Tentative Translation

White Paper on Nuclear Energy 2009

< Chapter 1>

March 2010

Japan Atomic Energy Commission

Cabinet Office

Chapter 1. Overview
-- Toward the Beginning of a New Era of Nuclear Energy Utilization --

1-1 Change in government and nuclear energy policy

In Japan, under the Atomic Energy Basic Act (Act No. 186 of 1955), research, development and utilization of nuclear energy are done only for peaceful purposes with assuring safety, operating democratically and autonomously, publicizing the results, and actively contributing to international cooperation. With this principle, it is aimed to secure energy resources in the future, to achieve progress in the sciences and technology and the promotion of industries, and thereby contribute to the welfare of mankind and to the elevation of the national standard of living.

The research, development, and utilization of nuclear energy, including that related to advanced megatechnologies, which require huge investment, are supported by science and technical research in other fields than nuclear energy and various general industrial activities, and are developed with the understanding of the public. For this reason, in order for this initiative to achieve the foregoing aim, the State should play a major role in research and development, regulation, guidance, financial actions, etc. Hence, the Japan Atomic Energy Commission formulated the "Framework for Nuclear Energy Policy" to clarify the basic concept of the measures concerning the research, development, and utilization of nuclear energy and to provide the guidelines for the planning and promotion of measures in each ministry and agency. The Framework also represents the expectations from local governments and business operators closely involved in nuclear administration and all levels of the public, with whom mutual understanding is necessary in advancing the nuclear energy policy.

In September 2009, the Japanese government changed from the coalition government of the Liberal Democratic Party and the Komei Party to the coalition government consisting of the Democratic Party, Social Democratic Party, and People's New Party. The new administration is strongly promoting global warming countermeasures as represented by the target value announced in the speech of Prime Minister Hatoyama at the U.N. Climate Change Summit Meeting held in September 2009, just after the Cabinet's inauguration, i.e., to reduce greenhouse gas emissions by 25 percent by 2020 from 1990 levels on the condition that a fair and effective international framework in which all major economies participate is established and that all other major countries set high targets. Moreover, the New Growth Strategy (Basic Policies), which was decided by the Cabinet in December of the same year, announced "Green Innovation (innovation in the environmental energy field)", "Life Innovation (innovation in the field of medical care and nursing care)", etc. as strategic innovation fields and declared to actively promote them. Through the comprehensive implementation of measures for each innovation field, the New Growth Strategy aims to reduce annual greenhouse gas emissions in the whole world by 1,300 million tons no later than 2020 using the private sector technologies of Japan, to build a society in which the

elderly can live out their lives while maintaining ties to their families and society, etc.

Nuclear technologies are expected to make a great contribution to achieving the goal set out by the new administration. In terms of Green Innovation, 54 nuclear power stations have already been contributing to energy security and a reduction of greenhouse gas emissions in Japan. Improvement of the performance of these plants and construction of new nuclear power plants are expected to add to efforts to achieve the international commitment. Moreover, since interest in nuclear power generation is also increasing in foreign countries, efforts to export high-level technologies already developed by the industries of Japan, nuclear power plants supported by a wealth of experience, etc. to foreign countries are expected to contribute to the economic growth of Japan, as well as to the global reduction of greenhouse gas emissions.

With regard to Life Innovation, preventive diagnosis incorporating Positron Emission Tomography (PET), which uses radiation, and X-ray CT are conducted widely in medical practices. The technique for heavy ion cancer therapy developed by the incorporated administrative agency, the National Institute of Radiological Sciences (NIRS), is said to be excellent in dose concentration over the cancer site and biologically effective in killing cancer cells. Dissemination of such radiation technologies in the medical field can contribute not only to the realization of good health, at which Life Innovation aims, but also to the fight against disease in many countries.

The new administration provided in the New Growth Strategy (Basic Policies) the basic policy concerning the utilization of nuclear energy, i.e., to "work on nuclear utilization steadily while giving top priority to safety and obtaining public confidence." In March 2010, the Cabinet decided to specify in the Bill of the Basic Act for Global Warming Countermeasures the promotion of nuclear measures as basic measures against global warming, stating, "with the aim to contribute to global greenhouse gas emissions reduction, the Government shall promote measures to shift to energy sources that emit less greenhouse gas, while assuring safety and gaining understanding and confidence of the public, particularly for measures concerning nuclear energy."

The Framework for Nuclear Energy Policy expects all actors engaged in nuclear energy to respond to the people's mandate and expectations for years to come by competing for performance and working hard together with worthy competitors and by changing the vision of nuclear technology, if necessary, not forgetting the potential risk of nuclear facilities even for a moment and not overestimating the superiority of nuclear technology as a result of adherence to the potential characteristics of nuclear technology. Entering such a new age of nuclear energy, it is essential for all related actors to investigate the actual status anew and stake challenges for the realization of various innovations, aiming to solve issues of the foregoing contributions.

1-2 Nuclear energy's contribution to solving social issues
1. Contribution of nuclear energy to global warming countermeasures
(1) Global warming countermeasures and nuclear power generation

There are great expectations in nuclear power generation from the viewpoints of securing stable energy supplies and global warming countermeasures (greenhouse gas emissions reduction). In order to respond to these expectations, it is essential for Japan, with top priority placed on safety, to make steady efforts to improve the capacity factor of existing nuclear power stations, take measures against aging nuclear reactors, and construct new facilities. Relevant ministries and agencies, power companies, etc. should actively promote such efforts in cooperation with local governments based on their roles and responsibilities.

Japan's energy self-sufficiency rate is only about 4%. Even if nuclear energy is counted as home-grown energy, the self-sufficiency rate is only about 16%. In view of the recent changes in the energy situation, such as violent fluctuations in the market price of fossil fuels and the global expansion of energy demand, it is very important as national policy to ensure a stable supply of energy. In Japan, the "Act concerning the Promotion of Utilization of Non-fossil Energy Sources by Energy Supplier and Effective Utilization of Fossil Energy Materials" was enforced in August 2009, which led to further promotion of the utilization of non-fossil energy sources including nuclear power.

Nuclear power generation provides 26% of the total generated energy produced by the general electricity industry in Japan (~ about 1 trillion kWh (fiscal 2008)). Nuclear power generation excels in supply stability mainly because the plant can operate more than one year once fuel is loaded and the reasonably assured reserve of uranium used as fuel is large and its production areas are not concentrated in particular areas. For this reason, promotion of nuclear power generation is significant for securing a stable energy supply.

Moreover, in recent years, expectations for nuclear energy have grown remarkably from the viewpoint of not only stable energy supply but also as a global warming countermeasure.

(i) Rising global concern over countering global warming

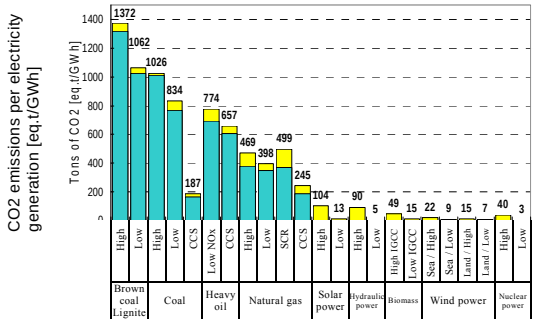
It is a common understanding around the world that global warming countermeasures are urgently required. In 2009, topics concerning global warming countermeasures or low-carbon societies were discussed at various international conferences, etc. For example, the Leaders' Declaration of the G8 L'Aquila Summit held in Italy in July 2009 reconfirmed the goal of "reducing worldwide greenhouse gas emissions at least 50% by 2050", etc. Also, the Copenhagen Accord adopted at the Fifteenth Session of the Conference of Parties to the United Nations Framework Convention on Climate Change ("COP15") held in Copenhagen, Denmark, in December of the same year, incorporated the recognition of the scientific view that global average temperature should be kept from rising more than two degrees Celsius and that greenhouse gas emissions should be reduced substantially. Furthermore, the Accord

required each member country to provide specific reduction targets / actions by the end of January 2010. As of March 2010, the countries and regions that account for more than 80% of the global emissions submitted such reduction targets / actions.

As Fig. 1-1 shows, nuclear power generation has very low emissions of carbon dioxide, which is a greenhouse gas, compared with power generation using coal, petroleum, natural gas, etc., thus realizing large-scale power generation with better fuel economy. For this reason, in order to realize sustainable growth while reducing greenhouse gas emissions, it is a shared understanding in the international community that the utilization of nuclear power is indispensable.

Figure 1-1: Carbon Dioxide Emissions from Various Power Sources

- With regard to solar, wind, and nuclear power, no carbon dioxide is emitted from the power generation process, and carbon-dioxide emissions per electricity generation are also small in the entire life cycle.



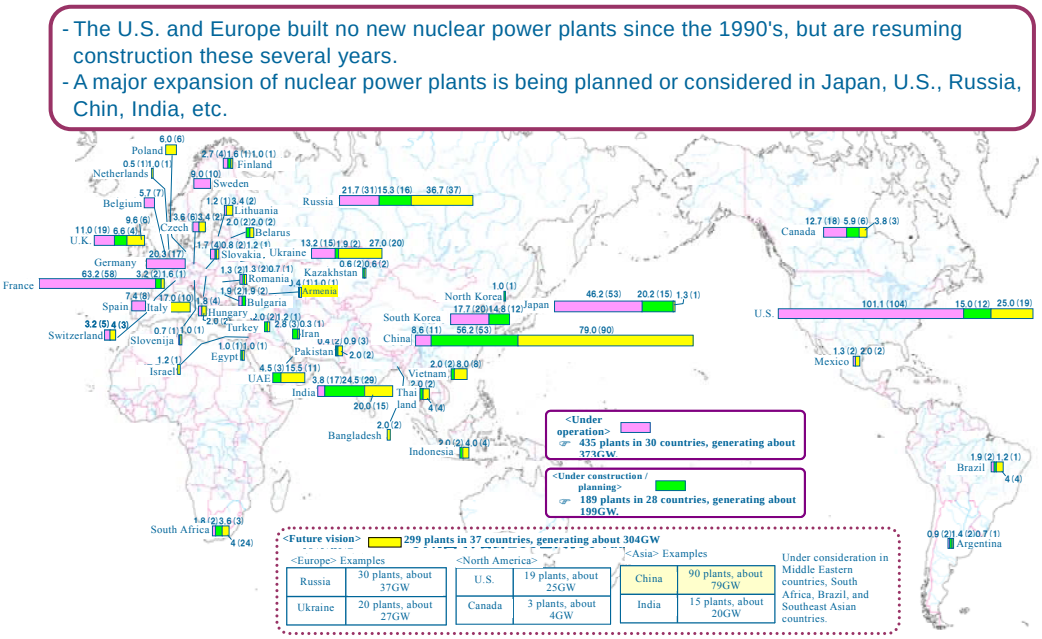
CO2 emissions per unit of production by power source

Note: The high / low values of each power source represent the maximum / minimum values of emissions resulting from a difference in conditions. The maximum value of nuclear power represents the case where the gas diffusion method was used for enrichment of uranium.
(The total capacity of facilities using the gas diffusion method accounts for about 20% of the total power generation capacity of the enrichment facilities in the world.)

Source: World Energy Council" Comparison of Energy System Using Life Cycle Assessment"

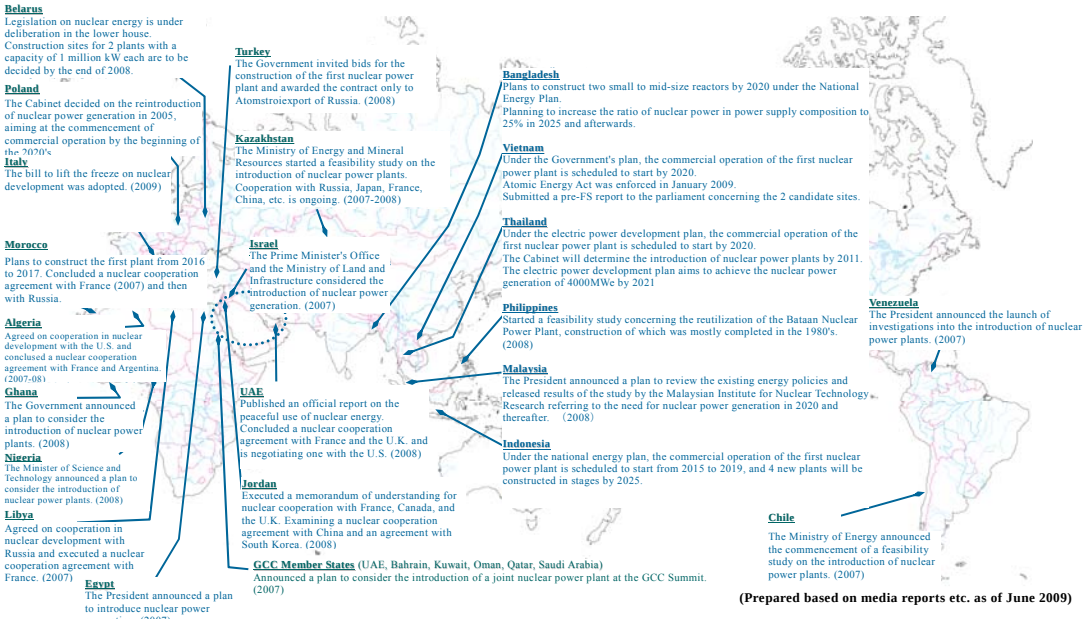
Accordingly, there is a general trend that nuclear power capacity will grow globally. As detailed in Chapter 5, the U.S. is planning the construction of about 30 new nuclear power plants for the first time in the past 30 years. In Europe, the U.K., Sweden, Italy, etc., changed their negative policy toward nuclear power generation. Thus, in Europe and the U.S., there is a move to return to nuclear power generation by reviewing their policy to phase out nuclear energy. China and India are moving toward the large scale introduction of nuclear power generation. In the Middle East and Southeast Asia, a move toward the new introduction of nuclear power is accelerating in the UAE, Vietnam, Indonesia, Thailand, etc. (Figs. 1-2 and 1-3). A new nuclear power plant construction plan is progressing in the UAE and Vietnam. The UAE has a goal of starting operation of the first nuclear power plant in 2017 and decided in December 2009 to order the construction of a nuclear power plant to a consortium of Korean companies centering on South Korean National Power Corporation. Vietnam plans to construct 4 plants on 2 sites (capacity of 1 million kWe each; 4 million kWe in total; 2 plants for each site). The first site is scheduled to start construction in 2014 and to start operation in 2020.

Figure 1-2: Expansion of Nuclear Power Generation around the World



The values stand for power generation capacity (Parenthesized figures represent the number of power plants).
Source: Prepared from data of the World Nuclear Association (WNA) as of December 2009.

Figure 1-3: Introduction of Nuclear Power in Various Countries



(ii) Expectations of greenhouse gas emissions reduction for nuclear energy in Japan

The new administration expressed its policy to strongly promote global warming countermeasures, aiming to reduce greenhouse gas emissions by 25 percent by 2020 from 1990 levels (Table 1-1).

Table 1-1: September 2009, Prime Minister Hatoyama's speech in the United Nations General Assembly (Extract)

As is apparent from the increased incidence of extreme weather events, rising sea levels and other phenomena, climate change is a danger that in fact already confronts us. Furthermore, efforts by one country can only produce limited effects. However, due to differences in short-term interests between developed and developing countries, and among developed countries as well as among developing countries, the path to creating a post-2012 framework will be anything but smooth.

The new Japanese government has set a very ambitious target for a greenhouse gas emissions reduction of 25% by 2020, as compared to the 1990 level. It has also made it clear that it is prepared to provide more financial and technical assistance to developing countries than in the past, in accordance with the progress of international negotiations. This international commitment is premised on the formulation of a fair and effective international framework by all major economies and agreement on their ambitious targets. Japan announced this ambitious pledge because it wishes to serve as a "bridge" among countries with varied interests and to preserve the planet for future generations.

I would like to appeal strongly to the distinguished representatives present today: let us work together to ensure the success of the upcoming COP 15 meeting.

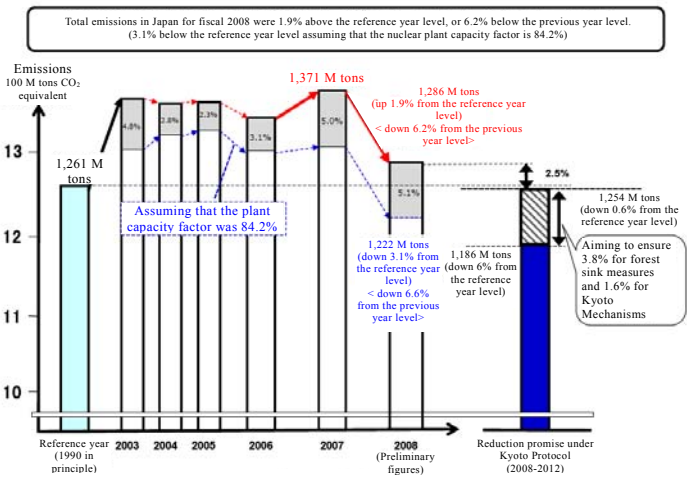
Source: Ministry of Foreign Affairs

According to the 2008 data on greenhouse gas emissions (preliminary figures) announced by Japan's Ministry of the Environment, total emissions in Japan amounted to 1,286 million tons, 1.9 percent higher than the level of the reference year (in principle 1990). However, the results of an analysis by the same Ministry showed that, if the average capacity factor of nuclear power plants were similar to the level of 1998 (about 84%), when plants were not subjected to the impact of long-term shutdown, and not the current level of about 60%, total emissions would have been lower than the reference year level for the first time, i.e., 3.1% below the same level. (Fig. 1-4).

In addition, METI provisionally calculated the reduction of carbon dioxide (CO2) emissions to result from the promotion of nuclear power generation through the "Long-term Energy Supply and Demand Outlook (Recalculated)" (August 2009) of the Advisory Committee for Natural Resources and Energy.

The Outlook indicates that CO2 emissions can be reduced about 60 million tons (4.8% of the 1990 total emissions) by raising the plant capacity factor from 60% to 80%, or about 50 million tons (4.0% of the 1990 total emissions) by starting the operation of the 9 new units of nuclear power stations scheduled to be completed by 2020.

Figure 1-4: Greenhouse Gas Emissions in Japan



Source: Ministry of the Environment

The Cabinet Office conducted the "Special Public Opinion Poll about Nuclear Energy" in 2009 October. According to the results of this Poll, the recognition of nuclear power generation as a global warming countermeasure increased as compared with the results of the Poll similarly

conducted in 2005.

(iii) Future issues

As mentioned, the effect of nuclear energy as a global warming countermeasure is also expected in Japan. Domestic electric power companies are working on improving the capacity factor of nuclear power plants, measures against aging, construction of new nuclear power plants, etc., while ensuring safety as an essential pre-condition.

In 2007, the Kashiwazaki Kariwa Nuclear Power Station, which was affected by the Niigata Chuetsu-Oki Earthquake and had been shut down for a long time, finished maintenance and inspection of the facilities, etc., and, its Units Nos. 7 and 6 resumed operation respectively in December 2009, for the first time in two years, and in January 2010. If Units Nos. 1-5 also resume operation in the future, the capacity factor will improve to the level before the long-term shutdown due to the Earthquake.

For seismic safety, all power stations conducted checks of their compliance with the Seismic Safety Review Guidelines, revised in 2006. Checks on Kashiwazaki Kariwa Nuclear Power Station Units Nos. 6 and 7 were completed before the end of fiscal 2009 in view of the findings of the Niigata Chuetsu-Oki Earthquake. For 3 other units of the Kashiwazaki Kariwa Nuclear Power Station, the interim report was completed.

In addition, the new inspection system was introduced in January 2009, enabling a flexible and elaborate inspection according to the characteristics of each power station through the improvement / reinforcement of the maintenance activities of each plant. As a result, it became possible to extend in stages the interval of periodic inspections to a maximum of 24 months while ensuring safety and reliability. Utilization of this system by power companies, etc., is expected to lead to steady improvement in the capacity factor.

Power companies, etc. are also systematically promoting measures against aging power plants that have been operating more than 30 years. The year 2010 marks the 40th year since Tsuruga Power Station Unit No. 1 of Japan Atomic Power, Inc. and Mihama Power Station Unit No. 1 of Kansai Electric Power Co., Inc. started operation. The two power companies plan to continue operation of these plants through the formulation of a long-term maintenance policy under a technical assessment of aging and a specific maintenance plan under the policy and examination / confirmation of the same by the NISA (Nuclear and Industrial Safety Agency).

Moreover, efforts to enhance capacity are ongoing, such as construction of new nuclear power plants. In December 2009, Unit No. 3 of the Tomari Power Station of Hokkaido Electric Power Co., Inc. started commercial operation. In the same month, Chugoku Electric Power Co., Inc. submitted an application for the construction of the Kaminoseki Power Station to NISA. As of the end of December 2009, 54 nuclear power units were in operation, and 14 units were under construction or preparation for construction. The rated thermal power operation, which was proposed by the JAEC in 2000, has been established, and many power plants exceed the rated electric power in winter. Some power plants improved turbine efficiency so that it operated at improved electricity output. Efforts to improve rated thermal power operation, which has already been implemented in some foreign countries, should be continued.

--- Results of Special Opinion Poll concerning Nuclear Power ---

The Cabinet Office conducted a special opinion poll concerning nuclear energy covering 3,000 persons nationwide aged 20 or more in October 2009. (The number [rate] of valid responses was 1,850 persons [61.7%].)

To the question asking how nuclear power generation in Japan should be advanced in the future, the respondents who answered "Should be promoted actively" or "Should be promoted carefully" amounted to about 60%. The percentage of respondents to the same question increased about 5% as compared with the previous poll (2005). This suggests that views on nuclear power generation are changing positively.

To the question how the respondents feel about nuclear power generation, those who answered "Feel secure" or "Feel somewhat secure" amounted to about 42%, an increase of 17% from the previous poll. As the reason for feeling secure, about 40% of the respondents chose "Because nuclear power plants in Japan have sufficient record of operation," which suggests that the performance record makes them feel secure.

On the other hand, the percentage of respondents who answered "Feel insecure" or "Feel somewhat insecure" reached about 54%, which decreased from the previous poll, about 66%, but still exceeds 50%. As the reason for feeling insecure, about 75% and about 53% of the respondents chose "Because a nuclear accident may occur even in Japan" and "Because earthquakes are frequent in Japan," respectively.

Other questions were concerned with the recognition of nuclear energy, high-level radioactive waste disposal, etc. The figure below outlines the Poll.

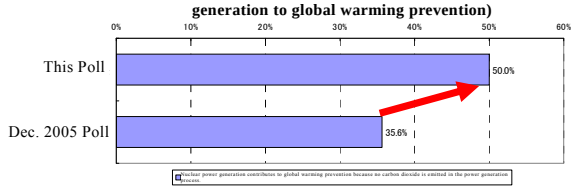
In planning and promoting nuclear policies, we sincerely accept the results of this Poll.

- Key Points of the Results of "Special Opinion Poll concerning Nuclear Power"

1. Recognition of nuclear energy

- The percentage of respondents who are aware that nuclear power generation "contributes to global warming prevention" increased not less than 10% from the 2005 Poll.
- Not less than a half of the respondents were aware that "waste called 'high-level radioactive waste' is generated."

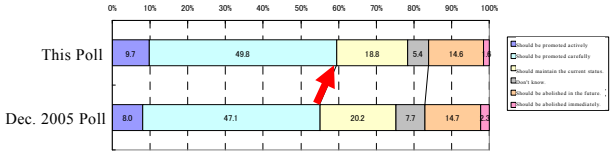
Recognition of nuclear energy (Contribution of nuclear power generation to global warming prevention)



2. Position concerning the promotion of nuclear power generation

- Opinions that support the promotion of nuclear power generation ("Should be promoted actively" and "Should be promoted carefully") increased from the 2005 Poll. (55.1% → 59.6%)

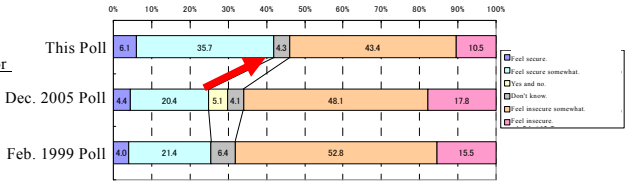
Position concerning the promotion of nuclear power generation



3 to 5. How do the respondents feel about nuclear power generation, etc.

- Those who consider nuclear power generation to be secure ("Feel secure" or "Feel secure somewhat") greatly increased from the 2005 Poll (24.8% → 41.8%)
- "Sufficient record of operation" was the most chosen as the reason for feeling secure.
- "Accidents" and "Earthquakes" were mostly chosen as the reason for feeling insecure.

How do you feel about nuclear power generation?



6 and 7. High-level radioactive waste disposal

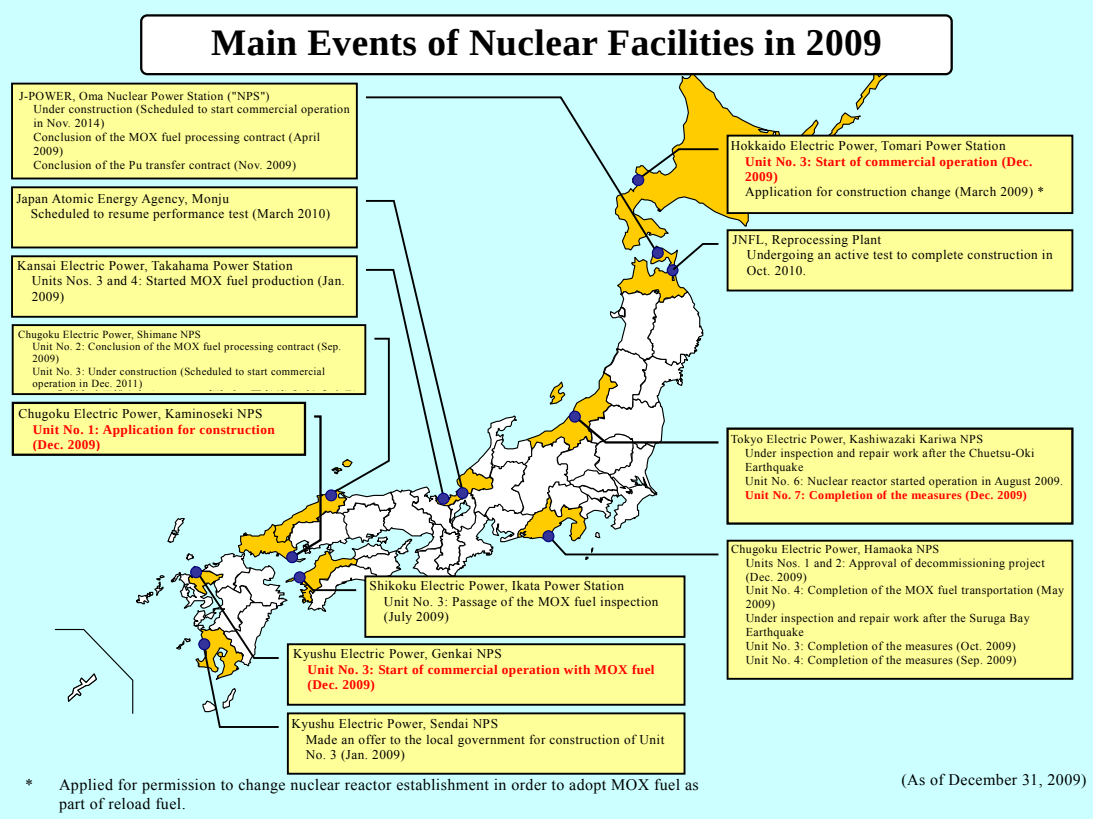
- More than 80% of the respondents answered that their generation should be responsible for selecting disposal sites for high-level radioactive waste.
- On the other hand, about 80% of the respondents answered that they oppose to the construction of a disposal site of high-level radioactive waste near their residence.
- The tendency of "NIMBY" is seen with regard to the disposal of high-level radioactive waste.

* NIMBY (Not In My Back Yard): People are aware of social needs for industrial waste disposal sites or power generation facilities, but they will actually oppose it if such site or facility is decided to be constructed near their residence.

These efforts should be steadily implemented by power companies, etc. for the maintenance and improvement of electric generating capacity. Accordingly, relevant administrative organs and power companies should fully perform their roles and responsibilities, and advance their programs to construct new nuclear power plants as planned in cooperation with local governments. Furthermore, they are expected to contribute to global warming countermeasures on a global scale, as well as to economic growth through the export of Japan's nuclear power systems, including nuclear power plants, operation / maintenance technologies, safety culture, etc.

On a mid- to long-term basis, nuclear power generation should be continued without interruption. Accordingly, it is important to advance cooperation with local communities where nuclear facilities are newly constructed or replaced, and consideration of future vision for the next-generation light water reactors, etc.

Figure 1-5: Main Events concerning Nuclear Power Generation / Nuclear Fuel Cycle in 2009



Source: Cabinet Office

(2) Status and issues of nuclear fuel cycle

Japan promotes a nuclear fuel cycle that supports nuclear power generation. It is a great step for nuclear fuel cycle that “pluthermal” (plutonium thermal recycling) power generation has started. Efforts to promote nuclear fuel cycle are now ongoing, including examination for the construction of intermediate storage facilities for spent nuclear fuel, MOX fuel processing plants for plutonium recycling, preparation for resuming the operation of "Monju," etc. Meanwhile, the Rokkasho Reprocessing Plant has still some issues with the vitrification process, which all concerned parties are striving to solve.

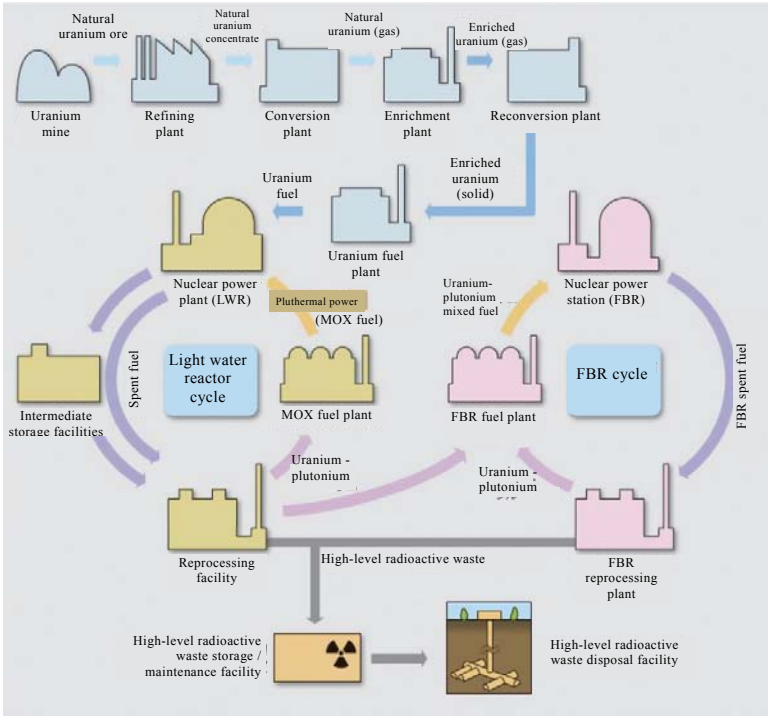
Also, under the policy that radioactive waste generated in the process of power generation or nuclear fuel cycle should be properly treated / disposed of according to the properties of the waste, some types of low-level radioactive waste has already been disposed of. Meanwhile, there is increasing need to secure intermediate storage facilities for spent nuclear fuel, select disposal sites for high-level and some types of low-level radioactive wastes, increase understanding of the reuse of clearance materials in society that can be handled as general industrial waste, etc.

(i) Status of the nuclear fuel cycle in Japan

1) Status of plutonium use, etc.

In Japan, the Framework for Nuclear Energy Policy provides for the promotion of a nuclear fuel cycle that reprocesses spent fuel produced in the power generation process and effectively uses the uranium and plutonium recovered (Fig. 1-7). The new administration aims to steadily implement a nuclear fuel cycle that supports nuclear power generation by giving top priority to assuring safety.

Figure 1-7: Concept of Nuclear Fuel Cycle



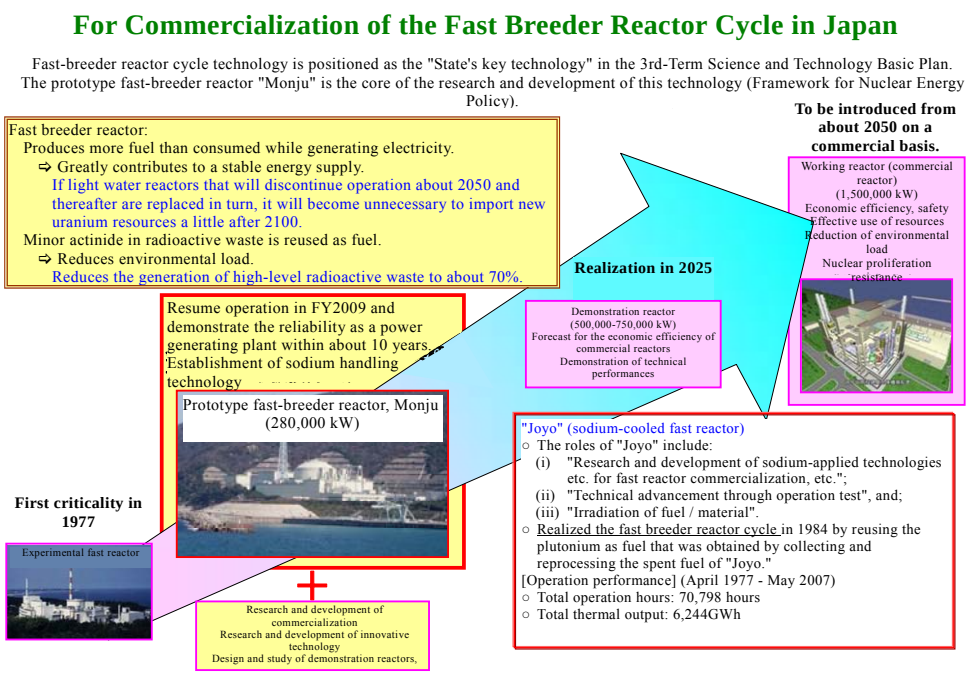
Source: Prepared by ANRE, METI

In December 2009, Kyushu Electric Power's Genkai Nuclear Power Station Unit No. 3. started the commercial operation of “pluthermal”(plutonium thermal recycling) power generation for the first time in Japan. In March 2010, the nuclear reactor of Ikata Power Station Unit No. 3, Shikoku Electric Power, was loaded with MOX fuel to start operation. In January 2010, Tohoku Electric Power's Onagawa Power Station was permitted to operate pluthermal power generation. Electric utilities aim to operate 16 to 18 nuclear reactors for plutonium recycling, including these units, by 2015.

The uranium enrichment plant in Rokkasho Village, Aomori, replaced part of the centrifugal separator used to prepare for uranium enrichment with a new high-performing centrifugal separator scheduled to start in fiscal 2011. The plant constructed a new enrichment machine manufacturing facility on its site and is undergoing examination for replacement by the Government. In addition, the final active test is ongoing in the reprocessing facility. Of the reprocessing process, tests were substantially finished with shearing / dissolution, separation, and refinement, etc., but some issues remain with the process of vitrifying high-level radioactive waste. In order to overcome these issues, Japan Nuclear Fuel (JNFL) is doing a mock-up test and working in the cell, and aims to complete the facility in October 2010. Moreover, an MOX fuel processing plant for plutonium recycling and intermediate storage facilities for spent nuclear fuel are scheduled to be constructed in Aomori Prefecture, and application for the construction is under examination by the Government.

The prototype fast-breeder reactor "Monju" is positioned as an important facility for progressing research and development concerning the fast breeder reactor cycle, which is part of the nuclear fuel cycle. Operation at Monju has been suspended for about 14 years since a sodium leak accident in 1995, but it aims to resume operation in the spring of 2010 through cause investigation, safety checks of the facility, work to improve seismic margin, etc. Furthermore, in order to plan a demonstration reactor following "Monju," research and development of innovative technologies are conducted as the FaCT (Fast Reactor Cycle Technology Development) Project, led by the Japan Atomic Energy Agency (JAEA). In connection with the results of this research and development, relevant administrative organs, power companies, etc. are considering to make joint efforts to start operation of a demonstration reactor around 2025 (Fig. 1-8) . Chapter 3 describes the status of the light water reactor cycle, and Chapter 4 describes the status of research and development concerning fast breeder reactors.

Figure 1-8: Positioning of "Monju" and FaCT Project for Realization of Fast Breeder Reactor Cycle



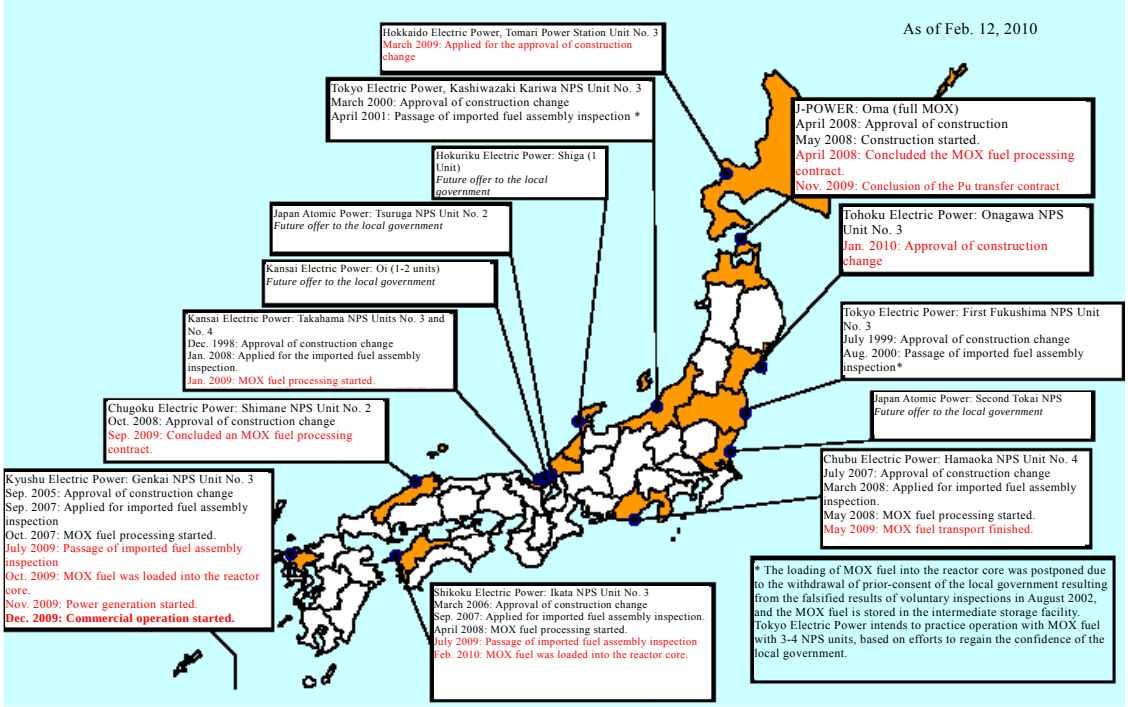
Source: Japan Atomic Energy Agency

(Reference) What is “Pluthermal”?

Electricity generation using plutonium with a light water reactor. The spent fuel in the light water reactor is collected and reprocessed to obtain plutonium and uranium, and they are processed into fuel (MOX fuel) by mixing and reloaded into the same reactor to generate electric power.

“Pluthermal” (plutonium thermal recycling) power generation has been adopted for many years in 9 foreign countries including France, Germany, and the U.S. In Japan, a demonstration of plutonium recycling was done in the 1980's using a fuel assembly consisting of a small number of elements, and a safety assessment was conducted by the NSC in 1995.

Figure 1-5: Main Events concerning Nuclear Power Generation / Nuclear Fuel Cycle in 2009



Source: Prepared by the Cabinet Office in reference to the "Efforts of Power Companies Using Energy (Nuclear fuel cycle)"--- Material No. 2 of the 2nd JAEC Policy Evaluation Committee Meeting concerning Energy Use (Nuclear Fuel Cycle).

2) Status of waste disposal

Radioactive wastes generated from the use of nuclear energy are classified into high-level and low-level radioactive wastes according to the properties, and they are both disposed of appropriately. Chapter 2 describes the types of radioactive wastes and other details.

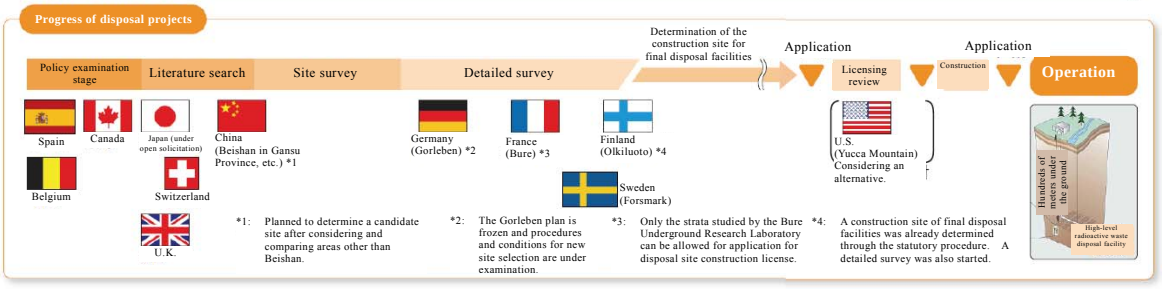
For the disposal of high-level radioactive waste, geologic disposal is selected as the most practical disposal method in many countries, and efforts to realize geologic disposal are carried on (Fig. 1-9).

In Japan, the Nuclear Waste Management Organization (NUMO) is openly soliciting throughout the country "volunteer municipalities for preliminary investigations of their area as a site for high-level radioactive waste disposal facility." This system was revised in fiscal 2008 to allow the Government to offer a literature survey to the local government with regard to survey areas, but the Government is at

present advancing site selection through public solicitation. NUMO and METI also actively conducted public hearings / relations activities in fiscal 2009 so that the citizens may consider the issue of siting of disposal facilities as an issue of the entire population (Fig. 1-10).

Figure 1-9: Status of High-level Radioactive Waste Disposal Projects around the World

- Of the countries that advance disposal projects, only Finland and Sweden decided a disposal site.



Countries	Main events
U.S.	- Yucca Mountain had been determined as a disposal site and the NRC was examining the construction permit application, but the Obama Administration decided to cancel the Yucca Mountain plan and examine alternatives in 2010.
Finland	- Olkiluoto was determined as a disposal site and construction of the subsurface characteristic research facility is ongoing. - The construction permit application for the disposal site is scheduled in 2012.
Sweden	- Forsmark was determined as a disposal site. - The construction license application for the disposal site is scheduled in 2010, and test operation is planned in 2020.
France	- A disposal site is to be located in an area within 250 km^2 from the Bure Underground Research Laboratory. - Efforts for site selection and construction license application are ongoing.

Countries	Main events
Germany	- The compliance review of Gorleben as a candidate disposal site was frozen due to the shift to a policy to phase out nuclear energy. - Requirements for site selection and site compliance are under examination.
Switzerland	- A disposal site has not yet been determined. - Site selection is going on from October 2008.
U.K.	- A disposal site has not yet been determined. - Site selection has been ongoing since June 2008.
Canada	- A disposal site has not yet been determined. - Formulation of site selection procedures started in September 2008.
Spain	- Site selection activities were frozen due to the postponement of a decision on final waste control policy.
Belgium	- A decision was made to compare reprocessing and direct disposal, and the survey for the comparison is still ongoing.

Source: Prepared by the Cabinet Office in reference to the "Disposal of High-level Radioactive Waste in Foreign Countries" by the Agency of Natural Resources and Energy, Feb. 2009.

Figure 1-10: Symposium "Geologic Disposal Project Along With Local Community -- Learn from Sweden's Efforts --"

Source: Agency of Natural Resources and Energy

In accordance with the revisions of the Act on the Japan Atomic Energy Agency, Independent Administrative Agency in 2008, the JAEA was designated as the implementing entity of the disposal of low-level radioactive waste generated at research facilities, universities, medical institutions, private enterprises, etc. In response, the Government formulated the "Basic Policy concerning the Implementation of Land Disposal" in December 2008, and, in accordance with this Basic Policy, the JAEA worked out the "Land Disposal Implementation Plan" and started the project after obtaining approval in November 2009 from the Minister of Education, Culture, Sports, Science and Technology

(MEXT) and the Minister of Economy, Trade and Industry (METI). The JAEA plans to design the concepts of disposal facilities, formulate siting criteria and siting procedures, etc.

Of the low-level radioactive waste, the method of intermediate depth disposal, which disposes of waste 50-100m underground, is applied to waste of relatively high radiation. The Nuclear Safety Commission(NSC) is examining the criteria for the safety review of this method. Meanwhile, the Radioactive Waste Management Funding and Research Center is conducting research and study concerning the disposal technology of this method.

--- Necessity for High-level Radioactive Waste Disposal and Public Hearings and Publicities ---

Etsuko Akiba, Member of the Japan Atomic Energy Commission

In order to establish a sustainable society, "3R's (Reduce, Reuse, Recycle)" activities that use resources as long and effectively as possible, reuse them, and recycle them are important. Generally speaking, Recycling waste resources requires energy and costs, but there is waste that cannot be recycled by any means. Also, "garbage" remains in electric recycling of nuclear power plants. That is the waste fluid containing the fission product that is generated in the process of separating uranium and plutonium for recycling. When this waste fluid is vitrified through mixture with glass, it becomes high-level radioactive waste called "electric garbage," which has a very high radiation level and high temperature and, therefore, needs to be isolated from the public's living environment for a long time. In Japan, such "electric garbage" is planed to be disposed of in a stable stratum not less than 300m deep. Our generation is responsible for the safe disposal of waste producted for our convenience life in the process of the fuel recycling. At present, 1310 pieces of vitrified waste (as of October 2009) that were already reprocessed abroad are being stored in the storage control center of Rokkasho Village, Aomori, for 30 to 50 years.

Nuclear Waste Management Organization (NUMO) is openly soliciting for a final disposal site. Also, the State can make an offer. The Framework for Nuclear Energy Policy provides that the Government, NUMO, electric power companies, etc. should contrive ways to strengthen their organizations in mutual cooperation and with appropriate division of roles so that they may obtain the understanding and cooperation of various sectors of communities in the country, including local governments and electric power consumers who benefit from nuclear power generation, as well as local residents. Interactive communication between various stakeholders is sought. First of all, it is necessary to establish an environment so that local governments may easily apply as a candidate site, while mutual understanding with the public is more important than anything. For geologic disposal, it is essential to provide opportunities where people consider it as "their own business," not as "other people's business," and to provide information politely, such as answering questions from various viewpoints, e.g., "safety", "site selection process", and "cost sharing."

According to the public poll conducted by the Cabinet Office, about 80% of the respondents answered that "their generation should be responsible for the prompt selection of disposal sites for high-level radioactive waste," while about 80% of the respondents answered that "they oppose to the construction of a disposal site of high-level radioactive waste near their residence." It is important to consider those public opinions in selecting a disposal site.

Japan Atomic Power's Tokai Power Station discontinued commercial operation in March 1998, and decommissioning action of the station started in December 2001. In 2009, the work to disassemble its steam generator, etc. was conducted. In order to complete the decommissioning by March 2018, other various works including equipment removal will be steadily conducted. Within the JAEA, the advanced

thermal reactor "Fugen," which discontinued operation in March 2003, was renamed the "Fugen Decommissioning Engineering Center" in February 2008. In 2009, the JAEA advanced the dismantlement of turbine equipment, which has a lower radiation level, and research and development of cutting methods for disassembling the nuclear reactor. In November 2009, Chubu Electric Power Co., Inc. was given permission for their decommissioning plan for Hamaoka Power Station Units Nos. 1 and 2, which are decommissioned for the first time in Japan as a commercial light-water type power-generating reactor facility. Radioactive waste to be generated in decommissioning is appropriately treated / disposed of according to each radiation level.

Some waste generated in the decommissioning of nuclear reactors includes radioactive materials whose impact on health can be ignored because of a low concentration. Such materials can be reused or disposed of as general industrial waste under the "clearance system." Iron material, etc. made of such materials are actually processed into and used as benches, tables, shields, etc.

(ii) Future issues

First of all, the construction of the Rokkasho Reprocessing Plant should be steadily completed in order to realize the nuclear fuel cycle. The causes of each problem found in the process of producing vitrified waste should be analyzed and certainly solved in cooperation with research institutions experienced in reprocessing and power companies, and through collection of knowledge from the persons involved. It is also an important issue to secure intermediate storage facilities that can cover the amount of spent fuel generated by nuclear power stations. With regard to how to deal with the spent fuel stored in intermediate storage facilities and spent MOX fuel generated through plutonium recycling, in view of the results of consideration made by relevant administrative organs, power companies, etc. about the vision of next reprocessing plant that follow the Rokkasho Reprocessing Plant, the Government should start consideration.

For disposal of high-level radioactive waste, no local governments have ever responded to open solicitation as a candidate survey area in spite of the activities of NUMO and METI. It is, therefore, necessary to continue to explain the safety and public benefits of disposal to the public and to promote the creation of an environment that facilitates the response of municipalities to the solicitation.

In addition, as regards the clearance system, the usage of clearance materials remains very low at present. Materials to which the clearance system is applicable are regarded as resources, not waste. Aiming for the wide use of such resources, it is important first to develop activities for further understanding so that a wide range of people may learn about the system.

2. Use of radiation

Radiation is used in various fields, including medical care, agriculture, and industry, and greatly contributes to the public welfare and an affluent way of life. Use of radiation is also making great contribution in the fields of Life Innovation and Green Innovation. Thus, steady expansion is essential in the utilization of radiation.

(1) Status of radiation use

Radiation is used in various fields, including medical care, agriculture, and industry. We benefit from radiation in various ways in our lives. For example, radiation is used for cancer treatment and preventive diagnosis in the medical field, improvement of plant species in the agricultural field, and semiconductor manufacturing and radial-ply tire production in the industrial field. Moreover, radiation use greatly contributes to the fields of Life Innovation and Green Innovation.

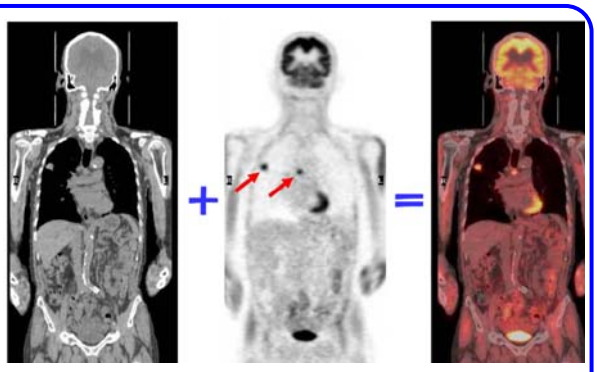
In the field of Life Innovation, "diagnosis" and "treatment" using radiation are widely conducted and advancement of related technologies is ongoing, while radiation technologies for protein structure analysis, etc. are applied to the development of new drugs.

Diagnosis using roentgenography, which detects radiation passing through the human body to find a diseases, etc., is a technique of examination that many people have experienced. Using the same principle, X-ray CT obtains tomographic and three-dimensional images of the human body, and diagnosis using this technology has been popular in recent years, amounting to about 2 million cases per month. In addition, the techniques of nuclear medicine diagnosis (PET, SPECT, etc.) have been applied to about 1.4 million cases every year, which detects a disease, dysfunction, etc. with images of the metabolism, etc. in the living body obtained by administering radiopharmaceuticals and measuring radiation emitted from the inside of the body with radiation measurement equipment set outside the body. In recent years, technologies concerning nuclear medicine diagnosis, such as imaging of human body functions with higher spatial resolution, is progressing, and are expected to promote the detection of cancer at an early stage, advanced investigation of dysfunction in the human body, verification of the effect of new drug candidate compounds, etc. (Fig. 1-11)

Figure 1-11: PET-CT Equipment and Diagnostic Images

PET-CT equipment provided with CT and PET functions

Source: Material by New Plan Formulation Meeting, Atomic Energy Commission of Japan



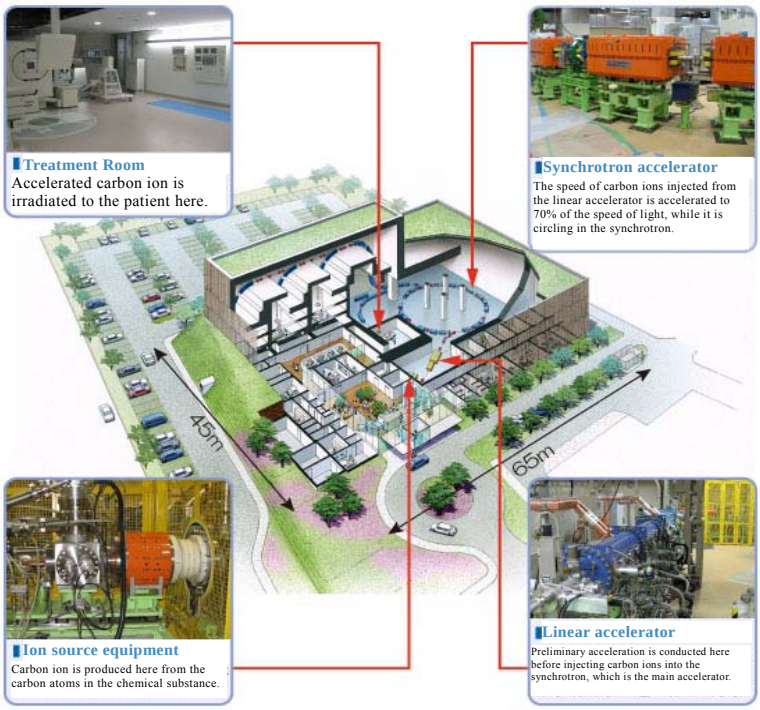
X-ray CT PET PET-CT

Diagnostic image of lung cancer (X-ray CT, PET, PET-CT)

Source: Gunma University

"Treatment" based on radiation uses the ability of radiation to kill cells. Treatment using radiation, such as X-rays and γ rays, is widely conducted in medical practices. In recent years, leading-edge treatment using corpuscular beams generated by an accelerator, such as proton beams and heavy ion beams, is also progressing. For example, regarding the new radiotherapy for cancer using heavy ion beams, the National Institute of Radiological Sciences (NIRS) accumulated more than 4,800 clinical cases as of July 2009. This new radiotherapy is applied to cancers that are difficult to treat with surgical operation or other method, and are said to be excellent in dose concentration on the cancer region and the biological effect of killing cancer cells as compared with the conventional radiotherapy using X-rays, γ rays, etc. A facility holding smaller equipment for this new radiotherapy was recently constructed at Gunma University and has startedoperation since March 2010 (Fig. 1-12). Construction of a similar facility with a heavy ion medical accelerator is also planned in Saga Prefecture. Moreover, studies on the radiotherapy that kills cancer cells using neutron beams generated by nuclear reactor (Boron-neutron capture therapy) are ongoing. As of January 2009, clinical trials were conducted for 525 cases.

Figure 1-12: Overview of Heavy Ion Irradiation Facilities, Gunma University Heavy Ion Medical Center



Source: Gunma University

In the field of Green Innovation, development of materials using radiation is ongoing, including a polymer electrode film that contributes to higher performance of fuel cells, a capturing material that can selectively adsorb useful resources such as uranium, superconductor, etc. Thus, radiation is used for the development, etc. of technologies and materials that contribute to the promotion of the creation of a low carbon society (Fig. 1-13).

Figure 1-13: Efforts for Green Innovation

Development of a high-performance fuel cell film

Development of capturing materials for useful resources such as sea water uranium

Source: Japan Atomic Energy Agency

(2) Future issues

As mentioned in section (1), the use of radiation is making great contributions to the development of the Life Innovation and Green Innovation fields. Thus, steady expansion of radiation use is important in the future.

For further use of radiation, it is important to deepen the understanding of the public about radiation use through active dissemination, by the interested parties and individuals, of information concerning the effectiveness and safety of radiation use.

It is also important to promote an understanding of the benefits and safety of radiation use among potential users, mainly through trial use of radiation facilities, and thereby expand the scope of users.

In the medical field, a globally short supply of molybdenum-99, a raw material of radiopharmaceuticals broadly used for nuclear medicine diagnosis, is pointed out as a serious issue by the persons concerned. In order to solve this issue, the persons involved should closely cooperate with each other, including consideration of the production of molybdenum-99 in Japan. Moreover, while radiotherapy is expected to further develop, the number of radiation oncologists, etc. in Japan is insufficient compared with overseas countries, so the development / securing of human resources is sought in the radiotherapy field.

Furthermore, Japan has developed the world's most advanced research facilities for radiation use, including J-PARC, SPring-8, RI Beam Factory, and heavy ion medical accelerator (HIMA), and will begin the use of an X-ray free electron laser in fiscal 2011. These facilities will greatly contribute to the development of materials with new functions, accreditation of the development of new drugs, advancement of medical technologies, etc., and are expected to be used widely by the industrial world as a base for promoting Life Innovation and Green Innovation.

--- Utilization of Atomic Energy and Radiation as Science / Technology ---

Tatsujiro Suzuki, Vice Chairperson of the Japan Atomic Energy Commission

When you speak of the peaceful uses of nuclear energy, nuclear power generation usually comes to the mind of most people. There is, however, another peaceful use of nuclear energy not involving "nuclear fission." According to a survey in fiscal 2007, the market size of radiation use is estimated at 4.1 trillion yen, which is almost the same as that of nuclear energy use (4.7 trillion yen). In terms of the science and technology concerning atomic energy, the existence of "radiation" is notable as a decisive difference from other sciences and technologies. In a sense, radiation identifies atomic energy as a science / technology.

In fact, the nuclear engineering department of the Massachusetts Institute of Technology (MIT) in the U.S. once discussed in the 1980's whether to change the department name. At that time, the names of nuclear engineering departments at Japanese universities were changed from "nuclear engineering department" to the ones that impressed nuclear power as "nuclear power as an integrated science / technology," such as the "system quantum engineering" or "energy quantum engineering" department. Similar discussion was also made at MIT, which consequently changed the department name to "Nuclear Engineering and Radiation Science." As a result, the number of students who applied for study in medical care or industrial use increased, which stopped the declining trend of the number of students in the nuclear engineering department. The department was then renamed the department of "Nuclear Science and Engineering," but the vision of the department is the same as in the previous name. Sciences concerning the nucleus include nuclear fusion and radiation science.

As mentioned, atomic energy as a science / technology has developed based on the two pillars of energy use and radiation use. For radiation use, relevant information should be made publicly available as much as possible and the risks and benefits should be properly discussed.

1-3 Rising awareness of nuclear nonproliferation and security, and reinforcement of international activities concerning nuclear power

1. Trends of nuclear nonproliferation and security

Japan has so far been committed only to the peaceful uses of nuclear energy. In order for the public to enjoy the benefits of peaceful use, it is necessary to ensure efforts for nuclear nonproliferation. For this reason, Japan contributes human resources, finances, and technologies so that the IAEA may conduct safeguards activities effectively, and cooperate in strengthening the international nuclear nonproliferation regime so that nuclear proliferation risks may not increase in line with the expansion of nuclear use.

Japan has also been exerting efforts to ensure nuclear security so that nuclear materials, etc. may not be used unlawfully, and should also consider an appropriate way of ensuring nuclear security for Japan in view of the results of discussion in the JAEA, etc.

In Japan, nuclear energy can be used only for peaceful purposes. In using nuclear energy, it is required to make the best use of benefits from it while ensuring safety, nuclear nonproliferation, and nuclear security.

(1) Rising awareness of nuclear nonproliferation and security around the world

In 2009, awareness increased globally of the significance of efforts for nuclear nonproliferation. Speeches and consensuses concerning nuclear disarmament, nonproliferation, and security were made in that year through various opportunities, such as U.S. President Obama's speech on "A world without nuclear weapons" made in Prague in April, and the U.N. Security Council Summit Meeting in September. Prime Minister Hatoyama also made a speech at the U.N. Security Council Summit Meeting, emphasizing to the world the necessity for observing the 3S's (Safeguards, Security, Safety) for the peaceful use of nuclear energy (Fig. 1-14 and Table 1-2).

In addition to the reinforcement of safeguards activities by the IAEA, discussions have been made from a viewpoint of nuclear nonproliferation, e.g., discussion in the Global Nuclear Energy Partnership (GNEP) concerning the usefulness of the framework of multi-national control of nuclear fuel cycle activities. Summarizing these discussions, the U.N. Security Council Summit Meeting adopted a resolution that indicated the action guidelines for future international community. As a specific action for the guidelines, a "Nuclear Security Summit" will be held in April 2010 with the aim to raise international concern about the significance of nuclear security.

Figure 1-14: Prime Minister Hatoyama making a speech in the United Nations

Source: Cabinet Public Relations Office

Table 1-2: Points of Prime Minister Hatoyama's Speech in the U.N. Security Council Summit Meeting

(a)	Firmly maintain the three non-nuclear principles. Japan takes the lead in efforts for the abolition of nuclear weapons.
(b)	Request nuclear weapon countries to disarm their nuclear arsenals.
(c)	Make a strong call for the early effectuation of CTBT and early start of negotiations for the Fissile Material Cutoff Treaty.
(d)	Japan promotes active diplomacy to take the lead in nuclear disarmament and nonproliferation.
(e)	Actively respond to a new move of nuclear proliferation.
(f)	The highest level of compliance with safeguards, security, and safety (3S's) is required in the peaceful use of nuclear energy.

Source: Cabinet Public Relations Office

(2) Japan's efforts for nuclear nonproliferation and security

Japan has developed legal systems, organizations, technologies, etc., to secure the peaceful use of nuclear energy, and received the confidence of the international community for its performance. Japan strictly applies the IAEA and domestic safeguards, and has received application of the IAEA's integrated safeguards since 2004. Moreover, the Japan Atomic Energy Commission (JAEC) checks whether the use of nuclear technologies for energy use by related institutions. is limited to peaceful purposes, and obliges power companies, etc. to publicly announce their plans for plutonium use from the viewpoint of transparency improvement, and checks and otherwise examines the appropriateness of those plans.

Since the terrorist attacks on the U.S. in September 2001, activities to ensure nuclear security have been significant so that nuclear materials, radioactive materials, etc. will not be used for terrorism. In Japan, the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors and other laws oblige power companies to take protective action responding to the Design Basis Threat (DBT) formulated by the Government, provide a Physical Protection Program and receive its approval and examination from the Government, and specify a Physical Protection Manager. In addition, Japan entered into an international treaty concerning the prevention of nuclear terrorism with foreign countries. At the Summit Meeting held in November 2009 between Prime Minister Hatoyama and President Obama, the two countries agreed to cooperate with each other in nuclear nonproliferation, safeguards, and security, and announced a Japan-US. joint statement entitled "Towards a World without Nuclear Weapons."

(3) Future issues

Since necessities for stable energy supply and global warming countermeasures are becoming a global concern and expectations for the role of nuclear energy are increasing accordingly, it is required to ensure nuclear nonproliferation and security in order to meet such expectations.

The "Interim Report" prepared by the JAEC Advisory Committee on International Affairs in December 2009 states that Japan is in the position of taking the initiative on nuclear nonproliferation and should contribute to the universalization of the Additional Protocol of the Safeguards Agreement, response to non-NPT countries and nuclear weapon countries, and activities of the IAEA. In order for the IAEA to conduct safeguards activities effectively, Japan should provide financial and technical

contributions, and cooperate in initiatives for strengthening the international nuclear nonproliferation regime so that nuclear proliferation risks may not increase in line with the expansion of nuclear use. The JAEC Advisory Committee on Nuclear Security has been discussing the basic policy on the future vision of nuclear security appropriate for Japan since December 2009 in view of the status of examination by the IAEA of the "IAEA Nuclear Security Series Documents." Based on a basic policy to be formulated in the future, relevant organs should review the actions concerning nuclear security as needed. In addition, in order to ensure the effective implementation of such efforts on the site, it is necessarily important to develop the awareness of nuclear nonproliferation and security among all people working at nuclear-related facilities, i.e., to nurture a culture of nuclear nonproliferation and security in the workplace, as well as to pursue such efforts involving the entire organization.

Figure 1-15: Inaugural Speech by New Secretary-general Amano

Source: IAEA

In December 2009, Mr. Yukiya Amano was inaugurated as the first Japanese secretary-general of IAEA. Taking this opportunity, Japan will continue to pursue efforts for nuclear nonproliferation so as to serve as a model for other countries, and has reconfirmed that we strive to cooperate with the IAEA in its efforts to build a framework for safeguards activities and nuclear nonproliferation.

--- A New Trend in International society and Roles of Japan on Peaceful Use of Nuclear Energy ---

Mie Oba, Commissioner, Japan Atomic Energy Commission

In recent years, the emerging countries are also increasing their political presence with their success of economic development. Accordingly, the rise of emerging countries in international society causes the construction of the new form of global governance, which reflects the opinions of emerging countries more than before. The increasing significance of G20 as a forum for consensus building represents this new trend in the international society.

The situation surrounding nuclear energy issues is also greatly influenced by the changes caused by the increased leverage of emerging countries. In September 2008, the Nuclear Suppliers Group (NSG) decided to lift the ban on export of nuclear technologies to India, which did not sign the NPT Treaty. This represents that special consideration had to be given to India, which is increasing its presence in the international society. Movements for expansion and introduction of nuclear power plants are becoming active in many emerging and developing countries in Asia, the Middle East, and East Europe. These now determine the trend of the nuclear power industry in the world.

Under such circumstances, Japan should promote external policies on nuclear energy issues. As a non-nuclear-weapon state, Japan has developed and managed domestic laws, systems, and technologies only for peaceful use of nuclear energy in accordance with the international criteria, and has also sincerely responded to the safeguards of the IAEA. Japan should continue to maintain

this policy in the future. Besides, cooperation with countries that aim to newly introduce civilian nuclear energy technology should be promoted, while keeping a balance between the full considerations of the maintenance of the nuclear nonproliferation regime. In short, Japan has to further contribute to initiatives for coexistence of the peaceful uses of nuclear energy and adherence of nuclear nonproliferation in the new scenes as for nuclear energy in the world.

Moreover, since the terrorist attacks on the U.S. in September 2001, ensuring nuclear security, including measures against nuclear terrorism, has come to surface as a significant issue. Japan has to further strengthen nuclear security measures including existing measures for nuclear security. Taking these into consideration, specific policies should be formulated promptly.

2. Strengthening international activities concerning nuclear energy

Japan has been promoting international frameworks such as the Forum for Nuclear Cooperation in Asia (FNCA) and Global Nuclear Energy Partnership (GNEP), bilateral cooperation, etc., and will further consider how Japan should continue to respond to international initiatives in the trend of increasing global concern about nuclear power generation, in view of the issues provided by the "Interim Report" of the JAEC Advisory Committee on International Affairs. Moreover, since global competition has been intensifying among the nuclear power industries of the world, Japan should strengthen the improvement of infrastructure, etc. at home and abroad so that the domestic nuclear industry may be able to compete in the world on equal terms.

As mentioned in 1-2, interest in nuclear power generation is increasing in many countries. Accordingly, competition among the nuclear power industries is intensifying in the international market. Under such circumstances, it is essential for Japan to strengthen international activities in the nuclear field in order to secure competitive position using its industrial power, as well as contribute to the economic growth of Japan.

Figure 1-16: Export of Nuclear Equipment by Japanese Manufacturers

- Japanese manufacturers have exported major nuclear equipment.

Actual Exports of Nuclear Equipment from Japan

Country / Region		Export item	Year of export	No. of contracts
North America	U.S.	Reactor pressure vessel	1973	1
		Control rod drive	2004	1
		Reactor vessel head for replacement	2003	1
			2004	1
			2005	4
			2006	2
			2009	1
			(2010)	1
		Steam generator for replacement	2006	1
			2010	1
		Pressurizer for replacement	2006	1
Central America	Mexico	Steam turbine	1976	1
	Brazil	Reactor vessel head for replacement	2010	1
Europe	France	Steam generator for replacement	(2011)	1
			(2014)	1
	Finland	Reactor pressure vessel	2008	1
	Belgium	Steam generator for replacement	1995	1
			2001	1
			2004	1
			2009	1
	Sweden	Reactor vessel head for replacement	1996	1
			2005	1
		Control rod drive	2005	1
			2008	1
	Switzerland	Core internals	1978	1
	Spain	Turbine rotor	1999	1
	Slovenija	Turbine rotor	2006	1
	Russia	Plant simulator	1996	1

Country / Region		Export item	Year of export	No. of contracts
Asia	China	Core internals	1985	1
		Reactor pressure vessel	1986	1
			1999	1
			(2011)	1
		Main feed pump	1987	1
			(2012)	2
		Auxiliary feed pump	1986	1
		Circulating water pump	(2012)	1
		Main coolant pump	1999	1
			2009	1
		Filling pump	1999	1
			2009	1
			(2011)	2
		Power generating turbine and plant auxiliary system	2000	1
		Turbine, generator, and plant auxiliary system	(2012)	1
			(2013)	1
		Digital measurement control system	(2011)	1
			(2012)	2
	Taiwan	Reactor containment vessel	1973	1
		Reactor pressure vessel, core internals	2004	1
		Radioactive waste disposal facilities	2005	1
		Steam turbine generator	2006	1
	South Korea	KEDO Main equipment of the project (Reactor vessel head, etc.)	Pending	1
	Pakistan	Steam turbine generator	1972	1

Notes:
1. Parenthesized figures of "Year of export" represent the year in which shipment is scheduled.
2. The year of an export extending two or more years is the year in which the export is completed or scheduled to be completed.
3. Export of minor parts, local improvement work, and export of technologies and services are excluded.
4. Prepared by the Cabinet Office based on the survey of the Japan Electrical Manufacturers' Association.

(1) Status of Japan's international development

(i) Status of the international development of the nuclear industry

The nuclear industry of Japan has accumulated knowledges and technologies, and developed and secured quality human resources provided therewith through the consistent construction of new power stations. Moreover, Japan has been exporting nuclear equipment as shown in Figure 1-16. In the future, Japan is expected to receive orders for the construction of entire nuclear power plants. Since the average annual number of new power stations to be constructed in Japan is expected to decrease to less than one in the future, loss of some of the existing nuclear knowledges and technologies, deterioration of their quality, shortage of human resources, etc. may occur in some segments. On a long-term basis, however, Japan will need to replace existing nuclear reactors, so it is indispensable to maintain knowledges and technologies and secure human resources to some extent. For this reason, power companies should strive to maintain / expand their business size, accumulate knowledges / technologies, and develop / secure human resources through active international development and so on, as well as contribute to the growth of Japan.

Japanese companies are actively working on the international development of their business. As an example, Toshiba Corp. purchased U.S. Westinghouse Electric Corp. (WH) and was accredited by the U.S. Nuclear Regulatory Commission (NRC) as a supplier of US-style ABWR nuclear reactors in 2009. In addition, business competition for construction of nuclear power stations is intensifying in the countries that newly introduce nuclear power generation in the Middle East and Southeast Asia. In last December, South Korea received an order from UAE for the construction of a nuclear power station. It was the first time that a country other than Japan, U.S., France, and Russia, which have already experiences in nuclear reactor construction, received an order for construction, and represents the intensifying international competition in the nuclear-related market.

METI established the "International Strategy Subcommittee" in the Nuclear Energy Subcommittee of the Advisory Committee for Natural Resources and Energy to review international trends and study Japan's international responses in the future.

--- Thinking about International Development ---

Akira Omoto, a member of the Atomic Energy Commission

Globalization and networking beyond borders are now advancing around the world. Nuclear energy is no exception; today, not only merger and alliance of nuclear reactor suppliers, some nuclear power companiesare now operating nuclear power plants in foreign soil, networking of nuclear education is expanding, harmonization of safety standards is in progress in Europe, and best practices are shared around the world.

On the other hand, struggle for natural resources and fossil price fluctuations resulting from speculation increased concern over energy supply security and induced nearly 70 developing countries to consider the introduction of nuclear power. Fierce competition for market is seen among supplier countries.

It is expected that a great majority of new nuclear power plants in the coming 20 years will be

installed in existing nuclear power countries some of them will be in “new entrants” countries. For the latter, Japan will be able to cooperate in the development of sound nuclear infrastructure. The followigs could be some elements for future cooperation for new entrants considering launching nuclear power;

(i) Proactivesharing of advanced technologies. It will be almost Japan's responsibility to share the experiences and seismic design technologies for nuclear plants that Japan obtained through its bitter experiences as an earthquake-prone country, with such countries as Armenia, Turkey, and Jordan, (ii) Holistic support for infrastructure development in cooperation with the IAEA,(iii) Prompt and coordinated actions by the Government, private sector, and politics under clear definition of role / responsibility of each players,(iv) Providing knowledge/skill to operate and manage nuclear power plants together with plant technology, (v) Supporting broad range of utilization of nuclear technologies in recipient countries, (Japan has accumulated xperiences of cooperative projects in Asia, for domestic industries that support use of nuclear technologies and for the use of radiation in medical care and agriculture for better Quality of Life. Furthermore, consideration must go to the issue that the world nuclear community had failed to prevent the occurrence of Chernobyl Accident and to take an initiative to cooperate and evaluate the status of national nuclear infrastructure as well as the safety of new nuclear reactor designs.

It is important in the long run for Japan to play a positive role in the trend of globalization and networking, without being isolated such as regional cooperation in economics, joint development / collaboration for advanced technologies. It would be required todat to encourage young people to advance into the world (e.g., universities in Europe has developed credit systems to study in foreign countries and some universities obliges students to study in a foreign country for a year. Investment is necessary to train international nuclear experts).

In lieu of the international trends on nuclear energy after the formulation of the Nuclear Power Nation Plan, including the worldwide expansion of nuclear power generation, resultant expectation for increase in demand for uranium as fuel, increasing global concern about nuclear nonproliferation, nuclear safety, etc., and industrial reorganization and supply chain construction beyond the border, the International Strategy Subcommittee reviewed the major issues of Japan and the basic strategies to take in order to overcome them from the viewpoint of "responding actively to the expectations of individual countries and contribute to solutions on global issues while maintaining the capability of Japan as a leading nuclear developed country of the world while securing the stability and independence of Japan's nuclear energy policy".

The basic strategy summarized in their report consists of: (i) reinforcement of the infrastructure of the nuclear fuel cycle industry in Japan and international cooperation; (ii) promotion of cooperation between power companies and manufacturers and between public and private sectors; (iii) promotion of active nuclear diplomacy; (iv) environmental improvements with regard to human resources, finances, and systems; and (v) reinforcement of technical capabilities including the material / component industries. The section on "Reference Materials" includes the outline of this Subcommittee report. Moreover, METI took the initiative to establish a "Council for International Nuclear Cooperation" consisting of the relevant ministries and agencies, power companies, research institutions, etc. The

Council is strengthening cooperation among related organizations with an aim for international development, by holding meetings for information exchange, etc. concerning international cooperation.

(ii) Status of international cooperation in the nuclear field

The Framework for Nuclear Energy Policy states that it is important to promote international cooperation through bilateral cooperation, multilateral cooperation, involvement in the activities of international organizations, etc. fully based on the pursuit of peaceful use and assurances of nuclear nonproliferation, safety, and security. Japan's promotion of such international cooperation in the nuclear field is greatly significant towards enhancing the trust and presence of Japan in the international community and smoothly advancing international development of the nuclear industry in Japan.

In Asia, Japan hosted the Forum for Nuclear Cooperation in Asia (FNCA) and has cooperated in multilateral activities, such as the Asian Nuclear Safety Network (ANSN). The 10th FNCA Ministerial Level Meeting was also held in Tokyo in December 2009. Mr. Kan, the then-State Minister in Charge of Science and Technology Policy attended this Meeting and emphasized the increasing significance of FNCA's activities and sought understanding from the participating countries (Fig. 1-17). The joint statement included that "further cooperation should be promoted to facilitate the peaceful use of nuclear energy in the future aiming for the sustainable socio-economic development of individual countries and the Asian region as a whole." (See Chapter 5 for details.)

Japan has also been participating in the activities of the GNEP, Nuclear Suppliers Group (NSG), etc. In October 2009, Mr. Tsumura, Parliamentary Secretary of the Cabinet Office, attended the GNEP executive committee meeting held in Beijing, China, and expressed the expectation for further development of the GNEP to advance the peaceful use of nuclear energy.

Bilateral cooperation with foreign countries is also important. Details of actual initiatives for bilateral cooperation are described in Chapter 5, including the United States-Japan Joint Nuclear Energy Action Plan and Japan-US. Cooperation on Clean Energy Technologies agreed on between Prime Minister Hatoyama and President Obama in November 2009, and the development of fast breeder reactor cycle technologies together with France. Japan also newly signed atomic energy agreements with Russia in May 2009 and with Kazakhstan in March 2010. Moreover, Japan is continuing negotiations with South Korea to execute a bilateral agreement.

Figure 1-17: 10th FNCA Ministerial Level Meeting (Dec. 2009 in Tokyo)

Source: Cabinet Office

(2) Future issues

The JAEC Advisory Committee on International Affairs has been discussing the future vision of Japan's international response in the nuclear field since July 2009. The "Interim Report" prepared in December 2009 clarified the vision again on how Japan intends to cope with the peaceful use of nuclear energy in the future in view of Japan's record of peaceful use accumulated so far. Based on this vision, it was sought to determine Japan's vision on future international response concerning nuclear energy, and formulate and implement specific policies to achieve that vision (Table 1-3).

While specifying the basic strategy provided by the International Strategy Subcommittee, it is important towards economic growth of Japan to show the presence of Japan's nuclear industry in international competition by promoting policies that embody new response goals and strengthen Japan's presence and trust through international cooperation.

Table 1-3: Outline of "Interim Report" by the JAEC Advisory Committee on International Affairs

1. Promotion of peaceful use of nuclear energy and nuclear nonproliferation
   - 1-1 International significance of the peaceful use of nuclear energy in Japan
     Indicates the possibility of Japan's record in advancing the peaceful use of nuclear energy based on the trust of the international community to serve as an international model or norm. Also indicates the possibility of contribution to the international community through the safeguards systems and technologies that serve as good examples for the world.
   - 1-2 Contribution to the international nuclear nonproliferation regime
     Indicates the importance of ensuring nuclear nonproliferation alongside increasing global use of nuclear energy for peaceful purposes and Japan's taking the initiative in nuclear nonproliferation and nuclear disarmament. In relation to this indication, also indicated are the universalization of theAdditional Protocol of the Safeguards Agreement, contributions to the IAEA, requests to non-NPT member countries and nuclear-weapon states to ensure peaceful use, etc.
   - 1-3 Response to the concept of multilateral control of the nuclear fuel cycle
     Indicates the concept of multilateral control of the nuclear fuel cycle, which is highly effective in preventing diversion to military use and nuclear proliferation, and the necessity to examine advantages for Japan and regions arising from multilateral control.
2. Position of nuclear energy as a global warming countermeasure
   Indicates that Japan should pursue the incorporation of nuclear energy into the mechanism of international collaboration and cooperation in terms of the utilization of nuclear energy aiming to achieve the medium-to-long term goals for greenhouse gas reduction.
3. International development of nuclear industry / business
   Indicates the necessity for international development of the nuclear industry / business and relevant expanded support to countries involved in promoting assistance in the development of technical and social infrastructure of the countries that newly introduce nuclear power generation.
   Also indicates the necessity for continual support to relevant activities of the IAEA.
4. Securing a technological lead in the world
   Indicates that a technological lead based on international cooperation is necessary and that Japan should maintain / strengthen that lead based on analysis of the current status, and aim to secure the lead in future technologies. Also, indicates the necessity to analyze competitive strength and goals in international cooperation.
5. Development of human resources useful towards demonstrating comprehensive strengths
   Indicates the necessary for the development of human resources of high expertise in various fields, who understand the significance of cross-sectional work and effectively demonstrate comprehensive strengths, and who can state their opinions appropriately in the international community.

1-4 Improvement in research and development and basic activities concerning nuclear energy

Nuclear research and development and the development / securing of human resources are the basic activities that support utilization of atomic energy, and it is important to steadily advance these activities. For research and development, the JAEC Advisory Committee on Research and Development reviewed policies and provided issues. It is henceforth expected to make steady efforts to solve those issues.

(1) Status in Japan

(i) Steady promotion of research and development

Various organizations including universities, research institutions, and private sectors are working on research and development concerning the fast breeder reactor cycle, such as "Monju" and the FaCT Project, research on nuclear fusion, such as the ITER Project, nuclear safety research, and other basic / fundamental R&D concerning nuclear energy. The State has also taken various measures necessary to support and promote such R&D activities. (Details of the status of research and development are described in Chapter 4.)

Japan is also developing large R&D facilities that are necessary towards advancing nuclear R&D. The Japan Proton Accelerator Research Complex (J-PARC), which the JAEA and the High Energy Accelerator Research Organization are jointly developing, succeeded in producing neutrinos in 2009. Following this success, in March 2010, neutrinos sent from J-PARC were detected by Super-Kamiokande, located about 295 km away from J-PARC. In addition, development of new materials, drugs, etc. is expected from materials to which neutron beams are subjected, and from life science research.

The JAEC Advisory Committee on Research and Development started discussions on measures to promote nuclear R&D in August 2008, and prepared a report in November 2009. The report indicates in terms of R&D activities in Japan that "Almost all necessary activities are being performed, but some projects are not progressing as intended and their schedules were being reviewed." Also indicated is the future vision of nuclear R&D in Japan, including adoption of a "spiral-type" R&D approach, which consistently reviews R&D activities through the proposal / utilization of the latest scientific findings in order to respond to social requests, instead of the linear approach of "fundamental research → empirical study → commercialization." The report is outlined in Chapter 4. The JAEC asked relevant administrative organs to respond to the matters proposed in the report, such as examination of specific measures.

(ii) Development / Securing of human resources related to nuclear energy

In order to advance the utilization, research, and development of nuclear energy, it is indispensable to develop / secure the human resources who support them. In fiscal 2007, the Nuclear Energy Human Resource Development Council, consisting of persons concerned with nuclear energy from industry, universities, and government, was established, and prepared a report in April 2009 by analyzing the status of human resources related to nuclear energy and examining specific activities according to the

roles of industry, universities and government. The report includes proposals concerning improvement in the quality of persons engaged in the nuclear community, necessity for human resources who can contribute to the international development of the nuclear industry, future vision for initiatives of each relevant organization, etc. Further examinations to complete the final report are ongoing .

MEXT and METI have been implementing the "Nuclear Human Resources Development Program," a measure to support initiatives that contribute to human resources development, since fiscal 2007. Through the utilization of this program and other measures, universities and other organizations are developing unique activities for human resource development in cooperation with research institutions and local governments where a nuclear power station is located. Moreover, while the number of nuclear engineering departments (and similar departments) is declining at universities and graduate schools, departments and subjects with a name including "nuclear" are increasing, as shown by the joint graduate school to be opened in April 2010 by Waseda University and Tokyo City University and the nuclear engineering department to be established at Tokai University.

(iii) Improvement of education concerning nuclear energy

In accordance with the revision of the Government Curriculum Guidelines in March 2008 for elementary and junior high schools and in March 2009 for senior high schools, the contents concerning nuclear power and energy were improved in the subjects of social studies, science, etc. (Table 1-4). Guidance under the new Government Curriculum Guidelines will be provided to new entrants to elementary, junior high, and senior high schools from fiscal 2010, 2011, and 2012, respectively.

Table 1-4: Examples of Improvement of Energy Education in the Revised Government Curriculum Guidelines

○ Government Curriculum Guidelines for elementary schools (Revised in March 2008)
Social studies [3rd and 4th grades] Effective use of resources such as water / power saving (New)
Science [6th grade] To be able to think about the nature and action of electricity by examining how to use electricity with a hand generator. (New)
○ Government Curriculum Guidelines for junior high schools (Revised in March 2008)
Social studies [Field of civics] (4) Issues facing us and international community - To understand the importance of economic / technical cooperation for the solution of issues on global environment, resources and energies, poverty, etc. - Pursuit of issues to be solved for the establishment of a sustainable society. (New)
Science [First field] (7) Science and technology and human beings - Use of various energy conversions in daily life and society. (New) - Quality and use of radiation (New)
Science [First and Second fields] (7) Science and technology and human beings (7) Nature and human beings To build scientific mindsets for thinking about how natural environments should be conserved, how science and technology should be used, and recognize the importance of establishing a sustainable society. (New)
○ Government Curriculum Guidelines for senior high schools (Revised in March 2009)
Civics [Politics and economy] Pursuit of issues on the global environment and resources / energies in the politics and economy of the international community
Science (Use of contents) Use contents such as environmental issues including the importance of establishing a sustainable society. (New)

Science [Basic physics]
- Characteristics and uses of energies originating in hydraulic power, fossil fuel, nuclear energy, solar power, etc.
- Utilization of radiation and nuclear energy, and issues concerning their safety

Sources: Government Curriculum Guidelines for elementary schools (revised in March 2008), Government Curriculum Guidelines for junior high schools (revised in March 2008), Government Curriculum Guidelines for senior high schools (revised in March 2009)

(2) Future issues

The Advisory Committee on Research and Development proposes future visions for nuclear research in Japan, such as encouragement of a spiral-type R&D approach. R&D organizations, etc. are expected to promote R&D activities based on these proposals.

--- Way to tackle human resources development problems affects the future of Japan ---

Shunsuke Kondo, Chairperson of the Japan Atomic Energy Commission

One of the important prerequisites in securing human resources for a workplace is the people's recognition that its mission is worth working for and its human resource management rewards his efforts. The Japan Atomic Energy Commission (JAEC) is requesting nuclear industries as well as nuclear research and development organizations to make their workplace attractive in this respect, in parallel with asking universities to actively promote nuclear education so that students may develop their capability to work effectively at a site of research, development, or utilization of nuclear energy anywhere in the world. The JAEC also requests the State to provide financial support to such initiatives of universities..

Countries that desire to use nuclear power generation for the purpose of energy security and or combating global warming have been increasing recently, and Japan often receives requests from such countries for cooperation in human resources development as a part of their development of nuclear infrastructure. The JAEC asks relevant organizations to cooperate with such countries in the development of nuclear utilization, coming up to such requests through the effective utilization of the aforementioned initiatives.

We believe it an important choice of Japan's growth strategy to position human resources development as an important element of Japan's nuclear value chain and make a significant investment in related high-level education. Such education may serve as a factor for Japan to be respected in the international community, not to mention that it would be very effective in maintaining the vitality of Japan whose society is aging as we can have many students coming to Japan from various countries to receive such high level education.

In terms of the development / securing of human resources concerning nuclear energy, industry, higher education institutions, and R&D organizations are all making unique efforts. Human resources development will not produce an effect in a short time but should be continued consistently. It is necessary not only for relevant organs to steadily promote their efforts but also to implement a strategic development of human resources related to nuclear energy including international viewpoints by strengthening the comprehensive function of human resources development for nuclear energy in Japan

as a whole through further reinforcement of cooperation between industry, universities, and government. In addition, the maintenance / enhancement of motivation for the personnel of nuclear organizations to engage in their operations are important not only for the personnel currently in service but also for securing superior human resources in the nuclear energy field on a long-term basis.

As regards the improvement of guidance concerning nuclear energy and radiation in elementary and secondary education, since the Government Curriculum Guidelines were revised and the framework to handle nuclear power and energy was established, nuclear organizations are expected to provide cooperation according to requests from schools, such as by providing easy-to-understand materials and, opportunities for training of teachers, and dispatching lecturers so that such guidance may be provided effectively.

Conclusion

As mentioned, the situation surrounding nuclear energy policy is changing substantially at home and abroad. The Atomic Energy Basic Act, which is the basis of nuclear energy policy, provides as the basic principle that "the research, development and utilization of nuclear energy are done only for peaceful purposes while ensuring safety, operating democratically and autonomously, publicizing the results, and actively contributing to international cooperation." The Act seeks to promote this principle in order "to secure energy resources in the future, to achieve progress in the sciences and technology and the promotion of industries and thereby contribute to the welfare of mankind and to the elevation of the national standard of living."

Japan has the technology and experience of nuclear power generation on a large scale. The international community has understood that global warming prevention is difficult without using nuclear energy. Also, radiation uses are expected to make further contribution in Life Innovation and other fields. For the purpose of ensuring that people feel secure in enjoying the benefits of nuclear energy at home and abroad, and improving the quality of their life through the effective use of radiation, the persons involved in nuclear energy should pursue technologies and system innovation that contribute to this purpose, while ensuring safety.

The JAEC will promote nuclear utilization as required under the Atomic Energy Basic Act by evaluating / disclosing not only the benefits of nuclear energy but also its costs and risks, and evaluating / selecting such actions through a fair and transparent decision-making process involving the public so as to obtain trust from the public.