Japanese Nuclear Energy Policy and Its Expectation to Universities

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Thank you for kind introduction, Mr. Chairman.
Good morning, ladies and Gentlemen.

It is a great pleasure for me to be here and present you the objectives of nuclear energy policy in Japan and major problems we are facing and struggling to solve, with some comment on the roles of universities expected in this context.

The basic goal of nuclear energy policy in Japan is to realize safe, secure, safeguarded and sustainable utilization of nuclear energy for the promotion of science and industry and the improvement of a living standard of the people and contribute to the shaping of international environment for realizing safe, secure, safeguarded and sustainable utilization of nuclear energy in any part of the world.

The strategic objectives to pursue this goal are; a) to maintain the infrastructure for assuring nuclear safety, security and nonproliferation and the public trust in it; b) to make the share of nuclear power in electricity generation after 2030 greater than 40 %; c) to reprocess used fuel from LWRs and utilize fissile material recovered by the reprocessing in LWRs; d) to develop geologic repositories for disposing vitrified high-level radioactive waste from the reprocessing; e) to expand the opportunity of utilizing radiation in science, medicine, agriculture, industry, etc.; f) to promote carefully planned but aggressive R&D of nuclear energy technology; and g) to promote international cooperation and trade for facilitating safe, secure, safeguarded and sustainable utilization of nuclear energy in every part of the world.

Owing to the actions to attain these objectives taken by the Government and industry so far, 10 electric power companies are currently operating 30 BWRs and 24 PWRs, of which total capacity is 48 GWe: the latest one of them is Tomari-3 that started operation in last December. They are supplying about 30% of electricity generated in Japan. They are contributing to the reduction of greenhouse gas emissions equivalent to about 15% of the total emissions in Japan and to the increase in Japan's energy self-supply ratio from 4 % to 16 %, as it can be categorized as an indigenous energy source.

As for radiation utilization, more than 5000 firms are currently registered as a user of radiation and or radioactive materials, and large-scale radiation facilities such as Radioisotope Beam Facility and SPring-8 (8 GeV synchrotron radiation facility) of RIKEN, J-PARC (Japan Proton Accelerator Research Complex) of the Japan Atomic Energy Agency (JAEA) and KEK, of which photo taken recently is shown below, HIMAC (heavy ion accelerator for cancer therapy) of National Institute of Radiological Sciences (NIRS) are open to users of government, academia, and industry at home and abroad.

Then, what are problems we are facing at present for attaining these objectives?

The first one I would like to mention is to make the share of nuclear power in electricity generation about 50 % in 2030, which was set by the Government as a part of goals for combating global warming. Responding to this decision, we are asking the Government and electric power companies to make an utmost effort to a) improve the capacity factor of operating plants by pursuing innovation in risk and quality management, since lately it has been low due to long outage period of the plants owing to the works for improving their seismic safety as well as frequent, time-consuming overhaul inspection of major components; b) promote the ageing management of long life plants with a view to continuing their operation beyond 40 years and c) promote the

construction of new plants, replacing aged plants in some cases. We are expecting the addition of 9 new units by 2020 and 14 new units by 2030 at least.

To induce electric power companies to do so is not so easy, however, as the energy security and climate change are interest come from outside the marketplace. Therefore we are asking the Government to pursue the understanding of the public about the validity of innovations in the safety regulation as well as risk management activities of electric power companies, ensuring the public meaningful participation in the process of regulatory decision making on these issues. We are also asking them, in addition to pursue the understanding of the public about the importance of nuclear energy for both assuring energy security and combating global warming, to strengthen the incentives for the public to join the attainment of the goal, such as the subsidy for developing the area to the municipalities that accept the nuclear power plants and related facilities, through conscientious public consultation.

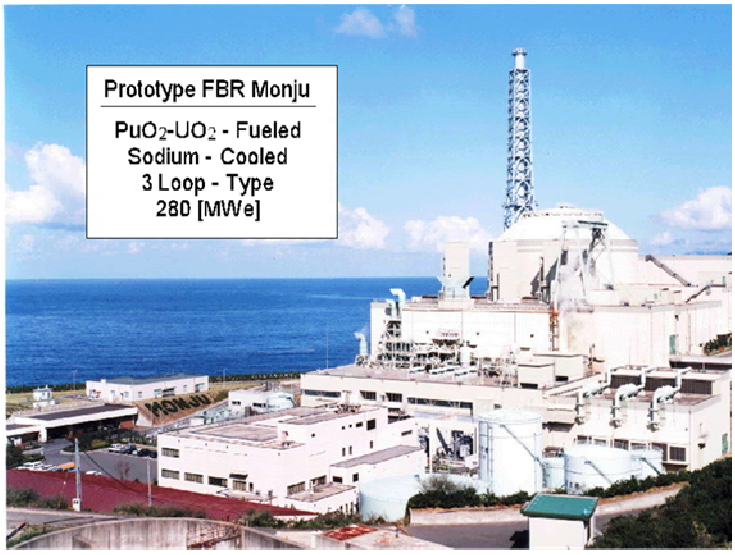
It is a prerequisite for promoting these activities, however, to assure the seismic safety of the facilities, as Japan is a country with frequent earthquakes and the seismic safety is always the public's the greatest concern.

Although seismic safety has been one of the most important topics in the safety evaluation of nuclear power plants, the seismic input to some of the Kashiwazaki-Kariwa NPPs exceeded the level of their design-basis seismic input at the occasion of the 2007 Niigata-ken Chuetsuoki earthquake. The cause of the exceedance was found to be the existence of a peculiar geological structure around the site unknown beforehand, which caused unexpectedly weak seismic wave attenuation from the source to the site.

The regulatory authority has asked plant operators to review the seismic safety of their plant against seismic motions of which return period is up to 100, 000 years, by evaluating such seismic motions owing to nearby fault taking into consideration not only the characteristics of the fault but also the seismic wave propagation characteristics of geological structure between the fault and the site. The preliminary review based on a conservative assumption has been completed and explained to the public at most of the operating plants. It is important, however, to finalize the review based on the latest knowledge of seismology and inform the public the process as well as the result of such review.

The second problem I would like to mention is the establishment of spent fuel and radioactive waste management capability necessary for sustaining the nuclear power generation. First, let me summarize the history.

Since 1960s, recognizing the importance of aiming at establishing closed fuel cycle in the pursuit of energy security by making use of nuclear energy, the Government has been promoting the research and development (R&D) of advanced thermal reactor (ATR) and fast neutron reactor (FNR) both of which utilize plutonium recovered from the reprocessing of used fuel by constructing experimental FNR JOYO, prototype ATR FUGEN, prototype FNR MONJU and the Tokai reprocessing plant.



In 1970s, the electric power companies that had been devoting to the introduction of nuclear power plants till then jointly decided to invest into reprocessing businesses in Europe so as to assure a necessary amount of reprocessing service for the time being and to start the construction of a commercial reprocessing plant in Aomori, i.e. the Rokkasho Reprocessing Plant (RRP) by establishing the JNFL.

In order to promote the nuclear fuel cycle activities for nuclear power generation, it is important to assure international confidence in observing the commitment of nuclear nonproliferation pledged by ratifying the NPT. Based on the experience of the extensive negotiations with the USA about the start of Tokai reprocessing plant in 1978, Japan initiated, before starting the construction of the RRP, an international project called LASCAR to develop an internationally acceptable concept and technology for the IAEA safeguards to large bulk-plutonium handling facilities, in cooperation with the IAEA, the United States, France etc. The current IAEA safeguards activities at the RRP are based on the result of this project.

In the end of 1990s, after rejecting to invest into the construction of a demonstration ATR, electric power companies jointly decided to start the use of MOX fuel in one-third of their LWRs, utilizing the plutonium recovered in Europe for the time being and later the plutonium that would be recovered at the RRP.

At the beginning of the 2000s, a dispute whether to suspend the hot operation of the RRP got considerable media attention and the AEC took up the issue in its committee in 2004. The committee concluded after evaluating four policy options including an option of choosing the direct disposal of spent fuel from various viewpoints that, though the electricity generation cost in the case of pursuing the reprocessing will be about 10% higher than that of pursuing direct disposal, the reprocessing option is superior to the direct disposal option from the viewpoint of pursuing energy security and a sound material-cycling society as well as assuring measures to cope with future uncertainties.

Based on this conclusion, the AEC recommended that Japan should pursue the recycling of fuel materials through reprocessing of spent fuel as Japan wants to use nuclear power as one of the major methods for power generation over a long period of time. In response, considering the progress of deregulation of electric industry at the same time, the Government established in 2005 the “Fund for Reprocessing”, collecting fees from electricity customers based on the generation of spent fuel. The fee is about 0.3 yen/kwh, which corresponds to about 1 yen/kwh of electricity from nuclear power plants.

Now I will give you some information on the achievement up to the present. 5600 tons of used LWR fuel and 1500 tons of used GCR fuel were reprocessed in Europe and 1020 tons of used LWR fuel were reprocessed at Tokai Reprocessing Plant (TRP) and utilizing plutonium transported from Europe and recovered at the TRP, MOX fuels have been fabricated at the Plutonium Fuel Fabrication Facility (PFFF) at Tokai-mura and loaded to FUGEN, JOYO and MONJU

As for MOX fuel utilization in LWRs, 3 LWRs are currently in operation, loading MOX fuel fabricated in Europe in the core: the number will be 5 before the end of the year and will be 16–18 in due course.

As for the RRP, the completion of commissioning test had been postponed due to the difficulty in establishing the operating procedure of the melter to vitrify the HLW,

though the JNFL recently announced that the test will be completed in two years. By the way, the JNFL started the construction of the Rokkasho MOX fuel fabrication plant (JMOX) in October.

In the future, among 66,000 tons of spent fuel to be generated before 2046, 32,000 tons will be reprocessed in the Rokkasho RP and 34,000 tons, including spent MOX fuel will be stored at “at reactor” and or “away-from-reactor” spent fuel storage facilities for the time being. Therefore the AEC is asking electric power companies to assure the availability of spent fuel storage capacity, taking into consideration of uncertainty in the performance of the RRP.

In parallel with the promotion of reprocessing activities, a group of experts had started in 1970s the study on the feasibility of disposing the vitrified high level radioactive waste from the reprocessing in a geologic repository, after storing for 30 to 50 years at a surface facility to allow cooling, based on a multi-barrier system in stable geology at a depth greater than 300 m below ground surface. They concluded in 1992 that a sufficiently stable deep geological environment to ensure the performance of the multi-barrier system can be found in Japan, even though the country is located in a tectonically active zone and complex geology is expected in many part of Japan.

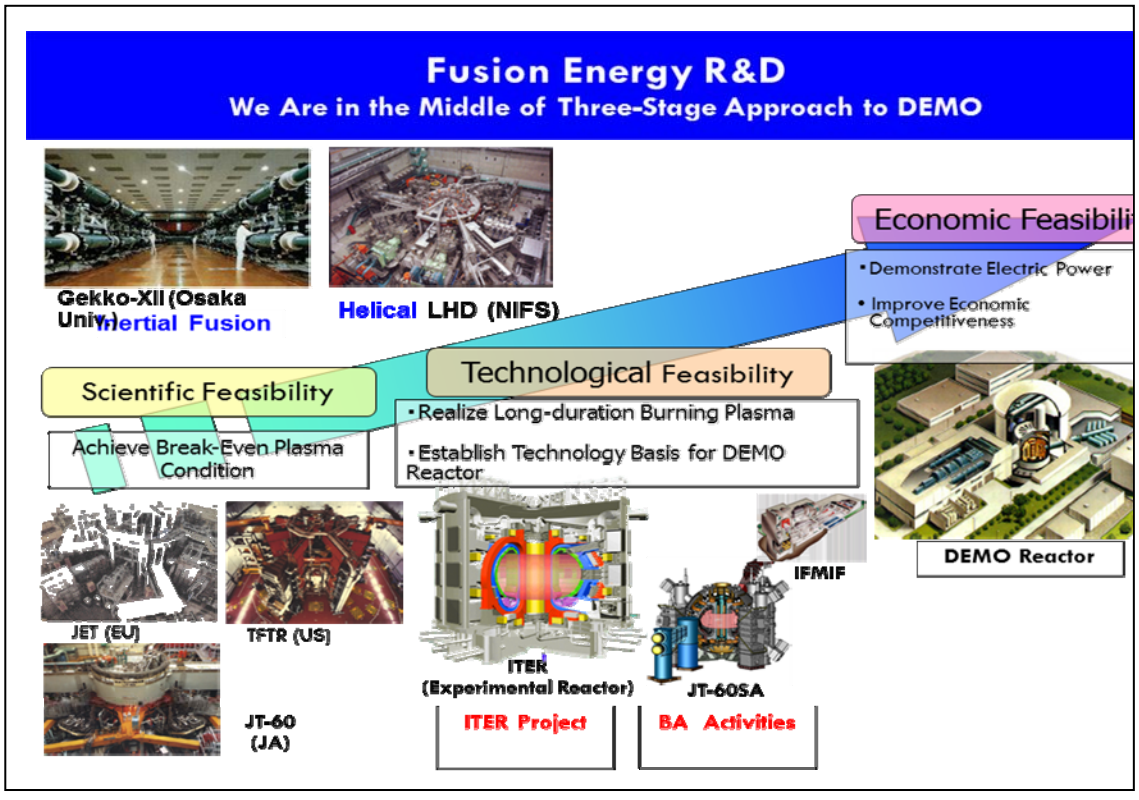
Based on this conclusion, the AEC decided in 2000 that the activity to determine the site of the geologic repository should be started and the site should be determined through a three stage program of which first stage should be to invite application for site suitability study from mayors of municipalities. In response, the electric power companies established the NUMO, an organization authorized to promote the disposal activity in the end of 2000 and in 2002, it started to invite mayors of municipalities to apply for site suitability study.

In 2008, as no mayor had successfully applied yet, the AEC asked the Government and the NUMO to strengthen the public outreach activities. In response, the Government and the NUMO have started to strengthen the activity to appeal to the public on the merit of accepting the repository that can be expected from the principle of equity of benefit, as well as the safety and the importance of the repository.

The result of 2009 public opinion poll showed that now a majority of the public recognized the importance of deciding the site without delay but that they were negative

to allow the siting of the facility in their neighborhood. The AEC is asking the Government and the NUMO to continue to faithfully talk to the public about safety, responsibility and benefit, providing with the opportunity to see the related facilities including mock up facilities, as a picture is worth a thousand words.

The third problem we are struggling with is how to promote nuclear energy research and development activities effectively. The AEC are asking the government and industry to promote four categories of R&D activity in parallel. The first is base technology R&Ds that maintain and expand technology basis for nuclear energy. The second is near-term R&Ds that create knowledge for using existing assets effectively such as that for trouble shooting, ageing, power up-rating, etc. The R&D to develop technical basis for high-level radioactive waste disposal project is also one of the major short term R&Ds. The third is medium-term R&Ds that develop new products and processes to replace those currently in use. The typical one is R&D of the next generation LWRs. The fourth is long-term R&Ds that explore innovative products and processes that open new / sustainable nuclear energy use. Included are the R&D of fast neutron reactor and its fuel cycle technology of which flagship at present is MONJU that has resumed operation recently, obtaining the understanding of its importance by the municipalities it is located, HTGR R&D, and fusion energy R&D of which strategy is summarized in the following figure.



As Professor Abernathy of Harvard Business School pointed out, the short term R&D demands toughness, determination and close attention to detail, the medium term R&D demands, in addition to them, the willingness to take sizable financial risk and the long-term R&D demands, besides, imagination and a certain amount of technical daring, which might be turn out to be a wrong choice later.

As a matter of fact, in the case of fast neutron reactor R&D, though there had been active R&D programs in the world in the previous century, commercial development of fast neutron reactors was put on hold in the 1980s and 1990s for numerous reasons, but primarily because they were projected to be uncompetitive. In the case of Japan, the confusion of management at the occasion of the secondary sodium leakage accident at MONJU in 1995 was an additional reason.

At the crack of this century, however, several countries have started to consider it wise to promote a significant research and development of fast neutron reactors that meet the technology goals in sustainability, economics, safety and reliability, and proliferation resistance. In the case of Japan, after comprehensive review of the future potential of fast neutron reactor technology performed during 1999-2005, the AEC has asked the JAEA in 2006 to promote a fast neutron reactor R&D project, which is called FaCT, with a view to proposing a conceptual design of fast neutron reactor and its fuel cycle technology that can make nuclear energy competitive and sustainable in the energy supply market beyond 2050 before 2015, in cooperation with electric power companies and nuclear power companies.

Currently the Government is reviewing the interim result of the FaCT project in which the JAEA has been exploring, in cooperation with industries, candidate technologies for a sodium cooled fast neutron reactor that loads mixed-oxide fuel that contains minor actinides as ingredients so as to make the reactor and its fuel cycle system a very unattractive route for diversion of weapons-usable materials and reduce the volume and radio-toxicity of the waste to be disposed of.

On the other hand, the AEC has been recommending, after reviewing numerous bitter experiences in the past nuclear energy technology R&Ds including the secondary sodium leakage accident at MONJU in 1995, that leaders of R&D should; a) lead to invest, innovate and create values where none existed before, having determination to excel and timely decide what he should decide; b) strengthen front-loading activities

through effective uses of modeling and simulation and spiral development that facilitate effective interaction with stakeholders, recognizing the importance of risk management to cope with the fact that devils lie in details; c) make their three main priorities science, science and science. However, we believe that it will continue to be a good topic to find the best way to mange R&D activities as the research on research is as difficult as the research itself.

The forth problem we are facing is international cooperation of which importance has been increasing in these years. Traditionally, the AEC has encouraged the Government to contribute to the shaping of international environment for promoting safe, secure, safeguarded and sustainable utilization of nuclear energy by participating in the activities of the IAEA, the NEA etc. and promote mutually beneficial bilateral and or multilateral cooperative activities such as ITER project, GIF project etc.

In recent years, we have been encouraging the Government to support countries that wish to promote the utilization of nuclear energy by way of supporting human resource development and capacity building for safe, secure, safeguarded and sustainable utilization of nuclear energy. We have been encouraging Japanese nuclear industries also to continue to supply high-quality products to the global market. At present we are expecting electric power companies to share with foreign operators the organizational culture to value quality, a sense of security, cleanliness of workplaces and visualization that has been cultivated in Japan by socialization and externalization of such tacit knowledge of managing nuclear power plants.

Finally I would like to mention our expectation to universities. First of all, I greatly appreciate what universities have done for the promotion of nuclear energy utilization through human resource development and knowledge creation in diverse disciplinary areas. That said, though, I would like to limit my expectation here to the activities related with nuclear science and engineering discipline.

As for education, the core competence of nuclear science and engineering discipline is a systems engineering and design. I sincerely hope that the university nuclear engineering faculty will preserve the character by maintaining the comprehensive curriculum for nuclear science and engineering education. I do praise as well the effort for increasing the supply of nuclear workforce such as the effort to establish dual engineering degree programs and educate students who have finished undergraduate education other than

nuclear science and engineering in the graduate course. As for latter, due attention should be paid to such endeavors in the international community as the International Master's Degrees in Nuclear Energy Science and in Materials Science for Nuclear Engineering in France.

Another noticeable move is networking. Networking has been widely recognized as a key strategy for capacity building and better use of available educational resources. Networks have been established at all levels, i.e. national, regional and global levels as already discussed in this gathering. It is highly probable that networking might even become more important in the future both in terms of extent and depth of cooperation.

In summary, I sincerely hope that universities will continue to supply Masters and Doctors with such education and technical expertise in nuclear science and engineering that can be employed at leading universalities, the national laboratories and all parts of industries and the governments, incessantly innovating the education systems and programs.

As for research, the first expectation should be to sustain the intellectual growth and development of nuclear science and engineering discipline in the university research communities, promoting science-based exploration to pursue high-risk ideas that can enhance research discoveries and take us beyond our present understanding in nuclear science and engineering.

At the same time the AEC are insisting that the Government should also support the promotion of collaborative research and development activities among universities, national laboratories and industry that place a larger emphasis on engineering applications and integrated technologies that basically respond to missions specified outside of universities.

The second category of research we are expecting to universities is to help us to promote the spiral approach in research, development and commercialization of nuclear energy technology that promotes the evaluation of risk of successful completion of the project based on the feedback from the market including end-users to the team that is responsible research and development. We hope that multidisciplinary programs of understanding the reason why technologies accepted or rejected by consumers, the barriers to its adoption, and the market condition necessary for a technology to compete

in our society promoted in universities will give insight to the management of policy and project in this context.

That said, and here is my final comment, universities should continually pursue international character and diversity in the promotion of such education and research, with a view to contributing to safe, secure, safeguarded and sustainable utilization of nuclear energy in the world. It is because it is time for Japan to make nuclear energy technology sustainable and available not only to us but also to those who want to use it as one of the mainstay technologies to the fostering of economic growth / poverty eradication, energy security and low-carbon economy.

Thank you for your attention.