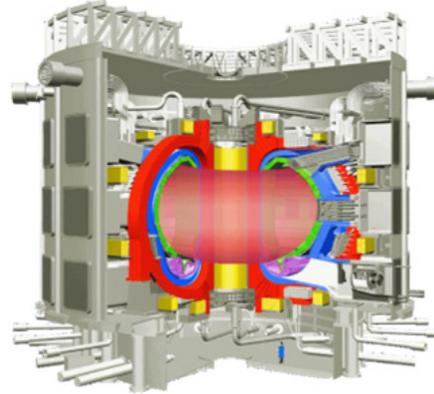


system International Forum (GIF)), in light of experience gained through the accident at TEPCO Fukushima Daiichi Nuclear Power Station and in terms of international cooperation.



FBR "Monju" (Tsuruga City, Fukui Pref.)  
Photo: JAEA



ITER (International Thermonuclear  
Experimental Reactor)  
Photo: JAEA/ITER



International Fusion Energy Research Center  
(Rokkasho Village, Aomori Pref.)  
Photo: JAEA

#### (iv) Fusion energy

Because of the existence of numerous fuel resources, no emissions of greenhouse gas in the process of power generation and the possibility of large-scale power generation from a small amount of fuel, the fusion energy is expected to serve as the essential future energy source to solve both the energy problems and the global environmental problems. Regarding the fusion energy, the advanced R&D with three types of reactors - Tokamak reactor [JAEA, Break-even Plasma Test Facilities: JT-60, shutdown since August 2008, subsequently dismantled for repair and in the process of assembling high performance fusion experiment system (JT-60SA)], Helical reactor (National Institute for Fusion Science (NIFS), Large Helical Device (LHD)) and laser fusion reactor (Institute of Laser Engineering, Osaka University, GEKKO-XII Laser) - have produced world-class results in the fusion field.

On the other hand, Japan takes the initiative in participating in the ITER, project aiming at demonstration of scientific/technical feasibility of the fusion energy, and is advancing the Broader Approach (BA) as the advanced R&D project complementing and supporting the ITER Project in

partnership with Europe in Rokkasho Village, Aomori Prefecture and Naka City, Ibaraki Prefecture.

(v) Securing of nuclear safety

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

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

The Nuclear Regulation Authority, in light of experience gained through the accident at TEPCO Fukushima Daiichi Nuclear Power Station, is poised to rebuild the nuclear power safety administration and to establish the safety at the highest global standards by giving top priority to public safety in order not to cause the same accident again.

(vi) Spread of radiopraxis

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

In the medical field, the diagnosis and cancer therapy with radiation has been partially put to practical use. Ion-beam cancer therapy has the advantage of reduction the strain on patients because it is not need to surgery with anesthesia or incision. In the agricultural field, irradiation has been applied to pest control or cultivar improvement. Academic researches such as study on water dynamics and toxic metals accumulating process in plants are also in progress. In the industrial field, the radiation has been applied to production of semiconductor devices, radial tires and so on. Irradiation has actively been utilized for modification and production of various industrial materials, and to sterilization of medical instruments. And also, irradiations of semiconductor, creation of new materials and R&D to create new applications by irradiation have been progressed at the Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) in the Takasaki Advanced Radiation Research Institute, JAEA.

(vii) Disposal of waste from research facilities

Although it is still the case that radioactive waste released from research or medical facilities (waste from research facilities) is stored without disposal by each companies concerned, realizing the disposal of such waste is becoming an important issue in advancing R&D and utilization of the atomic energy in the future. In response to this issue, JAEA was designated as body conducting the disposal according to Japan Atomic Energy Agency Act revised in 2008.

JAEA is making efforts to establish site criterion and procedures of the disposal facilities according to the “Basic Policy Concerning Implementation of Land Disposal” (decided in December 2008) and the “General Plan for Implementation of Land Disposal” (approved in November 2009 and approved a

change in March 2012) with the aim of realizing the disposal of waste from research facilities.

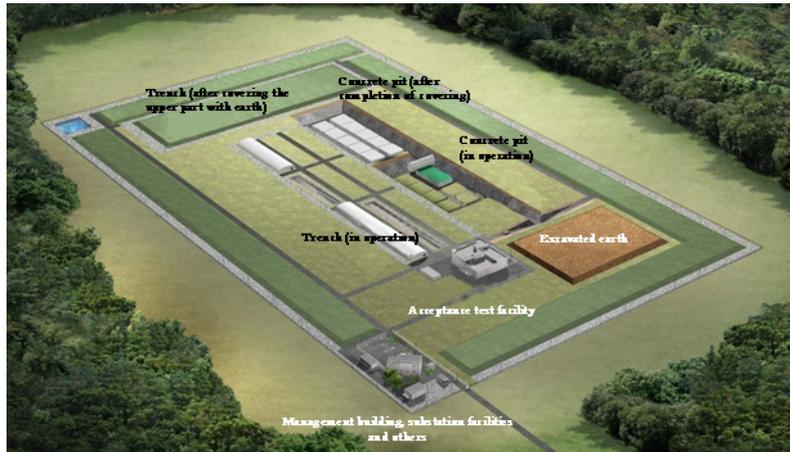


Image of Disposal Facility

Source: JAEA

(viii) Efforts for assuring trust and coexistence with communities

For R&D and utilization of nuclear energy, it is important to obtain public understanding and confidence. MEXT is implementing activities to eliminate anxieties about nuclear energy by providing public hearings for the residents living in the vicinity of the Fast Breeder Reactor (FBR) “Monju” on the subject of what they want to know or questions in light of the lessons learned from the accident at TEPCO Fukushima Daiichi Nuclear Power Station. The ministry has also provided financial support on education programs related to energy and radiation including nuclear power implemented mainly by prefectural governments, and supported education programs related to radiation at schools including seminars on radiation for the educators and lending service of simple radiation measuring equipment<sup>1</sup>.

In addition, towards the coexistence of nuclear power research facilities and regions where such facilities are located, the government is supporting the programs which the regions voluntarily execute with governmental subsidies for the Power Source Siting Laws.

(ix) International nuclear power cooperation

MEXT is holding the initiative in promoting peaceful use and non-proliferation of nuclear power through the ministry’s contribution to the projects conducted by the International Atomic Energy Agency (IAEA) and other international organizations, and assisting the member countries mainly in Asia in human resource and infrastructural development in the fields of radiation utilization, nuclear power safety and others under a framework of the Forum for Nuclear Cooperation in Asia (FNCA). In addition, the Ministry, through collaboration among industry, academia and government, conducted acceptance of trainees from overseas based on the “Nuclear Human Resource Development Network” and the other activities.

Along with the United States, France, and other countries advanced in the use of atomic energy, Japan is collaborating in a variety of fields such as R&D of the atomic power system with high sustainability, including FBR, through the Generation-IV International Forum (GIF).

<sup>1</sup> In FY 2011, MEXT has reviewed the support for the education programs related to energy including nuclear power so as to focus on promoting the public understanding of radiation which is of particular interest to the public, in light of the accident at TEPCO Fukushima Daiichi NPS.

## (2) Increasing and smartening of energy utilization efficiency

Towards increasing the energy utilization efficiency, R&D for more efficient use of fossil resources in manufacturing sectors, for more low-carbon and energy conservation in consumer (domestic use, business use) and transport sectors which account for approximately half of the final energy consumption in Japan.

Concerning the information and communication technology necessary to advance the innovation of energy supply and use or social infrastructures, the government is also promoting R&D for further energy conservation.

### 1) More efficient use of fossil resources in manufacturing sectors

RIKEN is promoting the study and technology development necessary to establish the innovative consistent bioprocess - from production of plant biomass, through efficient decomposition and conditioning of plant biomass by new enzymes, to creation of bioplastic -, making full use of biotechnology in order to utilize carbon dioxide as a resource.

The National Institute for Materials Science (NIMS) is conducting R&D on materials such as photocatalyst which can render hazardous materials in water, air or soil environment harmless.

METI is making efforts in diversifying chemical raw materials, innovating manufacturing process and waste disposal process, promoting the innovations by applying advanced chemical technology and advanced chemical manufacturing process, and improving the common evaluation bases for chemical materials to promote R&D for the Green Sustainable Chemistry contributing to realization of a human- and environment-friendly, sustainable society. In concrete, with the aim of solving resource and environmental problems such as hikes in oil prices and depletion risk simultaneously the Ministry is conducting technology development such as innovative catalysts to produce essential chemical products including plastic materials and others with solar energy using carbon dioxide and water without depending on oil (Artificial Photosynthesis Project) and to produce high-performance organosilicon materials from sand since FY 2012 as the "Future Development Research." The Ministry is also conducting development of technology to produce chemical products from biomass and others, development of technology which can produce innovatively enhanced energy-saving and highly-efficient electronic devices (electronic paper, large-area sensor) by applying a printing process compared to traditional manufacturing methods, and evaluation method for materials for lithium-ion cells such as organic EL which will lead to the improvement in materials development speed. For steel manufacture, the Ministry is developing the innovative carbon dioxide reduction technology in steel manufacturing process, including the technology to partially substitute hydrogen for coke as reductant in steel manufacturing process, to separate and capture carbon dioxide from blast furnace gas towards further improving the utilization efficiency of fossil fuel. In addition, the Ministry is developing technology to ensure good compatibility between energy-saving and response capability to resources based on utilization of low-grade coal or ore which helps to speed-up the reduction reaction and to lower the temperature in blast furnace. On the other hand, the ministry started the development of and the empirical study on basic technology to highly-efficiently produce high value-added products (for example, vaccine, functional food) with genetic modification, in order to promptly put into practical use the production technology of safe and productive substances with plant function.

With the aim of construction of the dispersion energy system using fuel cells, METI is also supporting R&D on innovative hydrogen production technology to produce high-purity hydrogen

necessary for fuel cell cars by efficiently utilizing hydrogen made through the existing equipment in refineries and promoting development and demonstration of facilities for efficiently shipping out produced high purity hydrogen.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is conducting technical study on the safety of floating mooring facilities against drift, turnover, sinking and others which are challenges specific to floating facilities, in order to ensure safe operation of floating offshore wind power generation facilities in severe natural environmental conditions such as offshore.

## 2) Low-carbon and energy-saving in consumer and transport sectors

The National Institute for Materials Science (NIMS) is developing long-lasting, functionally-stabilized and low-cost fuel cell helping to improve the efficiency of energy use in industries and homes which consume a large amount of energy at present, and conducting R&D towards technical breakthrough in magnet for motors, wide-gap semiconductor and LED lighting system which is already used for various purposes. The institute is also conducting R&D of the innovative material technology for lightweight materials for mobile structures which contribute to energy-saving.

The New Energy and Industrial Technology Development Organization (NEDO) implemented the development of innovative energy-saving technology through proposed public offering which focused on the key technologies listed in the “Energy-conservation Technology Strategies 2011” formulated in March 2011 in consideration of the fact that energy-saving technology encompasses many fields and is very wide. Furthermore, aiming at intensive use of energy and expansion of use application, NEDO conducted “R&D of Next-generation Heat Pump System.”

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is supporting various private technology development contributing to the innovative energy conservation for ships, such as development of hull form with high propulsion efficiency, streamlining of ship operation and handling, to reduce carbon dioxide emissions of newly built ships by 30%. The ministry is also integrating the technology development as above with construction of an international framework to regulate carbon dioxide emissions from ships and thus expecting to deploy the developed technology across the world.

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

The National Maritime Research Institute (NMRI) is conducting the study on basic technology contributing to the realization of environmental regulations both for environmental impact reduction by a large extent towards zero emission, and social rationality, in order to reduce carbon dioxide from ships by a large extent.

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

## 3) Improvement of the information and communication technology

MIC has started R&D for the practical application of optical transmission technology capable of meeting the expected rapid increase in network traffic at 400 gigabit per second. NICT is promoting R&D for an all-optical network realizing ultrahigh-speed and low-power consumption of the entire

network at the same time to respond to exponential increase in communications traffic and power consumption by utilizing the information and communication technology (ICT). NICT is also promoting R&D on basic technology for realization of a next-generation network following the internet by 2020 with industry-academia-government collaboration.

Regarding semiconductor technology, METI conducts the following research: 1) fundamental evaluation technology necessary for next-generation EUV (extreme ultraviolet radiation) lithography systems that realize a semiconductor manufacturing process in 10-nm technology, 2) ultra-lower-power technology with new materials/structures, 3) Normally off computing “Normally OFF—instantly ON computing,” a fundamental technology that consumes electric power only when data processing is required, by embedding nonvolatile elements into the semiconductor, and 4) three-dimensional integration technology for semiconductors. In order to realize the enhancement and energy-saving of information processing capabilities at data centers, METI also conducts the “Green IT Project,” which includes the development of green cloud-computing technology and next-generation power devices, in addition to the “Future Pioneering Projects,” which includes the development and application of technology used in hybrid optical and electronic circuits.

### (3) Greening of social infrastructure

Japan is promoting R&D for construction of a highly-efficient transport system towards realizing an environmentally-advanced city and efforts to innovate on resource recycling technologies or create substitute materials for rare earth elements<sup>1</sup> and others. In addition, Japan is to greatly improve the technologies related to the information obtained from Earth observation, projection and integration analysis which is an important social and public base, and to promote to utilize such information in various fields.

#### 1) R&D for construction of the highly-efficient transport system

The National Police Agency has been implementing an advanced model project for the traffic control system using probe information<sup>2</sup> in the Tokyo Metropolitan Area and Kanagawa Prefecture for four years since FY 2009 for the purpose of reduction of carbon dioxide emissions and traffic jams. In FY 2012, the agency conducted a comprehensive review of the usefulness of the systems developed so far.

#### 2) Efforts to create substitute materials for exiting rare resources

In order to overcome the constraint on scarce elements such as rare earths or rare metals<sup>3</sup> as materials necessary for next-generation cars or wind power generations, MEXT and METI have been conducting R&D to reduce use of and to create substitute materials for such materials while providing mutual coordination since FY 2007.

MEXT is promoting the “Elements Strategy Project Research Base Formation Oriented” designed to create a completely new material without using scarce elements such as rare earths or rare metals<sup>1</sup> to overcome Japan’s resource constraints and regain lost ground in the internationally competitive materials

<sup>1</sup> Rare earth elements consisting of a set of seventeen metallic elements in the periodic table

<sup>2</sup> Running history stored in the car-mounted device

<sup>3</sup> Some metals of which to secure stable supply is important in the national policy as long as there is the industrial demand (or perspective demand) for them, among the metals “of which the amount in existence is a little or which are difficult to extract for technical or economical reasons,” according to a definition accepted by the Mining Industry Council (at present, 31 metals to be covered)

science.

METI did not only implement technology development of substitute materials which would substitute the function of rare metals with resources abundantly available and of considerable reduction in use through the “Rare Metal Substitute Materials Development Project” implemented since FY 2007, but also assisted in the technology development for the recovery of rare earth magnet used in motors of automobiles, air-conditioners and others, and for the improvement of efficiency in the extraction of rare earths from magnet, in addition to the building of recycling systems of spent rare earth magnet. Moreover, the Ministry implemented the “Development of Magnet Material Technology for a high Efficient Motor for Next Generation Automobiles” aimed to develop a more powerful magnetic material than before without using rare earths such as unevenly distributed dysprosium in cooperation with MEXT as a new long-term measure.

The Ministry is also promoting the development of technology capable of producing substances which were difficult to be synthesized in the past, significant improvement in production efficiency of useful materials, reduction of energy consumption in material production, tremendous reduction in environmental load, and dramatic improvement in development efficiency of light-weight, high performance materials through the development of genetic design and recombinant technology based on large-scale genome information.

METI and MOE started to study appropriate measures for recycling rare metals from used products which contain many rare metals in the joint council consisting of Industrial Structure Council and Central Environment Council since November 2011 and compiled and submitted an interim report which showed the countermeasures to be addressed for economically viable recycling programs of rare metals in September 2012. Said report focused on the “securing of recovery amount of used products containing rare metals” and “improvement in recycling efficiency,” and defined the period from now to late 2010s when the discharge of used products will begin in earnest as the “period for conditions development”, showing the measures to be taken during said period.

### 3) Promotion of efforts responding to climate change or wide-scale disaster

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

#### (i) Promotion of Earth observation

Japan is promoting Earth observation with different means from the standpoint of satellites, land and ocean to contribute to the “Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan” agreed in Earth Observation Summit.

Earth observation with satellites is a useful mean which can continuously collect the geoenvironmental information about precipitation, clouds, aerosol<sup>1</sup> and vegetation over a wide range. Japan Aerospace Exploration Agency (JAXA) had been conducting operation of the Advanced Land Observing Satellite

<sup>1</sup> Fine solid particles or liquid droplets suspending in a gas, including floating substances released from ground or sea, smoke discharged from industrial facilities, which have effects on sunlight absorption or scattering and cloud formation

“DAICHI” (ALOS, operation stopped in May 2011), the Greenhouse Gases Observing Satellite “IBUKI” (GOSAT), and the water cycle observation satellite “SHIZUKU” (GCOM-W, launched in May 2012) as well as R&D of satellite including the “DAICHI 2” (ALOS-2) to promote the earth observation utilizing such satellites (refer to Part 2, Chapter 3, Section 1, 3, (1)).

MEXT is conducting a research and observation program in the Antarctic and North Polar region where it is possible to distinctly capture global environmental change. The Ministry, under the “Headquarters for Japanese Antarctic Research Expedition” (chief of Headquarters: the minister of MEXT) in the Antarctic Research Programs, in cooperation with the ministries concerned and research institutions including the National Institute of Polar Research is conducting research and observation in a variety of research fields with the “Exploring Global Warming from Antarctica” as the main theme, under an international cooperation, based on “the 8<sup>th</sup> six-year Antarctic Research Program” (FY 2010 to 2015). In the North Polar region, the Ministry is conducting the Arctic Climate Change Research Project as part of the “University-originated Green Innovation Creation Program” and is promoting research and observation aimed at strategic goals such as the evaluation of effect of environmental change in the North Polar region on Japan and the evaluation of availability of the Northern Sea Route in collaboration with model researchers and observation researchers under the Arctic Research Consortium.

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

In Addition, the agency is transmitting information on the current state of and prospects for the oceanic fluctuation related to the global environment based on collection and analysis of various observation data obtained from vessels, Argo Floats<sup>1</sup>, satellites and others.

The Geospatial Information Authority of Japan is conducting technology development of data improvement method based on data quality standards, working manuals, earth observation satellite data and others for the Earth Map which is fundamental geospatial information to be used in a variety of fields such as measures against global warming, wide-area disaster response and others.

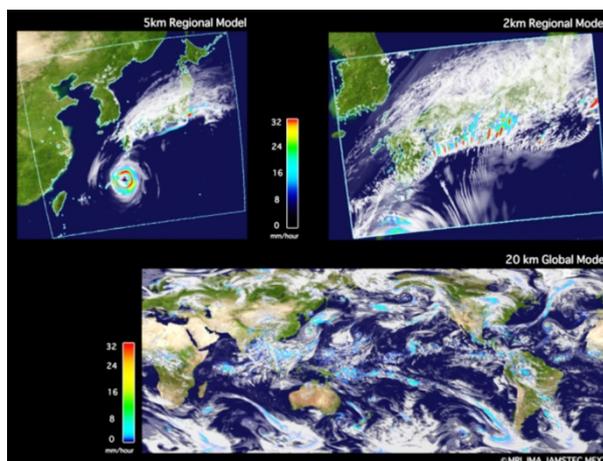
The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has established a global earth observation system to observe and collect data and information on water, thermal and material cycles not only on regional but also on a global scale, and is conducting R&D to understand the global change of water cycle through the on-site or satellite observation on air, ocean and land.

#### (ii) Promotion of climate change projection study

MEXT is implementing the “Program for Risk Information on Climate Change” aiming at the generation and submission of fundamental information necessary for the management of a variety of risks generated by the climate change with the sophistication of climate change prediction. In concrete terms, the Ministry is promoting R&D in the research system in which prediction and diagnosis of global environmental change facing the world in the coming a few years to a few tens of years (near future), long-term climate change prediction associated with the research on greenhouse gas emission

<sup>1</sup> An observation device to measure water temperature, salinity etc. while diving to depths of 2,000 m and floating to the surface to transmit the measured data via satellites

scenarios, development of probabilistic prediction technology of climate change, development of evaluation technology of precise effects and others are organically combined, using the world-class supercomputer such as “Earth Simulator.” Besides the above, the ministry is implementing the basic study towards understanding of the mechanism of the environmental change and making a future prediction of it using “Earth Simulator” and R&D for technology to increase the speed and accuracy of simulation and for the technology to predict the global environmental change using the simulation technology.



Examples of Typhoon simulation  
Data: Meteorological Research Institute, JMA

The Meteorological Research Institute is conducting a near future prediction about the climate changes in the next ten years or a long-term prediction according to an emission scenario prepared by IPCC<sup>1</sup>. Regarding Japanese areas, the institute is conducting a spatially detailed regional warming prediction (refer to Part 2, Chapter 3, Section 1, 3, (1)).

### (iii) Promotion of integration and analysis of data

MEXT has implemented a new program to enhance the functions and expand the range of application of the “Data Integration and Analysis System (DIAS).” DIAS is a system to integrate and analyze Earth observation data (such as satellite remote sensing, data of climate change projection etc.) and socioeconomic data to create scientific knowledge. Knowledge will be provided to policy makers and scientists who are concerned with such as water resource, agricultural produce, and fishery resource management. Furthermore, as part of the “University-originated Green Innovation Creation Program”, MEXT has implemented the “Green Network of Excellence Program (environment information field)” to build a research network of universities and research institutions using DIAS as the core information platform to work on global issues, such as climate change.

The National Institute of Information and Communications Technology (NICT) is selected as the host organization of the International Program Office for the building plan of the world's largest scientific data platform in accordance with the “World Data System (WDS)” plan promoted by the International Council for Science (ICSU), and in cooperation with the Science Council of Japan and domestic and foreign related research institutions among others, NICT is advancing R&D for phenomenon analysis

<sup>1</sup> Intergovernmental Panel on Climate Change

technology, correlation analysis advancing technology and science cloud technology<sup>1</sup> aiming at realizing a world-class science data platform on which analysis of Earth observation data is available.

(iv) Promotion towards a climate change adapted society

MEXT is promoting a R&D program called “Research Program on Climate Change Adaptation” (RECCA, started in FY 2010) to provide scientific knowledge for decision makers in local governments so that they can reflect the result of climate change projection in local level to their climate change adaptation policies. RECCA is promoting R&D in the following three fields - advanced data downscaling methods, as global climate change projection data is not useful enough for local scale, adaptation simulation technology to convert data into information which is necessary for planning adaptation measures on local scale, and technology to assimilate observation data into the simulation models to reduce uncertainty of the simulation results. The research results of RECCA will be provided as scientific knowledge to local districts for their consideration on adaptation measures for climate change. In addition, in FY 2012, RECCA held symposiums in Aichi Prefecture and Kagawa Prefecture in order to foster a better understanding of the climate change adaptation with promotion of broad participation from the public.

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

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

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

Regarding climate change adaptation technology in agriculture, forestry and fisheries, the ministry has developed a high precision yield and quality prediction model and others to assess the impact of climate change on agricultural and marine products, and promoted the development of the production stabilization technology that can cope with the progress of global warming. In addition, the ministry has promoted the development of breeds resistant to high temperature or dryness, making the most of genome information.

MOE is promoting a research aimed at realizing a safe and secure society adaptable to climate change through support in the formulation of adaptation plans in each region by predicting in detail the effects of climate warming in Japan and Asia in the environmental research comprehensive fund program “Comprehensive Research on Climate Change Impact Assessment and Adaptation Policies (S-8).” The

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<sup>1</sup> Cloud computing environment or services especially-suitable for data processing of large-capacity data for the purpose of scientific research

Ministry held a symposium on climate change adaptation in October 2012 in order to diffuse its results widely.

(v) Town development in accord with nature

MLIT is implementing the technology development contributing to realization of a sustainable society where humans live in coexistence with nature, including conservation and restoration of nature, maintenance of secure water cycle and establishment of production bases in Hokkaido for improvement of food supply capacity.

The Meteorological Research Institute, JMA is addressing the development of observation and monitoring technology to detect unusual meteorological phenomena such as local heavy rain (the so-called “guerrilla rain”) in real time by means of dual polarization radar or GPS. The institute is also advancing the development of a numerical prediction model with enough resolution capability to display local heavy rains with the aim of accuracy improvement of weather information helping to reduce damage due to local meteorological phenomena.

The Public Works Research Institute (PWRI) is developing low-carbon mixed cement application technology, low-carbon pavement technology, and recycling technology to reuse the heavy-metal containing soil discharged from construction sites as embankment material.

## 2 System reforms for promotion of green innovation

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

MIC has been engaged in international standardization activities including establishment of best practice models for carbon dioxide reduction with Information and Communication Technology (ICT) and methodology for environmental impact assessment in “Environment and Climate Change” (ITU-T SG5<sup>1</sup>) of International Telecommunication Union in order to help to resolve the environment problems related to ICT utilization in light of the results of its demonstration experiments and others. As the results of such engagement, in addition to the “L. 1300: Best Practice for Green Data Centers” and the “L. 1410: Methodology for Environmental Impact Assessment of ICT Goods, Networks and Services,” the “L. 1200: Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment” was recommended in May 2012.

MEXT is implementing Strategic Funds for the Promotion of Science and Technology “Social System Reformation Program for Adaptation to Climate Change” to advance the social implementation of environmental technologies that can cope with climate change through the development of elemental technologies such as energy management as base of climate change adaptation for system reforms and the demonstration experiment in a social system consisting of such elemental technologies.

METI is conducting the full-scale demonstration towards construction of a smart community with the participation of residents, local governments and private companies since FY 2011 (refer to Part 2, Chapter 2, Section 2, 1, (1)).

Concerning renewable energy facilities such as binary power generation facilities, photovoltaic solar power generation facilities and others, the Ministry has made a study on the range in which the

<sup>1</sup> International Telecommunication Union Telecommunication Standardization Sector Study Group 5

appointment of chief engineers and the notification of a new plan become unnecessary and reviewed safety regulations under the Electricity Business Act in the range in which a high level of public safety is required in terms of the scale of facilities.

Column  
2-1

## Development of Methane Hydrate Production Technology

Currently, methane hydrate attracts attention as the next generation natural gas resource. Between January and March 2013, Japan achieved gas extraction from methane hydrate under the seabed as the first test in the world off the coast from the Atsumi Peninsula of Aichi prefecture to the Shima Peninsula of Mie Prefecture, and confirmed gas production on March 12.

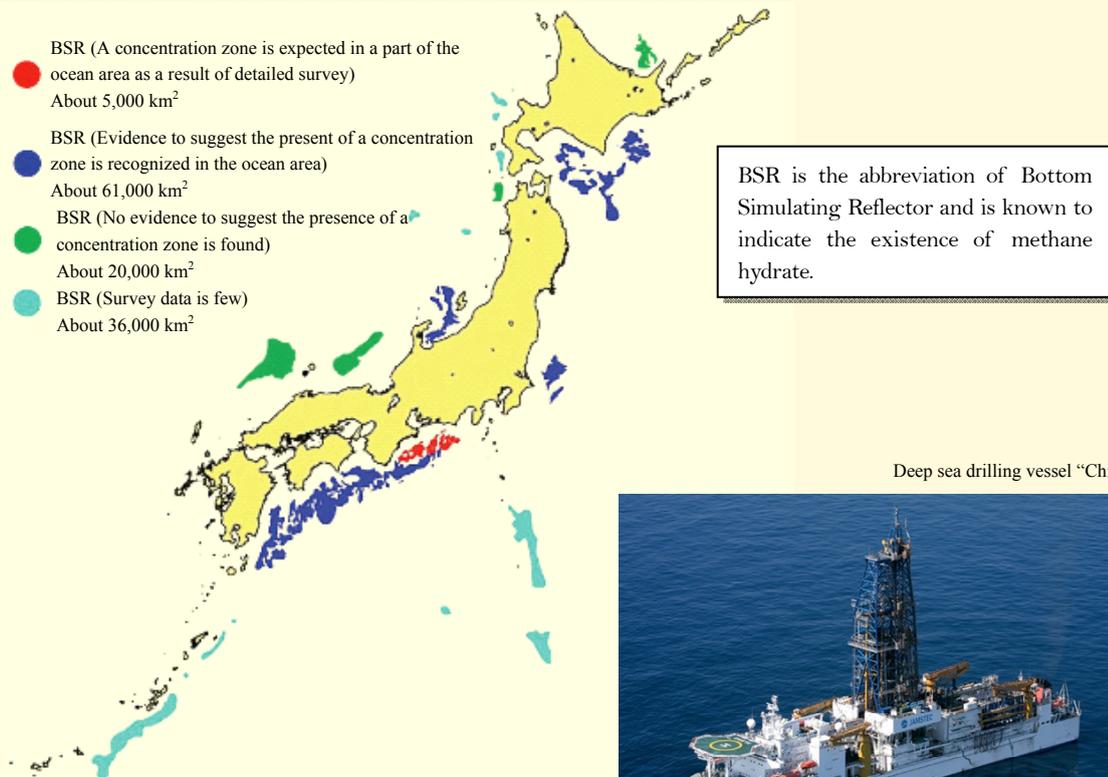
Methane hydrates are sherbet-like substances consisting of methane molecules surrounded by water molecules under the low temperature and high pressure conditions, and when the temperature and pressure conditions change, they are separated into water and methane gas which is the main component of natural gas. These substances are in deep underground of the seabed and permafrost zones and it is estimated that an amount equivalent to about 11 years worth of natural gas consumption in Japan resides also in the eastern Nankai Trough (see figure). Under the circumstances, methane hydrates are expected as the future domestic energy.

So far, technology development for the commercialization of methane hydrates has been conducted mainly by the Ministry of Economy, Trade and Industry, Technology. In the winter of 2008, a production test in land was carried out as an international joint research between Japan and Canada and continuous production using the "decompression" method whereby methane hydrates are broken down in the underground for gas extraction is currently underway. Subsequently, the Japan Oil, Gas and Metals National Corporation (JOGMEC) and the National Institute of Advanced Industrial Science and Technology conducted the gas extraction from methane hydrate under the seabed as the first test in the world off the coast from the Atsumi Peninsula of Aichi prefecture to the Shima Peninsula of Mie Prefecture between January and March 2013. For the production test, the deep sea drilling vessel "Chikyu (Earth)" (photo) owned by the Japan Agency for Marine-Earth Science and Technology was used and methane gas was collected by lowering and connecting metal pipes with the geological layers where methane hydrates are found at about 300m below the seafloor (water depth of about 1000m) and breaking down them into water and methane gas through the decompression in the geological formation. This was the world's first methane production test in the sea and the production had been made for about six days continuously between March 12 and 18.

The Ministry plans to develop technology for commercialization by the end of FY 2018 by conducting analysis of various data obtained from this test and clarification of problems as well as economic analysis and environmental impact assessment in the future.

Since the Great East Japan Earthquake, the value of imports of liquefied natural gas for thermal-power plants increased rapidly, causing a trade deficit. It is expected that development of domestic resource such as methane hydrates will reduce the risk of energy supply in a medium-to-long-term perspective.

Estimated distribution map of BSR



Deep sea drilling vessel "Chikyu"



Source: JOGMEC (2009)

Table 2-2-6/ Main measures for promotion of green innovation (FY 2012)

Ministry	Research organization	Subject
National Police Agency	Metropolitan Police Department, Kanagawa Prefectural Police	Enhancement of Traffic Control System Using Probe Information
Ministry of Internal Affairs and Communications (MIC)	MIC	R&D of Ultra-high-speed and Low-power Optical Network Technology
	National Institute of Information and Communications Technology (NICT)	R&D of Electromagnetic Wave Sensing Infrastructure Technology
		R&D of Network Infrastructure Technology
Ministry of Education, Culture, Sports, Science and Technology (MEXT)	MEXT	Program for Risk Information on Climate Change
		Research Promotion Program on Climate Change Adaptation
		Global Environment Information Integration Program
		University-originated Green Innovation Creation Program
		Tohoku Recovery Next Generation Energy Research & Development Project
		Strategic Funds for the Promotion of Science and Technology “Social System Reformation Program Aimed at the Creation of a New Society Adaptable to Climate Change”
		Elements Strategy Project <Focused on Industry-Academia-Government Collaboration >
		Development of Environmental Technology Using Nanotechnology
		Environmental Technology Development Using Nanotechnology
		Ocean-resource Use Promotion Technology Development Program (Technology Upgrading for Securing Living Marine Resources)
	Japanese Antarctic Research Program	
	Elements Strategy Project <Focused on Research Base formation>	
	Promotion of R&D for Advanced Materials Responding to Social Needs	
	Studies of Advanced Superconducting Materials	
	R&D on High Performance Materials for Power Storage and Generation	
	R&D on Reliability Assessment Technology for Energy-related Structural Materials	
	R&D on Energy Saving Magnetic Material	
	Biomass Engineering	
	RIKEN	Research Program of Environmental and Resource Science
		Emergent Matter Science Program (provisional)
	Japan Science and Technology Agency (JST)	R&D Programs Focused on Technology Transfer (Development of Systems and Technology for Advanced Measurement and Analysis)
		Strategic Basic Research Programs (Advanced Low Carbon Technology R&D Program)
	Japan Aerospace Exploration Agency (JAXA)	Enhancement of Satellite Observation Data for Global Environment Projection Integration and Analysis
		R&D of a High Efficiency Aircraft with Low Fuel Consumption and Low Environmental Load
		R&D on Space Solar Power Generation
	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Research on Global Environmental Change
		Promotion of Earth Simulator Project
Ministry of	MAFF	Development of Technologies for Biofuel Production Systems in Rural Areas.

Agriculture, Forestry and Fisheries (MAFF)		Development of Sustainable Aquaculture Technology Independent of Wild Fishery Resources
		Technology Development for Circulatory Food Production Systems Responsive to Climate Change
Ministry of Economy, Trade and Industry (METI)	METI	R&D on Advanced Aerodynamic Design
		Creation of Structural Members for Next Generation Aircraft and Development of Processing Technology
		Dissemination and Promotion Program of Global Warming Countermeasure Technologies
		Technology Development for Innovative Carbon Fiber Base
		Development of Magnetic Material Technology for Next Generation Automobile Engines
		Japan-U.S. Cooperation on Environmental Technology Research and Standardization Program
		Carbon Dioxide Reduction Technology Demonstration Project Funds
		Subsidy for the Introduction of Clean-Energy Vehicles
		Project Cost for the development of Carbon Capture and Storage Safety Assessment Technology
		Development of Fundamental Technologies for Green-Sustainable Chemical Process
		Highly Functional Genome design Technology development for Realization of Innovative Biomaterials
		Innovative Manufacturing Process Technology Development (Minimal Fab)
		Development of Innovative Iron Making Process Technology for Strengthening Resource Adaptivity
		Expenses for Technology Development for an Ultra-low-power Optoelectronics Implementation System
	Promotion of the Domestic Location of Innovative, Low-Carbon Technology-Intensive Industries	
	Agency for Natural Resources and Energy	Subsidies for Model Project Expenses to Promote the Introduction of Small Hydroelectric Power Generation
		Concession Costs for Common Base Development Promotion Project such as New Energies.
		Subsidy for International Joint Demonstration Project for Coal Use
		Subsidy for Commercialization Element Technology Development Cost of Advanced Super Critical Thermal Power Generation
		Concessions cost for Streamlining Project of International Energy Use
		Subsidy for Supporting Commercial Fuel Cell Introduction
		International Cooperation Project on Clean Coal Technology for Climate Change
		Concessions cost for New Energy Equipment Introduction Promotion Project (New Energy Equipment Introduction Promotion Diffusion Project)
		Subsidies for Supporting Operators Streamlining Energy Use
		Subsidies for Energy Conservation Measures Introduction Promotion Project
		Subsidies for Accelerated Support of Renewable Energy Heat Utilization
		Subsidies for Gas Co-Generation Promotion Project
Subsidies for Next Generation Energy Social System Demonstration Project		
Subsidies for Next Generation Energy Technology Demonstration Project		
Subsidies for Stand-alone Renewable Energy Power Generation Systems		
Subsidies for Integrated Coal Gasification Fuel Cell Combined Cycle Demonstration Project		
Subsidies for High Efficiency Gas Turbine Technology Demonstration Project		

	National Institute of Advanced Industrial Science and Technology (AIST)	Subsidies for Supporting Operators Streamlining Energy Use (For Private Corporations) (For Natural Gas)
		Subsidies for Promotion of Net Zero Energy Houses & Buildings
		Subsidies for Specific Equipment Introduction Promotion Project for Streamlining Energy Use
		Development of Advanced Handling Technology such as Heavy Oil
		Development of High-Efficiency Hydrogen Production Technology
		Effective Resources Use and Alternative Technology
		Mass-production Technology and Application of Nanotube, Carbon Materials
		Promotion of low-cost, high-efficiency and low-environmental impact of Fabrication Technology
		Fabrication Technology of Microelectronic Device System with High Energy-saving Rate
		Expanding of Biomass Use
		Technologies to Efficiently Manufacture High-quality Substances Using Bioprocesses
		Improvement of Efficiency and Reliability of Solar Power Generation
		Development of Power Conversion Electronics
		Development of Storage Device with High Energy Densities for Next-generation Vehicles
		Safety Evaluation Methods to Support Innovation of Advanced Science Technologies
	Promotion of Green Sustainable Chemistry	
	Development of Energy Utilization Technology with High Conversion Efficiency by Fuel Cells	
	Measurement Standards to Support Green Innovation	
	Energy Conservation technology in IT	
	Development of Evaluation Technology for Conservation and Utilization of Geosphere Environment	
	New Energy and Industrial Technology Development Organization (NEDO)	Social Demonstration of Regional Hydrogen Supply Infrastructure Technology
		Development of Infrastructure for Normally-off Computing Technology
		Next-Generation Ultra-low Power Consumption Device Development Project
		Green IT Project
		Development of Functionality Innovative Three-dimensional Integrated Circuit (Dream Chip) Technology
Project to Develop Innovative Cellulosic Ethanol Production System		
Project to Develop Next-generation Technology for Strategic Utilization of Biomass Energy		
Rare Metal Substitute Materials Development Project		
New Material Power Semi-conductor Project toward Achieving a Low-carbon Society		
Innovative Ultra-light and High-strength Integrated Materials Project toward Achieving a Low-carbon Society		
Development of Clean Coal Technology		
Development of Environmentally Friendly Steelmaking Process Technology		
Fundamental Technology Development of Next-generation High-efficiency and High-quality Lighting		

		Leading Energy-Efficient Industrial Technology Creation Project
		Development of Next-generation High-performance Technologies for Photovoltaic Power Generation System
		R&D on Innovative Solar Cells
		R&D of Offshore Wind Power Generation Technology
		Program for New Energy-venture Technology Innovation
		Advanced Science Basic Research Project for Innovative Batteries
		R&D of Ocean Energy Technology
		Development Project of Promotion Technology for Application of Polymer Electrolyte Fuel Cell
		Development Project for Cutting-Edge Technology for Application of Organic Solar Cells
		Development Project for Cutting-Edge Technology for Practical Use and Application of Lithium Ion Battery
		Development Project of Technology for Battery System Compatible with the New Energy System
		Demonstration Project for Technologies and Systems to improve International Energy Consumption Efficiency
		Strategic Innovation Program for Energy Conservation Technologies
		Technology Development of Superconducting Power Cable System
		High-Temperature Superconducting Cable Demonstration Project
		Development of Fundamental Technologies for Green-Sustainable Chemical Process
		Development of Fundamental Technologies for Next-Generation Printed Electronic Materials and Processes
	R&D of a Next-generation Heat Pump System	
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)	MLIT	R&D on Safety of Floating Offshore Wind Power Facilities
		R&D of Innovative Energy-Saving Ship Technologies
	National Institute for Land and Infrastructure Management (NILIM)	Sewage Innovative Technology Demonstration Project (B-DASH Project)
		Research on Technical Potential of Sewage Treatment Plant as Resources and Energy Circulation Base in Local Areas
	Geospatial Information Authority of Japan (GSI)	Review on Normal Flows Setting Method in Mountain Areas
		Promotion of Global Mapping Project (Development of the time-series data maintenance method).
	Japan Meteorological Agency (JMA)	Improvement of Geostationary Operational Environmental Satellites
	Meteorological Research Institute, JMA	Research on Countermeasures for Heavy Guerrilla Rain (Heavy Localized Rain)
	National Maritime Research Institute (NMRI)	Study on Energy-saving Technologies Evaluation for Ships
		Study on Development of Maritime Performance and Operation Evaluation Technology
		Study on Development of CO <sub>2</sub> Emission Reduction Technologies
		Research on Development of Conceptual Design and Regulatory Method for Ocean and Air Regulations
		Study on Development of Basic Technology Contributing to Reduction of Air Pollutants such as NO <sub>x</sub> , SO <sub>x</sub> and PM and Development and Enhancement of Environment Impact Assessment Method Necessary to Spread the Technology
		Study on Building of Assessment Technology for Ecosystem Impact Arising from Ship Operation
		Study on Establishment of Comprehensive Measures against Oil or Harmful Liquid Substances Spill
Study on Development and Enhancement of Advanced Structural Strength Evaluation Method		

		Study on Development of Safety Evaluation Method for New Power System Research on Construction of Reasonable Safety Regulation Using Risk-based Safety Evaluation Method Study on Development of Inspection and Diagnosis Technologies for Aging and Thickness Effect on Fatigue Strength Study on Improvement of Re-enactment and Analysis Technology for Sea Disasters Study on Establishment of Reasonable Safety and Operation Rule Systems Based on Accident Cause Analysis and Human Factors Analysis Study on Development and Improvement of Policy-based Evaluation Method for Streamlining and Optimizing of Marine Transport Study on Development of Operation Support Technology and Transport System Responding to New Needs for Marine Transport Study on Development of Basic Technology for Marine Resource Production System Using Floating Technology and Development and Improvement of Safety Evaluation Method Study on Environment Impact Reduction as well as Development of Assessment Method for Environment Impact Arising from Marine Utilization or Development Study on the Maintenance, Restoration, CO2 Absorption and of Coastal Ecosystems and, and Improvement of Environment of Closed Inner Bay Research on the Effective Use of Ocean's Space and Energy		
	Public Works Research Institute (PWRI)	Promotion of Low-Carbon of Social Infrastructure Improvement and Efficient Resources Utilization		
	Building Research Institute	Energy Consumption Reduction by Enhancement of Energy-saving Performance Evaluation Method for Houses and Construction		
	Ministry of the Environment (MOE)	MOE	Studies on Radioactive Substances, Disaster and Environment Environment Research and Technology Development Fund (Competitive Funding) Strengthening of Ibuki (GOSAT) Observation Systems and Preparation of System for the Development of the Successor of Ibuki Contributions to the Institute for Global Environmental Strategies Technology Development Project of Global Warming Countermeasure (Competitive Funding) Autonomous and Diversified Power Distribution System Technology Demonstration Project	
			Accelerated Biofuel Introduction Project Floating Offshore Wind Turbine Demonstration Project Waste Energy Introduction and Low Carbon Promotion Project	
			Nuclear regulation Authority	Comprehensive Emergency Measures Support Detailed Soundness Survey of Light Water Reactor Materials and Fuels
			National Institute for Environmental Studies	Satellite Observation Cost Biodiversity Research Program