3) Fostering and acquiring nuclear human resources

In order to foster outstanding nuclear human resources who can support the foundation and safety of nuclear power, MEXT and METI have implemented the Nuclear Human Resource Development Program to support the education of students wishing to become nuclear technicians in universities and colleges of technology. In addition, in order to effectively, efficiently, and strategically foster personnel, "Nuclear Human Resource Development Network" was established in November 2010 by collaboration among industry, academia, and the government. In accordance with "Global Nuclear-HRD Initiative (GN-HRD)," MEXT is supporting by providing grants for collaborative human resource development projects with related organizations.

4) Disposal of radioactive waste

Radioactive waste generated by research institutes and medical facilities is not disposed of, but rather is stored by individual entities; however, disposal of this waste is an important issue for the advancement of the research, development and utilization of nuclear energy in the future. To this end, in 2008, the law was revised so that JAEA became the main entity to discard radioactive waste.

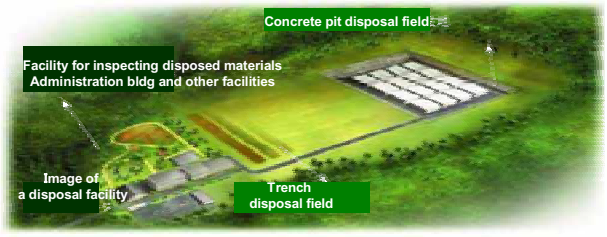

Image of a disposal facility
Photo: Japan Atomic Energy Agency

Based on the revision, the national government set forth the "Basic Policy on the Underground Waste Disposal Business [literal translation]" in December 2008, and the "Plan Concerning the Disposal Business Execution" prepared by the JAEA was approved in November 2009. At present, based on the implementation plan, JAEA is addressing implementation of conceptual design of underground facilities, creation of location standards and its procedures, and waste disposal of research facilities.

5) Efforts for assuring trust and coexistence with communities

For research, development, and utilization of nuclear energy, it is important to obtain public understanding and confidence and until now, government implemented activities to enhance the public's understanding of nuclear energy by providing public hearings for the local community on the Fast Breeder Reactor (FBR) "Monju" and utilizing mediums such as newspapers and T.V. In addition, while providing financial support on education programs related to energy including nuclear power implemented mainly by the prefectural governments of Japan, they are also providing support of education programs[1] at schools such as seminars on nuclear energy for educators and the loan of simple radiation measuring equipment.

Furthermore, to promote the coexistence of nuclear power research facilities and regions where such facilities are located, voluntarily-executed programs are being subsidized under the power source siting laws.

1 Due to the accidents that occurred at Fukushima No.1 Plant and No.2 Plant of Tokyo Electric, Co., JAEA is focused on the promotion of public's understanding of radiation which is attracting much attention as a mean to support the education related to energy including nuclear power in FY 2011.

6) International nuclear power cooperation

MEXT holds the initiative in promotion of non-proliferation and peaceful use of nuclear power through the projects conducted by IAEA and other international organizations. At the same time, under the framework of Forum for Nuclear Cooperation in Asia (FNCA)[1], Japan also assists the member countries in human resource training and infrastructural development in the fields of radioactivity and nuclear power safety. In addition, based on the "Nuclear Human Resource Development Network," to accept trainees from overseas, a system was set up for collaboration among industry, academia, and the government.

Along with the United States, France, and other countries that are advanced in the use of atomic energy, Japan has been collaborating in a variety of fields, such as R&D of an atomic power system with safer and higher economic efficiency, including FBR, through the Generation-IV International Forum (GIF)[2] and other activities. In particular, Japan has been collaborating with the U.S. in promoting technology development and human resources trainings to contribute to the enhancement of global nuclear non-proliferation and security including the previously mentioned initiatives declared at the nuclear security summit in April, 2010, and the Nuclear Security Working Group established at the Japan-United States Summit in November of the same year.

(Promotion of the use of renewable-energy)

Renewable energy, including solar energy, biomass and wind energy, faces issues such as instability of power generation and higher cost. However, since it has advantages, including lower burden on the environment and availability of many types domestically, it is expected to have effects such as the diversification of energy sources, creation of new markets and employment opportunities. As such, active promotion of technology development is necessary to solve existing problems, thereby facilitating the introduction and dissemination of renewable energy.

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 cost has fallen. However, in order to expand the dissemination of photovoltaic power generation, it is essential to achieve further reduction in cost and higher level of efficiency through the development of surrounding technology and technology development of innovative materials. For this purpose, MEXT and METI are promoting the research and development for realizing higher levels of efficiency and cost reduction.

2) Biomass energy

Based on the Biomass Nippon Strategy (Cabinet decision): March 2006) and others, the Cabinet Office,

1 Forum for Nuclear Cooperation in Asia. A framework aiming to promote social and economic development by promoting peaceful and safe use of nuclear power technologies in Asian countries. 12 participating countries including Japan, Australia, Bangladesh, China, Indonesia, Kazakhstan, Korea, Malaysia, Mongolia, The Philippines, Thailand, and Vietnam.

2 Generation-IV International Forum. Cooperation based on the promotion of R&D on next generation nuclear power system by international cooperation. Participating countries are Japan, Argentina, Brazil, Canada, China, France, Korea, Russia, Republic of South Africa, Switzerland, Great Britain, United States and EURATOM.

MIC, MEXT, MAFF, METI, MLIT and MOE promoted R&D into technologies for the highly efficient conversion of animal wastes, forest residues, wooden based waste materials, organic sewage, food wastes, and other biomass sources into energy resources.

In particular, while promoting the R&D to improve the biomass energy by collaborating with each ministry, large-scale experimental projects toward full-scale introduction of bioethanol were conducted. Furthermore, they are promoting R&D on biomass energy technology utilizing the micro-algae that would not compete with food and its energy production is comparatively large per unit area.

In addition, based on the "Fundamental Law for the Promotion of Utilization of Biomass," the Cabinet has decided on "Basic Plan for the Promotion of Biomass Utilization" in December 2010. Based on this plan, they are promoting R&D for securing technology for efficient and effective biomass applications, dissemination of practical applications and achievements.

(Hydrogen energy/Fuel cells)

National Institute for Materials Science is conducting R&D on highly functional hydrogen producing materials and fuel cell materials for nano-structure fuel cells.

METI is implementing demonstration research for operation of infrastructure for fuel cell-powered vehicles and hydrogen supply, as well as technology development for highly functional and low cost hydrogen supply infrastructure necessary for production, transportation and storage of hydrogen fuels, and development of elemental technologies to produce highly functional and low cost fuel cells.

(Promotion of development and utilization of fossil fuels)

1) Petroleum

In response to the requirements for dealing with polymerization of crude oil[1] and lightening[2] of the demands of petroleum products, and to promote sophistication of oil refineries, 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 is important to develop technologies allowing for promotion of energy conservation and resource saving by means of the advancement and improved efficiency 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 refineries, 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.

1 Ratio of heavy-gravity crude oil that is in great demand, becomes higher

2 Within the national demand, ratio of petroleum products using gasoline and kerosene, which is in lesser demand, becomes greater in comparison to petroleum products using crude oil which is in higher demand.

In addition, R&D of Carbon dioxide Capture and Storage (CCS) technology is promoted with mid- and long-term frames of reference.

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 technologies for the utilization of methane hydrates as an energy source, as they are believed to be available in relatively large quantities from the seas around Japan.

(2) Promotion of energy saving measures

From the viewpoint of global warming prevention and effective 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 by applying unused energy such as waste heat. It is also necessary to promote R&D from the viewpoint of reducing all energy (life cycle energy) that is directly or indirectly consumed during the production, use, re-use, and disposal of various products.

For this purpose, METI established a strategy for the development of energy conservation technologies from discovery through commercialization of a new technology, thereby enhancing the effectiveness of energy conservation technology development. In order to effectively promote a wide range and variety of energy-conserving technological R&D, it is important to prioritize and as such the ministry has specified the important fields that contribute to the promotion of energy conservation in the "Energy-conservation Technology Strategies 2011" enacted in March 2011.

(3) Other

Issues concerning energy and environment require research in both natural science and social science. The problems on global warming are the most crucial and urgent issue that humanity is facing. Therefore, on the "Research project on social scenarios for realizing a low-carbon society," the Japan Science and Technology Agency (JST) is conducting quantitative scenario research that is compatible with dissemination, financial effects and R&D on technologies devoted to reducing the emission of greenhouse gases. In addition, JST is implementing R&D aiming to create "Game changing technology" that converts existing concepts and realizes breakthrough on creation of technologies that enable continuous and steady reduction of the emission of greenhouse gases during the mid to long term (2030-2050) as stated in the "Advanced Low Carbon Technology Research and Development Program (ALCA)".

Table 2-2-6 shows major research topics in the energy sector (excluding nuclear power) implemented during FY 2010.

Table 2-2-6/ Major Research Projects in Non-nuclear Energy (FY 2010)

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	-R&D in new energy and energy conservation -Development of fuel cells featuring higher performance and lower cost than conventional types
	Japan Science and Technology Agency	-Social scenario research for low carbon society -Development of advanced low carbon technology
	National Institute for Materials Science	-Development of new heat-resistant materials that resist ultra high temperatures for long durations -Development of ultra-light and highly intense structural materials featuring excellent workability that contributes to efficient use of energy -Basic research for high efficient low cost next generation solar batteries. -Research on materials for nano-structure fuel cell. -Solid lithium secondary batteries with high reliability and high functions -Development of florescent materials for next generation white LED -Development of new thermo-electric materials for high temperature for unused heat waste
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		-Development of innovative technologies including those for petroleum refining responsive to heavier crude oil -Development of technologies that fuses advanced functions of petroleum refining within industrial complexes -Development of hydrogen energy technologies -Development of methane hydrate technologies -Research and development into clean coal technologies -Development of Integrated coal Gasification Combined Cycle Plant/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 nano-tube --Study on carbon-fiber reinforced composite materials for weight save of automotives --Development of core technology related to next-generation low power consumption semiconductors --Development of core technologies for inverters by using high-performance power devices (power elements) -Development of technology for distributed energy network systems -Development of technologies for sequestration and effective use of carbon dioxide
	National Institute of Advanced Industrial Science and Technology (AIST)	-Technologies for distributed energy network systems -Development of new fuel technologies including clean diesel engines -Technology development for commercialization of electron device using new semiconductor materials -Development of technologies for manufacturing ethanol from wood-derived biomass

Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization (NEDO)	-Demonstration research and technology development of a fuel cell (solid oxide fuel cell) using ceramics as electrolytes to improve reliability and durability [literal translation] -Highly functional and low cost technology development for fuel cells (polymer electrolyte fuel cells) that use ion-exchange membranes as electrolytes -Maintenance project for building common infrastructure for a hydrogen society (Basic principle of hydrogen storage and analysis for physical properties of hydrogen) -Research and development of new energy technologies -Development of technologies for practical use of next-generation battery systems -Development of fundamental technologies for evaluation of next generation storage batteries -Construction of consistent production system from production of cellulose based raw material to manufacture of ethanol -Development of production technologies for next generation bio-fuel by high efficient thermal energy conversion of micro-algae -Large-scale demonstration for dissemination of gas mixed with 3% ethanol -Technological Development of Yttrium-based Superconducting Power Equipment -R&D in innovative energy conservation technology -R&D in next generation heat pump system -Demonstration research on operation of fuel battery system on fuel cell-powered vehicle and hydrogen supply infrastructure -Development of technologies for hydrogen production, transportation and storage system with improved performance and low cost -Development of technologies for an environmentally friendly steel production process [literal translation] -Development of technologies for innovative glass melting process -Fundamental Technology Development of an Innovative Cement Manufacturing Process
	Japan Oil, Gas and Metals National Corporation	-Development of liquid fuel from natural gas -Promotion of development and utilization of oil and natural gas
Ministry of Land, Infrastructure, Transport and Tourism	National Institute for Land and Infrastructure Management	-Research on comprehensive evaluation methods and designing methods in relation to energy-saving functions in commercial construction [literal translation]
	National Maritime Research Institute	-Research contributing to the prevention of global warming derived from CO2 emission from ships [literal translation]
	Port and Airport Research Institute	-Demonstrative research of an offshore wind profile observation system [literal translation]

6 Manufacturing Technology

The manufacturing industry is one of the fields 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 3rd Basic Plan, manufacturing technology is being promoted in order to clearly show the viewpoint that it strengthens the ability of value-creating manufacturing, which aims for the development of S&T that raises the value of "things" by stepping out of the conventional development framework of manufacturing technology.

(1) Promotion of manufacturing technology with a shared foundation

MEXT promotes the development of the "only one, number one" advanced measurement analysis technology and devices that are able to respond to the needs of cutting-edge 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, complex, and large-scale simulation software in the area of manufacturing technology.

From FY 2010, METI is conducting the "Project on basic technology development for high output multi-wavelength laser processing,[Literal Translation]" to create a new manufacturing basic technology that allows realization of high precision, a short time and high quality processing for materials that are difficult to process without any direct contact. In addition, METI implements the development of manufacturing technologies from the different fields cooperating in the Bio Electro-mechanical Autonomous Nano Systems (BEANS) that integrate MEMS technology, biotechnology, and nanotechnology, leading to the generic technologies to realize next-generation micro devices which are high-performance and energy-saving (innovative biological devices that could not be manufactured before), such as medical instruments and environmental sensors. 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 manufacturing technology.

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

In pursuant to the "Act on Technology Advancement of SMEs," assistance is provided to improve the core manufacturing technology through budgetary measures.

1) Support for R&D by manufacturing SMEs

To support the R&D plans (Specific R&D plans) of SMEs approved by the national government based on the "Act on Technology Advancement of SMEs," the "Project for Strategic Promotion of Advanced Basic Technologies," which allows outsourcing the implementation of R&D, and the low-interest financing by the Japan Finance Corporation were implemented. In addition, expenses for patent application of achievements obtained through the plans of specific R&D by SMEs were mitigated.

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

METI implemented the "Upstream and downstream network construction support project, [Literal Translation]" where support was provided for activities to create opportunities to meet for 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, with establishment of opportunities for information exchange between them.

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

METI implemented 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 and advanced robots within

the scope of the Strategic Technology Roadmap. In addition, the "Green Sustainable Chemical Process Core Technology Development" has been implemented to enhance simplicity, cleanliness, lower energy consumption, and resource productivity in the manufacturing process of petrochemical products and functional chemicals, as well as to pursue waste reduction and easy recycling.

Such projects are expected to lead to innovative and dramatic development of manufacturing processes, thus contributing to industrial and international competitiveness.

(3) Development and fostering of personnel, ensuring thorough skill legacy

The manufacturing technology field can be referred to as the lifeline of our country, but a shortage in the quality and quantity of competent persons who support manufacturing technology is reaching serious proportions.

To solve this problem, MEXT is establishing systems to nurture individuals and is pursuing other versatile creative measures in elementary, lower secondary, and upper secondary education, and even in subsequent lifelong learning stages.

In elementary and lower secondary levels, manufacturing technology is taught within related academic subjects, based on 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 technical specialists reflecting specific regional characteristics, that was conducted in cooperation with local industries.

At the upper secondary level, under the Project to Foster Practical Competent Persons by Industry-Academia Collaboration: Towards fostering engineers, the engineers with advanced skills and education who were capable of innovating manufacturing were nurtured at universities, through development and implementation of educational programs organically combined with experiments, practical training and lectures in cooperation with regional communities and industries. In particular, technical colleges demonstrate the appeal of manufacturing technology through approaches such as the Idea Showdown: Technical College Robot Contest, while sharing manufacturing technology with the community through extension lectures and other efforts.

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 through practical training programs. Children are being given opportunities to experience and study manufacturing technology at the local level, through utilization of community centers, museums, and classrooms, ensuring ongoing nurturing of human resources in manufacturing. Furthermore, the retired population's knowledge and resources are also being tapped in order to ensure a continuation of skilled individuals in the field of manufacturing technology.

The major research topics in FY 2010 in manufacturing technology are as shown in Table 2-2-7.