the importance of multinational cooperation and collaboration in space technology are growing than ever. Japan, through Asia-Pacific Regional Space Agency Forum (APRSAF), which serves as the host country, as well as other international conferences such as Committee on the Peaceful Uses of Outer Space (COPUOS) and Committee on Earth Observation Satellites (CEOS), aims for further promotion of international cooperation in the area of space science. Especially in Asia, Japan promotes the Disaster Management Support System in Sentinel-Asia project under cooperation of 51 institutions in 20 countries in the world and eight international organizations (as of January 2009) through APRSAF. In addition, by Japan's initiative, the Satellite Application for Environment (SAFE) project to monitor global environmental changes and the Satellite Technology for the Asia-Pacific Region (STAR) project for the production of small-sized satellites which will be developed jointly with other countries aiming at fostering competent persons was established under APRSAF in December 2008, showing that the areas of Japan's activities have expanded.

(2) Ocean Development

[Promotion of R&D in frontier (oceans) science]

The ocean is still a new frontier for human beings because of its vastness and the difficulty in accessing, and it has been investigated and studied with the intellectual desire to clarify the unknown. By these approaches, the existence of unused energy and mineral resources and the relation of the ocean to global environmental changes, including climate changes, have been made clear. Thus, pursuing and clarifying the principle of various phenomena in the ocean are necessary to address important issues closely related to human advancement, including the solution to global environmental problems, countermeasures for ocean-trench earthquakes, and the development of ocean resources.

From such a viewpoint, the Basic Act on Ocean Policy enacted in April 2007 specifies that it is important to enhance scientific knowledge of the sea as a basic principle of ocean policy because there are too many areas that remain scientifically unclear in the sea, though scientific findings related to the ocean are indispensable for its development and utilization and for securing the environment in an appropriate manner.

Moreover, the Basic Plan on Ocean Policy (Cabinet decision: March, 2008) which showed the ocean policy for the coming five years was established based on the Basic Act on Ocean Policy. The plan specifies that it is important to give due considerations to the balance and collaboration between the ideas of "understanding the sea," "protecting the sea" and "exploiting the sea" in order to advance ocean policy aiming at making Japan a new ocean-oriented country. The plan also indicates the promotion of R&D of marine science and technology as measures that the government should execute integrally and systematically.

In the sectoral promotion strategy for the frontier (ocean) field in the Third Science and Technology Basic Plan, the Next-generation Ocean Exploration Technology which constitutes the

Earth Observation and Ocean Exploration System of the Key Technologies of National Importance, and the Offshore Platform Technology were chosen as strategically prioritized S&T. Furthermore, the important R&D issues in the following three domains were chosen.

(Deep sea and deep seabed exploration technology, technology to utilize living marine resources)

MEXT promotes the development of the advanced fundamental technology necessary for the observation/exploration of the oceans by JAMSTEC. For example, the Automatic Bottom Inspection and Sampling Mobile (ABISMO) Automatic Bottom Inspection and Sampling Mobile, succeeded in world's first multiple vertical sampling from mid-ocean, sea floor and sub-seafloor over depth of 10,000 m at the Challenger Deep in the Mariana Trench in May 2008. In addition, remote control of the small-sized deep-sea exploration vessel using satellites was successfully accomplished in November 2008. Moreover, the deep-sea cruising vessel "URASHIMA" with the world record for the longest continuous autonomous cruise (317km) and the manned research submersible SHINKAI 6500 with the world top-level depth range (6,500m in depth) operated for the investigation, observation and research of the ocean. Concerning strategically prioritized S&T, next-generation ocean exploration technology was selected as one of the technologies constituting the Earth Observation and Ocean Exploration System of the Key Technologies of National Importance. At JAMSTEC, MEXT promotes the development of technology for ocean riser drilling at the floor of the deepest sea in the world using the deep sea drilling vessel "CHIKYU" developed for drilling into Earth's mantle no one can previously reach and for collecting useful microorganisms in the crust, the development of technology for an next-generation deep-sea cruising vessel, and the development of technology for an deep-sea high-performance unmanned vessel. These technologies enable surveys and observations in the sea/hydrographic area where investigation is difficult by conventional means such as ships, and in the very deep sea where heavy or precise work is required.

MEXT discussed technology development for the exploration of marine resources focusing on the sea-floor hydrothermal deposits at the CST's Subdivision on Ocean Development for the development of unused marine resources, including sea-floor hydrothermal deposits. In FY 2008, MEXT implemented the Platform Tool Development Program for the Promotion of the Use of Marine Resources [literal translation], aiming at promoting the development of infrastructure technologies including the sensors which will be required for the exploration of marine resources, using technologies integrated at the universities.

Conceptual diagram of the next generation deep-sea cruising vessel (left) **and the deep-sea high-performance unmanned vessel** (right) **to be developed in the Next-generation Ocean Exploration Technology**
Picture: Japan Agency for Marine-Earth Science and Technology

(Oceanic environment observation/forecasting technology, ocean usage technology, oceanic environment conservation technology)

MEXT promotes observation prediction and simulation research on the global environment (observation of ocean, land and atmosphere and prediction/simulation of climate changes conducted around the world using observation facilities such as research vessels, buoys and terrestrial observation tools, aiming to clarify the global environmental changes including global warming) through JAMSTEC. Furthermore, MEXT analyzed the data obtained through observation and research by utilizing the supercomputer Earth Simulator, which has world's highest level of performance, conducted modeling research for physical, chemical, and ecological programs of the global environment. Through such activities, MEXT succeeded in three-year continuous predictions of the Indian Ocean Dipole mode phenomenon in July 2008, thus contributing to improvement in prediction accuracy of phenomena that affects climate on a global scale.

METI continues to implement surveys for reserves of oil and other resources in cooperation with Japan Oil, Gas and Metals National Corporation.

MLIT is working jointly with the Port and Airport Research Institute to improve the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS).

JMA continuously implements surveys and research to improve monitoring and observation information of ocean phenomena and climate changes, including the observation of oceanic and maritime climatic phenomena and the clarification of the El Nino phenomenon.

JCG conducts R&D on oceanic surveying and observation technology as well as analysis technology.

The National Maritime Research Institute implements research on safety and environmental conservation in terms of ocean technology. In relation to the North East Asian Regional-Global Ocean Observing System (NEAR-GOOS) project, JMA and JCG operate a system for promoting the exchange of oceanic data for NEAR-GOOS area, furthering order to better promote oceanographic research.

(Research on clarifying the inner structure of the earth, undersea earthquakes and tsunami prevention technologies)

MEXT promotes research on the dynamics of the earth's interior, wherein surveys on crustal structure contributing in the dynamics analysis of ocean floor plates and survey on the delimitation of the continental shelf are implemented, using the remotely operated unmanned research vessel KAIKO 7000 and deep sea research vessels. For example, development of an earthquake and tsunami observation system to monitor the magnitude of earthquakes and tsunamis or crustal movement in real-time at the predicted source zone of the Tonankai and Nankai Earthquakes, which may cause extensive damage in our country is being implemented from FY 2006. In addition, MEXT promotes ocean drilling employing the deep sea drilling vessel "CHIKYU" in the Kumano-nada offshore of the Kii Peninsula under the framework of the Integrated Ocean Drilling Program (IODP), aiming at clarifying the mechanism of massive ocean-trench earthquakes.

In June 2008, MOFA, MEXT, METI, and MLIT completed joint work involving the investigation of sea area required for defining the delimitation of the continental shelf of Japan under overall coordination by the Headquarters for Ocean Policy, and submitted an application to the United Nations Secretariat in November of the same year.

Major research areas in frontier science implemented in FY 2008 are as shown on Table2-2-11.

Table 2-2-11 Major Research Projects in Frontier Science (FY 2008)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	- Core technologies of satellite for disaster prevention measures and risk management
Ministry of Education, Culture, Sports, Science and Technology		- Infrastructural tool development program toward marine resource application
	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	**Technology for next generation ocean exploration system** - Development of the world's best deep sea riser drilling technology by CHIKYU - Development of technology for next-generation deep-sea cruising vessel - Development of technology for unmanned research vehicle for deep ocean with high performance
	Japan Aerospace Exploration Agency	**Highly reliable space transportation system technology** - Development, manufacturing and launch of H-IIA launch vehicles - H-IIB launch vehicles - H-II transfer vehicles (HTV) - GX launch vehicles **Technology to improve the reliability and functions of satellites** - Program to Improve Reliability (in Relation to Satellites)
Ministry of Economy, Trade and Industry		- R&D on remote sensing technology
	National Institute of Advanced Industrial Science and Technology (AIST)	- Prediction of Earth and ocean environments based on geochemical and paleontological research of modern and past environments - Marine geological research and survey
	New Energy and Industrial Technology Development Organization (NEDO)	- Project on the Development of Fundamental Technology for the Next-generation Transportation System Designing (GX launch vehicle)
	Japan Oil, Gas and Metals National Corporation (JOGMEC)	- Methane hydrate technology development - Deep-sea mineral exploitation survey
Ministry of Land, Infrastructure, Transport and Tourism	Maritime Bureau	- Research and development of offshore platform technologies - Development of natural gas hydrate (NGH) transportation vessel
	Hydrographic and Oceanographic Department, Japan Coast Guard	- IOC Sub-Commission for the Western Pacific Region (WESTPAC)
	Japan Meteorological Agency, Meteorological Research Institute	- Observational research on changes in ocean carbon cycle

[Interdisciplinary areas]

1 Key Technologies of National Importance

In order for Japan to achieve sustainable growth and lead the world in the rapidly changing conditions, such as the restricted supplies of resources and energy, global warming and frequent occurrence of natural disasters, it is important to establish a long-term national strategy, and carefully select and promote important technologies.

To this end, the government selected five Key Technologies of National Importance, namely space transportation system, earth observation and ocean exploration system, FBR cycle technologies, next-generation supercomputer and x-ray free electron laser upon the formulation of the Third Science and Technology Basic Plan.

These Key Technologies of National Importance are intended for the improvement of overall national security and the achievement of the top world-level research function, and will be

continuously promoted with high priority.

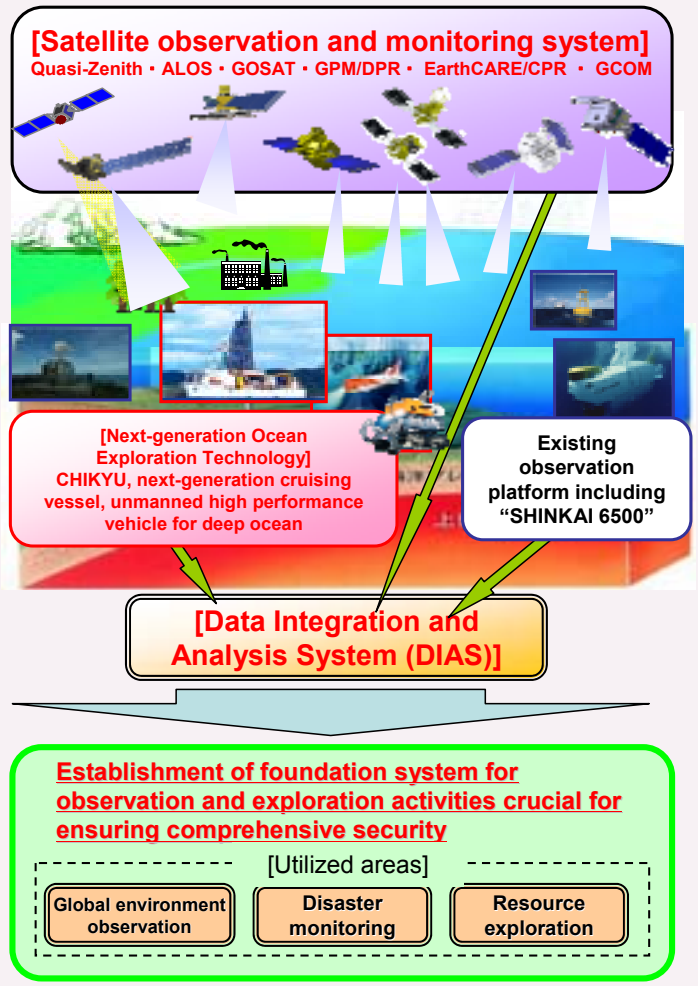
(1) Space transportation system technology

Refer to Part 2, Chapter 2, Section 2, 8 (1).

(2) Earth observation and ocean exploration system

In order to predict changes in the global environment, it is necessary to prepare a global observation network and to manage and data derived from the network. In addition, detailed topographic survey and resource exploration in sea areas surrounding Japan are necessary from the viewpoint of overall national security. The earth observation and ocean exploration system aims to integrate, analyze, and provide data obtained from observation and exploration from the oceans and space to address the settlement of such issues and comprises three technologies: next-generation ocean exploration technology, satellite observation and monitoring system, and data integration and analysis system (DIAS). The promotional framework for the entire system was evaluated by CSTP in FY 2006, and social contributions in the areas of global environment observation, disaster monitoring and resource exploration are expected in the future (Figure 2-2-12).

Figure 2-2-12 Conceptual Diagram of the Earth Observation and Ocean Exploration System



(3) FBR cycle technologies

Refer to Part 2, Chapter 2, Section 2, 5 (1).

(4) Next-generation supercomputer

Simulation using supercomputers is being firmly establishing its position as the method of S&T of modern days, together with theory and experiment. Because supercomputers enable a large-scale simulation at high speed, they are used for analysis of collisional damage of automobiles and forecast of the routes of typhoons or occurrence of concentrated heavy rain, etc. In order for Japan to maintain its world-leading positions in a wide range of areas such as science and technology, academic research, industry, and medicine, MEXT started the project Development and Use of an Next Generation Supercomputer (Project name: Development and Use of an

Next-Generation Supercomputer (Conceptual image)
Source: RIKEN

Advanced, High-Performance, General-Purpose Supercomputer) from FY 2006. Aiming to start partial operation in FY 2010 (and completion in 2012), the project is promoted mainly by RIKEN under close industry-academia-government collaboration.

In March 2007, MEXT decided the facility would be located in Kobe (Port Island Phase II), and is now proceeding the development.

(5) X-ray free electron laser

X-ray free electron laser (XFEL) is a light having the combined features of laser and radiation light, and is based on the technology to allow analysis that was impossible with conventional measures. XFEL is expected to contribute to new wisdom creation in the wide ranging S&T areas including life sciences and structure analysis at the nano-level as the bedrock of research that has the highest performance globally and enables researchers to measure, observe, and analyze in a flash the ultra-microstructures at the atomic level and the super-high-speed kinetics or changes in chemical reactions with a light having the properties of lasers and radiation, which were never achieved by conventional techniques. This technology is designated as Key Technologies of National Importance. RIKEN and the Japan Synchrotron Radiation Research Institute have improved their facilities since 2006, including the synchrotron radiation facility SPring-8 that is built at the same site. XFEL is expected to start its shared use in FY 2011. The facilities for linear accelerators and the beam lines were completed in FY 2008.

X-ray Free Electron Laser (XFEL) facility
[The rectangular-shaped building at left is XFEL. The circular-shaped building is the Super Photon ring-8 GeV (SPring-8)] (January 2009)
Source: RIKEN

2 Science and Technology for a Safe and Secure Society

The Third Basic Science and Technology Plan posts “The world's safest country: making Japan the world's safest" as one of goals of the policy and promotes S&T approaches that contribute to the building of a safe and secure society in accordance with strategies such as the sectoral promotion strategy, and the science and technology promotion strategy contributing to safety [literal translation].

MEXT finalized the policy to promote R&D on science and technology for a safe and secure society in July 2006 and implements R&D according to the policy. Furthermore, starting in FY

2007, MEXT implements the Project on Science and Technology for a Safe and Secure Society, which aims to make contributions to national security and security of people's life by promoting R&D of important R&D issues including anti-terrorism measures and sharing of knowledge and technologies.

International cooperation is executed mainly under the bilateral S&T cooperation agreements between Japan and the US. Concretely, cooperative activities are being implemented in a positive manner as the U.S.-Japan Framework Initiative for a Safe and Secure Society.

In addition, the Research Institute of Science and Technology for Society promotes solution-providing R&D based on various on-site knowledge and experiences in the five areas of Community-based Actions against Global Warming and Environment Degradation, Protection of Children from Crime, Science Technology and Humanity, Information Technology and Society, and Brain-Science and Society, utilizing knowledge not only in the area of natural sciences, but humanities and social sciences, with the objective of providing specific solutions to various problems in society and contributing to social security.