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Basic Policy for Nuclear Energy

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Contents

1. Introduction

Historical Background: "Long-term Program for Research, Development and Utilization of Nuclear Energy" and "Framework for Nuclear Energy Policy" issued by Atomic Energy Commission

The research, development, and utilization of nuclear energy (hereinafter "nuclear energy use") in Japan was started exclusively for peaceful purposes, on the premise the safety is secured and for the purpose of securing energy resources into the future and advancing scientific researches industrial development thereby contributing to the enhancement of the human welfare and national living standard nation's livelihoods as stipulated by the Atomic Energy Basic Law of 1955 (Act No.186).

In order to ensure the systematic implementation of national measures to achieve these goals, the Japan Atomic Energy Commission (JAEC), founded in 1956, had adopted "Long-term Program for Research, Development and Utilization of Nuclear Energy" (hereinafter "Long-term Program") and "Framework for Nuclear Energy Policy" (hereinafter "Framework") approximately every five years, ten times in total. The last framework was adopted in October 2005. Each framework was adopted as a plan for the succeeding decade in mind in view of the changed circumstances in and out of Japan.

From a "Long-term Program" and "Framework" to "Basic Policy for Nuclear Energy"

Following the accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station (hereinafter "Fukushima Accident") in 2011, drastic reform of the JAEC was discussed during 2013, in view of the drastically changed environment surrounding nuclear energy. Since the subsequent reform, the JAEC has been performing its tasks resuming its original position of conducting nuclear energy administration in strictly democratic manner.

In the course of the review of the JAEC, it was decided not to formulate comprehensive and detailed plans such as the "Long-term Program" or "Framework." The JAEC, instead, decided to adopt a set of broad guidelines titled "Basic Policy for Nuclear Energy" by overlooking entire nuclear energy use and from its own viewpoint that is based on the expert's view and international lessons learned in consideration of its role to provide an overarching nuclear energy policy directions encompassing relevant government ministries and agencies while securing neutrality from those related organizations. This "Basic Policy" intends to serve as a compass to show long-term directions for government policy on nuclear energy use for the coming years.

Elaboration of "Basic Policy for Nuclear Energy"

"Basic Policy for Nuclear Energy" can be characterized as follows:

- An articulation of policy directions and ultimate goals for cross-cutting issues of overall nuclear policy, such as, peaceful use of nuclear energy, deepening public understanding, human resource development, and research and development (R&D).
- A general description of policy goals with as sufficient level of details as necessary to serve as guideposts for the JAEC itself and the relevant government ministries, agencies in performing their respective roles and responsibilities,

- An indication of long-term policy directions, incorporating a wide variety of viewpoints surrounding nuclear energy, considering the "Basic Energy Plan", "Science and Technology Basic Plan" and the "Plan for Global Warming Countermeasures."

The JAEC has deliberated on nuclear energy that exists as an energy technology today, in a neutral and objective manner, without prejudice to pro- or con- nuclear energy use arguments. With this perspective, JAEC has held hearings from a wide range of experts and engaged in exchanges of views on such issues as the appropriate use of nuclear energy, the Fukushima Accident and its impact, the recovery and reconstruction of Fukushima, and the environment surrounding nuclear energy. Based on the information gathered, the JAEC examined ways to alleviate the anxieties of Japanese citizens and rebuild their trust, and developed the "Basic Policy for Nuclear Energy", taking the fact seriously that the JAEC received wide range of opinions from various values and positions.

Chapter 2 below describes the changes in the environment surrounding nuclear energy that need to be considered, while Chapter 3 describes the JAEC's recognition of the essential problems ingrained in nuclear energy-related organizations. Based on these findings, Chapters 4 and 5 then identify basic goals and directions for the future of nuclear energy use, highlighting high-priority measures to be strategically addressed.

In light of the fact that the environment surrounding nuclear energy will keep changing substantially in the coming years, "Basic Policy for Nuclear Energy" is to be reviewed and revised, as necessary, basically every five years or so.

2. Changing Environment Surrounding Nuclear Energy

2.1 Impact of the Fukushima Accident

The Fukushima Accident caused enormous damages to the people of Fukushima Prefecture and many other Japanese citizens. The accident greatly increased the level of distrust and anxiety about nuclear energy, not just in Japan, but also all over the world, causing a major shift in nuclear energy policies. It would be essential, for the continuation of nuclear energy use in the future, to sincerely face up to the distrust and anxiety including concerns about radiation risk, and rebuild social confidence through the efforts to mitigate such concerns.

In addition to steadily promoting the measures to ensure the safe use of nuclear energy, there is an obvious need to build up a successful track record in the use of nuclear energy to reduce public distrust and anxiety.

Also, the G7 Ise-Shima Summit Declaration (May 28, 2016) mentioned crucial importance of engaging the publics in science-based dialogue and transparency to inform policy making, and reaffirmation of G7's commitment to achieving and maintaining the highest levels of nuclear safety worldwide.

2.2 Changing environment surrounding nuclear energy use

Following the Fukushima Accident, operations of all nuclear power stations in Japan were suspended; thereby the dependence on nuclear power generation is drastically reduced. Also, with the full liberalization of the retail electricity market, the preexisting regional monopolies

and tariff regulations ("rate of return regulation"[1]) were eliminated. It is pointed out that the new competitive electric power business has made it difficult to make reliable prediction about the future of nuclear power business.

Internationally, after the Fukushima Accident, some countries and areas such as Germany, Italy and Switzerland decided or reaffirmed decisions to withdraw from or suspend nuclear power generations, whereas the tendency in Asia, the Middle East, and Africa - most evident in the planning and promotion of large expansions in nuclear power stations by China and India - was to try and introduce nuclear power generation. In the U.K. and other countries that had advanced in nuclear energy use, there have been moves to reaffirm the importance of nuclear power generation as a low-carbon form of energy source after trying a variety of policy tools aimed at adapting to liberalized energy environments.

Aside from the nuclear energy for power generation, the use of radiation in such fields as manufacturing, medicine, and agriculture is steadily advancing and it is expected to grow further in the years ahead.

On the other hand, as expansion of nuclear energy use may increase the risks of nuclear proliferation, there is a growing recognition of the importance of measures for ensuring peaceful use of nuclear energy and non-proliferation. While Japan has been working on initiatives to increase transparency of the management and use of plutonium, nevertheless, this issue will attract great attention from in and outside Japan; hence Japan needs to remain mindful of this matter.

2.3 Changing environment surrounding the global warming issue

The problem of global warming due to the greenhouse gas emissions as a result of extensive fossil fuel use and other economic activities since the Industrial Revolution of the mid-18th century is now recognized as a challenge for all humanity. At the 2015 United Nations Climate Change Conference (COP21), the "Paris Agreement" was signed as a new international framework for 2020 and beyond, aimed at significantly reducing human-made greenhouse gas emissions by accomplishing an equalization of the greenhouse gas emissions and removal by sinks in the latter half of the century. The agreement stipulates that all signatories are to set emission reduction targets. The Japanese Government adopted its "Intended Nationally Determined Contribution (INDC)" (Fiscal Year 2030 Greenhouse Gas Emission Reduction Target) at the Global Warming Prevention Headquarters and submitted it to the secretariat of the United Nations Framework Convention on Climate Change (July 2015), which intends to reduce greenhouse gas emissions by 26.0% relative to the FY2013 level (25.4% relative to the FY2005 level) by FY2030.

It is said that substantial further reduction of greenhouse gas emissions over a long term will require the pursuit and extensive application of innovative solutions because it will be difficult to achieve the necessary reductions just by continuing with current measures[2]. Japan's emissions accounts for a mere 3% or so of total world emissions, but considering Japan's advanced technological capability, it is expected to contribute to reduction of the emissions not just in Japan, but also worldwide.

In reference to this, the Leaders' Declaration at the G7 Ise-Shima Summit (May 2016) stated, "In those countries that opt to use nuclear energy, it substantially contributes to the reduction of future greenhouse gas emissions and works as a base load energy source." Accordingly, it

[1] According to the Electricity Enterprises Act, electricity tariffs must be calculated as "an appropriate cost price under efficient operation plus an appropriate rate of return."

[2] Plan for Global Warming Countermeasures (cabinet decision, May 2016)

is necessary to give a due consideration to the expectation that as a low-carbon electricity generation technology, nuclear power generation plays a role in Japan's efforts to ensure power supply stability as it addresses the challenge of global warming.

2.4 Issues surrounding energy that affect the livelihood and economic activities

The "Long-term Energy Supply and Demand Outlook" (July 2015, Ministry of Economy, Trade and Industry) presented an outlook of Japan's electric power supply and demand structure in FY2030, assuming that Japan's nuclear energy dependency, which was approximately 30% before the Fukushima Accident, might drop as low as possible.
Japan's energy self-sufficiency is extremely low in comparison to other advanced industrialized countries due to its high level of dependency on foreign energy resources. After the shutdown of all the country's nuclear power stations, the rate dropped from approximately 20%[3] (before the Great East Japan Earthquake) to a mere 6%[4]. Japan is constantly exposed to the risk of supply disruption due to instability in supplying countries or shipping routes, sea lanes, so securing the country's energy supply is a major challenge.

Also, due to a rise in imports of fossil fuels, resulting from the increased use of existing thermal power stations to make up for the nuclear power shortfall, a massive quantity of the country's wealth flows abroad. The combined effect of this and the introduction of a feed-in tariff (FIT) system for renewable energy has led to electricity tariffs higher. In turn, the rise in electricity tariffs has had a major negative impacts on people's livelihood and economic activities, due to reduced international competitiveness of industry and lost job opportunities.

3. Fundamental Issues Ingrained in Nuclear Energy-related Organizations

Since 1990s, in utilization of nuclear energy in Japan, long-term shutdowns of reactors and delays of projects, caused by various incidents, have been drawing public distrust and anxiety. On top of that, the Fukushima Accident, occurred in March 2011, caused severe disruption to the daily life of citizens. In that sense, not only the lessons of the Fukushima Accident have not been fully reflected, but it has now become indispensable to the fundamental issues ingrained in Japanese and nuclear energy-related organizations because these issues have caused long-term stagnation in the nuclear energy use in Japan.

It has been pointed out that national culture influences safety culture[5]. National culture is embedded in values and social structures and affects the work methods of individuals and the activities of organizations. The unique mindset[6] and groupthink in Japan, the pressure to conform tacitly or forcibly to the opinion of the majority, and the tendency to maintain the status quo are all very strong, and they can be a problem. Another tendency within organizations is to lapse into sub-optimization. As a result of the sub-optimization of information sharing in terms of the contents and scope, truly needed information does not get appropriately shared. It is, therefore, necessary to create a culture in which people can exchange a variety of opinions based on solid grounds, regardless of their standing inside or outside the organization.

[3] The actual value of energy self-sufficiency as of 2010 (IEA "Energy Balances of OECD Countries 2012 Edition")
[4] The actual value of energy self-sufficiency as of 2014 (IEA "World Energy Balances 2016)
[5] "The Safety Culture of an Effective Nuclear Regulatory Body," OECD/NEA
[6] "NAIIC Report on Fukushima," National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)

Recognizing those characteristics of Japanese organization and citizens have influenced not only the safety aspects but the entire works of the use of nuclear energy, nuclear energy-related organizations have to take drastic steps to improve their way of conducting their works. Further, as ensuring high level of transparency and accountability in using nuclear energy is mandatory and has to be taken seriously.

4. Basic Objectives of Nuclear Energy Use

Given the changing environment surrounding nuclear energy as described in Chapter 2, it is important to proceed with the use of nuclear energy with peaceful use and safety assurance as basic preconditions, winning the confidence of the people and bearing in mind both benefits and costs that nuclear technology can bring to the environment, people's livelihood, and economic activities. Taking into consideration the fundamental issues ingrained in nuclear energy-related organizations as described in Chapter 3, "Basic Objectives on Nuclear Energy Use" for specific directions for appropriate use of nuclear energy are elaborated hereinafter.

(1) Fukushima Accident: Seriously reflect on the accident and learn lessons therefrom.

The recovery and reconstruction of Fukushima after the accident is the point of departure for a fresh start in nuclear energy policy. It is essential to make every possible effort for recovery and reconstruction of Fukushima tackling unwaveringly the variety of challenges such as decommissioning of damaged reactors and containment and decontamination of contaminated water. At the same time, nuclear energy-related organizations need to constantly revisit lessons-learned from the accident, take the lessons sincerely to their heart, and engage in improvement of nuclear safety with the highest priority.

(2) Nuclear energy, addressing global warming issues and people's livelihood and the economy

Nuclear energy is expected to improve people's livelihood and strengthening Japan's international competitiveness while addressing the global warming issues and supplying the energy at the foundation of people's life and economic activities. As a readily available technology, nuclear energy is a powerful option that should be pursued - provided that its safety is ensured – bearing in mind its contribution to energy supply stability, to response to global warming issue, and to people's livelihood and economic vitalities.

(3) Nuclear energy in the global context

Nuclear energy-related organizations should strive to sharpen their global awareness and strategically work on the nuclear energy use in Japan and proceed international collaboration based on the timely and opportune adoption of global standards and international trends.

(4) Peaceful use of nuclear energy: enhancing non-proliferation and security regimes

Japan has been pursuing the use of nuclear energy exclusively for peaceful purposes, and this policy shall be steadfastly maintained and the international cooperation enhanced on that basis. As regards the utilization of plutonium, Japan will continuously improve transparency of plutonium management. Japan will also contribute to the international efforts for enhancing transparency of plutonium management and for nuclear security.

(5) Rebuilding public trust, as a major precondition

The Fukushima Accident renewed the recognition that nuclear energy use in Japan has become a nationwide issue not only for those who live close to the nuclear power stations but also for the entire nation including the consumers who benefit from supply of electricity. In considering nuclear energy use, nuclear energy-related organizations are required to listen humbly to every single voice of citizens, ensure transparency in relation to nuclear energy use, and to prepare an environment where each and every member of the public may develop deeper understanding of nuclear energy issues and form an opinion. To that effect, nuclear energy-related organizations should promote two-way dialogue and strive to provide accurate scientific facts and information based on objective facts fully bearing in mind the uncertainty and risks of the science.

(6) Steadily pursuing decommissioning and radioactive waste disposal

Once decision is made to decommission power reactors or research reactors, the decommissioning work need to be executed systematically and securely, in an integrated manner leading to disposal of the resulting radioactive waste.

As management of radioactive waste is considered the price to be borne by the present generation for the benefit provided by nuclear energy, it is the responsibility of current generation to steadily pursue the processing and disposal of the waste.

(7) Improving quality of life through the use of radiation and radioactive isotopes

Radiation and radioactive isotopes, radioisotopes, are utilized in a wide variety of fields, such as manufacturing, medicine, and agriculture. For improving the quality of life of citizens and also for addressing the global issues like environmental problems and food supply-related problems, the use of radiation should be explored and promoted further.

(8) Strengthening the foundations for the use of nuclear energy

Nuclear energy use is supported by a variety of resources at its basis, such as a knowledge base, technology base, and human resources; and these bases need to be strengthened. In particular, R&D institutions and nuclear industry need to cooperate in building solid knowledge base, while mutually recognizing and respecting their differences and competences. Also, in addition to promoting reform of R&D institutions, efforts should be made to pursue human resources development and fundamental research in accordance with the particular role of each nuclear energy-related organization.

5. Important initiatives and directions

5.1 Common points to be kept in mind

It is necessary to reflect sincerely on the failure to prevent the Fukushima Accident and utilize the lessons of the accident, to prevent recurrence of a similarly severe accident and to try to achieve the highest level of safety. The JAEC views that the following points should be kept in mind when pursuing future nuclear energy use.

Firstly, nuclear energy-related organizations and relevant people should continuously improve their use of nuclear energy regaining the public confidence being a major precondition. To this end, it is important that they establish a strong safety culture in Japan, by accurately understanding the actual status of nuclear business and utilizing international knowledge and experience to resolve the problems described in “3. Fundamental Issues Ingrained in Nuclear

Energy-related Organizations." It is also important that they adapt to the change in circumstances, by ensuring public accountability and delivering benefits to citizens. In the whole process of these efforts, they should appropriately check and verify their feasibility, and promote efficient and effective use of nuclear energy with limited resources.

In addition, it should be borne in mind that the nuclear energy policy needs to be formulated and implemented from a broader perspective, and the policy should be such that can deserve a test by future generations.

The key players involved in nuclear energy use are the National Government, local governments, nuclear industry (electric power companies and nuclear technology suppliers), R&D organizations including the Japan Atomic Energy Agency (JAEA), and universities. For the future use of nuclear energy, these nuclear energy-related organizations and relevant organizations need to carefully rethink where they stand and recognize anew the need to take the Fukushima Accident as a high time to make a fresh start. They also need to be clearly aware of their role and their heavy burden of accountability.

5.2 Important initiatives and directions

5.2.1 Continuous improvement of safety: zero-risk doesn't exist.

(1) Ensuring steady recovery and reconstruction of Fukushima, and learn lessons

It is important to keep working at full strength towards the recovery and rehabilitation of Fukushima. It is also essential to consider the plight of evacuees and their long exile since evacuation. Also, to solve social challenges, such as alleviating the psychological burden of evacuees and preparing suitable environments for them to return, detailed measures to enable the return and the recovery must be taken. It is also essential to support voluntary and autonomous activities, by helping people to rebuild their businesses, livelihoods, and personal lives, to re-establish their independence. Another issue is prolonged duration of storage of removed soil and waste generated by decontamination work. To ensure safety, this needs to be addressed with the understanding and cooperation of the local communities.

Furthermore, nuclear energy-related organizations need to apply the experience of Fukushima to the task of developing emergency response measures and nuclear disaster countermeasures for the future. Efforts need to be continued on the reputational damage to Fukushima's and Japanese agricultural and marine products and the import restrictions imposed on them by foreign countries, which still persist in some parts.

Through the systematic and continuous follow-up of progress in reflecting on and learning the lessons of the Fukushima Accident—as indicated in the various reports[7] on the accident issued by the IAEA, the Diet and the National Government— and through initiatives proposed in paragraphs (2) to (5) of this section nuclear, energy-related organizations need to comprehensively analyze the root causes and develop solutions.

(2) Preventing recurrence of severe accidents and reduction of the impacts

Prevention of the recurrence of severe accidents, and the reduction of its impacts once they occur are of utmost importance. Thus, every effort has to be made to secure safety. Making use

[7] "Fukushima Daiichi Accident Report by the Director General," International Atomic Energy Agency (IAEA), NAIIC Report," National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC), Final Report," Investigation Committee on the Accident at the Fukushima Nuclear Power Station of Tokyo Electric Power Company (ICANPS)

of knowledge about the Fukushima Accident, the National Government, JAEA and other R&D organizations, and nuclear industry should collaborate, with a clear division of responsibilities, to pursue the comprehensive and systematic examination and understanding of severe accidents, their impacts, and mitigation measures. They should also foster the capacity to understand and respond to a wide range of possible future scenarios. All available knowledge and measures should be compiled and disseminated in order help formulate ways and means for the prevention of severe accidents and the reduction of their impacts.

(3) Improving safety taking into account the structural characteristics of the nuclear energy field

Following the Fukushima Accident, safety-related administrative systems and regulatory standards have been reviewed, and nuclear industries are voluntarily taking initiatives to improve safety. In order to avoid falling into the mistaken view that accidents cannot happen if regulatory standards are satisfied, nuclear energy-related organizations such as the National Government and nuclear industry must remain alert at all times, listen attentively to the public, local governments and other stakeholders, implement measures to improve safety on a constant basis, and continue pursuing their tasks scrupulously, taking into account analysis of the structural factors and the lack of openness in organizations, that caused accidents.

It is essential to establish a safety culture that overcomes the weakness of traditional Japanese organizations and national culture. For example, nuclear energy-related organizations, instead of falling into groupthink, need to clarify the roles and responsibilities within the organization in relation to decision-making processes, and establish an environment that facilitates continuous improvement.

(4) Unremitting effort to improve safety on the basis of no zero-risk

Recurrence of a similarly severe accident like the Fukushima Accident must be prevented. The National Government and nuclear industry must let go of the "safety myth." There is no such thing as "zero risk" and an accident is bound to happen. With such recognition they should strive to improve safety so as "to minimize residual risk[8] and prevent it from actualizing."

The current voluntary efforts to improve safety by nuclear industry need to be upgraded, to make them more effective, referring to the good practices taken by their U.S. counterparts. For example, it is important that senior management commits itself to risk management comprehensively, based on the results of risk assessments that include a wide range of scenarios, and that required measures are selected from a large number of options (as in the concept of ISO 31000[9]). Such concept of risk management concept must be shared among all stakeholders and its effectiveness must be secured. In addition, case studies relating to operation and management, including ones focusing on the human errors that lie behind accidents and incidents, should be collected. A cycle of analyzing such case studies and then making effective improvements based on the analysis should be implemented continuously by nuclear industry. The information thus obtained should also be shared among nuclear industry members to improve safety standards across the industry. Furthermore, the National Government and nuclear industry need to promote research on safety, making use of the experience of the Fukushima Accident, and apply the findings to safety countermeasures.

[8] Residual risk after taking safety countermeasures

[9] A family of standards relating to risk management codified by the International Organization for Standardization

Additionally, in order to help develop effective and efficient safety assurance systems, nuclear industry needs to maintain communication with the National Government, using risk information as a common language to engage in constructive exchanges of views on an equal footing. In particular, with a view to realizing implementation of safety measures with consistency, predictability and transparency based on the substantive impacts on safety and risk assessments under the new regulatory regime, it is important to establish close and continuous communication so as to effectively improve essential safety and transparency.

Furthermore, such recognition should be shared not just between nuclear industry, the National Government and the related organizations, but rather with all stakeholders, including local governments, local residents, and the general public so that such risk management structure can be established across the entire society.

The above initiatives will enable a shift in safety assurance, from a "culture of enforcement" that gives importance only to satisfying regulatory standards, to a "culture of prevention" that emphasizes preemptive preventive measures, anticipating a wide variety of possible scenarios.

(5) Promoting disaster prevention and disaster mitigation focused on minimizing health impacts

While main cause of public anxiety relates to the risk of radiation exposure when an accident occurs at nuclear power station or facility, the experience of the Fukushima Accident showed that consideration must also be given to health risks associated with evacuation because a significant number of fatalities and injuries occurred as a result of forced evacuations. For this reason, when promoting disaster prevention and mitigation, the risk of radiation exposure should be weighed against the other health risks, and consider minimizing the psychological and social impact on disaster victims. These lessons learned from the Fukushima Accident need to be applied, and efforts should be continued to implement effective disaster prevention and mitigation measures, including improvement of evacuation paths, on a nation-wide basis. Further to that, it is necessary to make efforts to ensure security and safety of the residents through establishment of evacuation plans, development of human resources through exercise and training, assurance of evacuation routes by road improvement and enhancement and strengthening of radiation protection facilities

(6) Providing appropriate compensation through a nuclear damage reparation system

The payment of compensation for the Fukushima Accident stemming from TEPCO's liability needs to be continued appropriately, based on the Act on Compensation for Nuclear Damage (Act No.147, 1961) and the Nuclear Damage Compensation and Decommissioning Facilitation Corporation Act (Act No.94, 2011).

The experience of the Fukushima Accident made it clear that in the event of a nuclear accident, it is vital to provide relief to victims swiftly and appropriately. Considering the electricity market reforms and other changes in the nuclear business environment and the reduced predictability of nuclear industry, the National Government and nuclear industry need to review their respective roles from both specific and overall perspectives, and develop reparation-related measures to provide victims with prompt and appropriate compensations.

5.2.2 Nuclear energy and its impacts on global warming and nation's livelihood and economy

(1) Adapting to changes in the environment surrounding nuclear energy use

The environment surrounding nuclear power generation is changing rapidly. First, the environment in the Japanese electric power market has become more competitive as a result of the full liberalization of the retail electricity market, and countries such as China and India are fast emerging as influential players in the development and utilization of nuclear energy. Japan's nuclear power industry and its R&D activities, which previously focused on domestic energy use, now, need to become more conscious of international competitiveness and global trends. The National Government, nuclear industry, and R&D institutions must adapt to the new environment in a timely and effective manner.

Despite the fact that operational costs are relatively low when spread over a long period of business operation, the probability of return on the huge investments required to fund nuclear power plants and facilities has fallen as a result of changes in the operating environment such as greater competition in the domestic market, and due to the risk of government policy changes and various other kinds of special risks, the predictability of the nuclear power generation business may come to be regarded as low. The National Government should consider measures to resolve these issues so as to minimize the overall national energy cost increase taking advantage of the unique ability of nuclear power.

(2) Taking action based on comprehensive assessments considering impacts on nation's livelihoods, its economy, and global warming

Given the need for measures to address the global warming, it is important that such measures be developed with a comprehensive perspective that strike balance with nation's livelihoods and the economy, making use of the lessons-learned in Europe and the US.

There is an analysis that Japan's marginal cost for reducing emissions to combat global warming is amongst the highest in the world. Yet, it is reported that the 2030 emission targets of Japan can be met by accomplishing policies, measures and technologies that are backed up with due consideration of technical constraints and cost issues ensuring consistency with the "Energy Mix." Japan has also decided to aim at cutting greenhouse gas emissions by 80% by 2050. The goal is considered to be difficult to achieve just by applying existing countermeasures. Accordingly, long-term, strategic initiatives are necessary to pursue innovative solutions, with utmost efforts, that enable development and dissemination of innovative technology to enable drastic reduction of emissions, as well as to promote domestic investment, enhance international competitiveness, and to seek out ideas widely from the public.

In relation to nation's livelihoods and the economy, electricity tariffs have risen, due to the increased fossil fuel imports to compensate for the reduced nuclear power generation, and to the introduction of a FIT system for renewable energy. Although rising electricity tariffs have become constant and electricity-saving efforts have already been rooted in both households and industry, it is clear that the rising electricity cost is adversely affecting both general livelihoods and the Japan's economic activities, reducing the international competitiveness of the Japanese industry. Some manufacturers, for example, are struggling to compete with foreign counterparts and stay in business.

In light of this situation, while reduction of greenhouse gas emissions is required, it is important to minimize negative impacts on nation's livelihoods and economic activities. Thus, optimal answer has to be developed from a comprehensive perspective.

Amongst the existing usable electric power generation technologies, nuclear power certainly is a low-carbon, base-load power source with low operating costs. It follows that ensuring long-term, stable utilization of nuclear power generation is necessary not just to cut greenhouse gas emissions, but also to sustain nation's livelihoods and economic vitality, and provide a stable supply of power. For this reason, the National Government needs to clarify the role that nuclear power generation can play over a long term and examine the necessary measures therefor.

(3) Efforts for steady use of Light Water Reactors (LWR)

In view of the changed environments in and out of Japan, efforts are needed to restart necessary nuclear power stations and utilize them stably and to sustain the technology and human resources required for them, all the while guaranteeing safety and obtaining the understanding of the local communities and the Japanese public at large. In this respect, reference to the successful case of the U.S., where voluntary safety improvements and an improved regulatory system led to safer, and more economical nuclear power generation. This example shows that nuclear industry can rebuild public confidence through sustained success in delivering a safe and stable supply of nuclear energy.

Capital cost occupies a large portion of total nuclear power generation costs while fuel and other costs are smaller. It follows that the longer a nuclear power station is operated at an appropriate level, the lower the power generation cost becomes. It is, therefore, necessary to invest effort in the long-term utilization of LWRs in combination with the safety improvements.

To utilize LWRs over long periods, nuclear energy-related organizations need to strengthen their efforts to upgrade facilities and capabilities for intermediate storage of spent nuclear fuel.

(4) Nuclear fuel cycle

In Japan, the nuclear fuel cycle business, which reprocesses spent nuclear fuel and makes effective use of separated plutonium, is conducted by nuclear industry. In pursuing the effective use of plutonium, peaceful use is a major precondition. Japan, therefore, should continue to adhere strictly to the principle of not possessing excess plutonium without a specific purpose so as to secure international understanding and to contribute to nuclear non-proliferation. In doing so a good attention should be paid to the balance between the production and the consumption of plutonium. Plutonium should be appropriately managed and used through *pluthermal*.[10] Completion and commissioning of the Rokkasho Reprocessing Plant (RRP) and the Mixed Oxide (MOX) fuel fabrication plant would be necessary for this purpose.

In anticipation of the commissioning of the RRP, Japan may still require a certain amount of time and efforts for accumulating and maturing technologies for reprocessing and MOX fuel fabrication. Such process of accumulating and maturing the technologies needs to be carefully monitored and ascertained at each single step.

As for the development of fast reactor, the National Government needs to assess its strategic positioning and direction while reflecting on the experiences at Monju, including conditions and goals for its commercial viability. This should take into account the various technological

[10] Japanese terminology for the use of plutonium recovered from the reprocessing of spent fuel, as MOX fuel, in an ordinary nuclear power reactor (light water reactor)

achievements and knowledge acquired so far, and considering changed business environment surrounding power generation, such as electricity market liberalization, while affording strategic flexibility.

5.2.3 Nuclear energy in the global context

(1) Adapting to global standards

As social and economic systems become globalized, Japan's use of nuclear energy needs to be reviewed from global context. Nuclear energy-related organizations should, therefore, improve their international awareness; collect, share, and make use of international knowledge and experiences; and apply various global standards and systems to Japan's nuclear energy use.

(2) Promoting collaboration and cooperation in and outside Japan in response to globalization

It is essential to share the experiences and lessons of the Fukushima Accident with the international community and to utilize them for promoting safe nuclear energy use in and outside Japan. For this purpose, the National Government, nuclear industry, R&D organizations, and universities need to promote collaboration in and outside Japan, in accordance with their respective responsibilities. Such collaboration includes supports for the international organizations such as the IAEA and the OECD NEA, which promote initiatives to enhance international nuclear safety in newly emerging nuclear countries and the broader international community. Business development and international joint research involving Japan's outstanding nuclear energy technology and expertise needs to be promoted more strategically, by enhancing international mindset and more clearly defining the specific goals and measures to be realized. It should be noted that Japan's supply chains cannot all be maintained just by expanding business overseas; maintaining and strengthening Japan's high level nuclear energy technology capabilities and human resources is also vital.

International initiatives to broadly expand and promote the benefits of radiation use in industry, medicine, agriculture and other fields to newly emerging nuclear countries should also be enhanced as part of international efforts.

5.2.4 Peaceful use of nuclear energy: securing non-proliferation and nuclear security

Japan, as the only country to have experienced atomic bombs, has a responsibility to contribute to the global efforts on promoting nuclear disarmament and non-proliferation, and the peaceful use of nuclear energy. Japan is the only non-nuclear-weapon state that possesses nuclear fuel cycle capabilities, including reprocessing facilities on a commercial scale and is also known as one of the nuclear supplier countries that are capable of supplying nuclear-related equipment and materials and technologies. While Japan needs to continue its global contribution for realizing "a world without nuclear weapons," the National Government and nuclear industry also need to ensure that they implement appropriate countermeasures against emerging threats such as cyber attacks to the nuclear facilities.

Japan has been assuring the peaceful use of nuclear energy and implementing every nuclear activity under stringent Safeguards by the IAEA. Furthermore, for ensuring the transparency of the use of plutonium, the Government of Japan annually publishes the Status Report of Plutonium Management in Japan; it is indispensable that Japan continuously improves its

transparency for obtaining the sound understanding of the national as well as the international community. To this end, Japan is firmly committed to the policy of "not possessing excess plutonium reserves whose purpose of utilization is unspecified." At the same time, under growing international concerns over plutonium management and plan for its reduction, Japan needs to address the growing necessity of striking a balance between supply and demand of plutonium. Japan needs to ensure the steady consumption of plutonium in the form of MOX fuel for light water reactors, which is the only practical way of using plutonium as of today. At the same time, Japan needs to continue its unceasing efforts toward gaining the understanding and confidence of the international community on these plutonium related policies

Given the increasing globalization, Japan should contribute to global non-proliferation efforts through the implementation of stringent export controls on nuclear-related equipment, materials and technologies, and help establish strict nuclear technology management in the world.

To this end, continued efforts should be made to develop human resources that support the peaceful use and international cooperative and to conduct research and development activities associated with nuclear security.

5.2.5 Rebuilding public trust: precondition for nuclear energy use

(1) Direction toward deepening the understanding

The Fukushima Accident inflicted enormous damage to the people of Fukushima Prefecture and many other people in Japanese. Even today, distrust and anxiety about nuclear energy remain strong amongst the Japanese people. Bullying is also occurring to students who have evacuated after Fukushima Accident. In order to promote public discussion on the use of nuclear energy, it is vital that such an environment is prepared as not only nuclear energy-related organizations but each and every person in Japan has an opportunity to form their own views by deepening their understanding on the basis of scientifically accurate information and objective facts (evidence) as much as possible.

Particularly after the Fukushima Accident, "nuclear energy use" has become an issue of not just those living close to nuclear power stations but of all the Japanese people, including those who consume the electricity. In light of this situation, the National Government, nuclear industry, R&D institutions and other nuclear energy-related organizations need to pursue every measure necessary to further the understanding. To address the concerns of people living close to nuclear power stations as well as the broader Japanese public, it is essential to work harder on interactive dialogue, public hearings, and other kinds of communication activities, and also to set up an Internet-based information system that enables anyone with nuclear energy-related questions or doubts to quickly and independently find explanations and answers to help them develop a deeper understanding.

(2) Setting up an information system based on scientifically accurate information and objective facts (evidence)

When people have got a question, it is not enough just to provide scientifically accurate information and objective facts (evidence), for them to look up and deepen their understanding; it is necessary to offer them easy-to-understand explanations of scientific matters. Furthermore, it is necessary to ensure traceability, so that information can be traced back to more specialized

knowledge, according to the concerns of the people. In the US and UK, for example, large quantities of scientific knowledge, explanations, and summaries are created and published on the Internet by the National Government, international organizations, nuclear industry, and other nuclear energy-related organizations. This information is mutually linked together across the various organizations, and carefully arranged to make it readily searchable, allowing people to easily find the information they want and understand the evidence. With reference to such examples, nuclear industry and R&D institutions in Japan should create an information base consisting of scientifically accurate information and objective facts (evidence), paying due attention to scientific uncertainties and risks, and make it available to the public. This initiative could start with four main topics, representing the issues that are of greatest public interest and importance to nuclear energy policy—(i) global environment, economics and energy security; (ii) safety and emergency preparedness; (iii) radioactive waste; and (iv) the risks of radiation exposure. The National Government also has an obligation to make available easy-to-understand information regarding its nuclear energy policies for the public, while referring to the good practices of other countries.

(3) Enhancing communication

To address the social concerns of the public about nuclear energy use, the National Government and nuclear industry, R&D institutions, and other nuclear energy-related organizations, according to respective roles, need to pursue a dialogue and risk communications based on scientifically accurate information and objective facts (evidence), while reminding clearly the uncertainties and risks inherent in science. In conveying nuclear energy-related information to the public, it is important to engage in an interactive dialogue that furthers mutual understanding - avoiding a formal, one-sided style of communication - keeping in mind trans-scientific arguments [11]. It is also vital to execute such initiatives effectively, always appropriately recognizing the diversity of public opinion, as well as referring to precedents overseas, and to strive for continuous improvement by adapting to changes in methods of communication used by the public, e.g. the emerging importance of social networking services (SNS) in recent years.

(4) Dissemination of information by nuclear industry

While it is a matter of course that the National Government places importance on establishing ways of providing information and communicating with the public about nuclear energy, it is the nuclear industry that shall be ultimately responsible for ensuring safety and carrying out nuclear power business. In Japan, however, there is a large room for improvement in the way nuclear industry share information with the public. Therefore, as long as nuclear industry does business using nuclear energy, even in a competitive electricity market environment, it should effectively disseminate information, taking the successful cases of the US nuclear power companies as a good example.

5.2.6 Decommissioning and radioactive waste

(1) Decommissioning of the TEPCO Fukushima Nuclear Power Plant

To relieve the anxieties of local residents and the Japanese public and promote the recovery and reconstruction of Fukushima, nuclear energy-related organizations should continue to

[11] Trans-science is the idea that there are problems that can be asked of science but that cannot be answered solely by science.

work on the decommissioning of the TEPCO Fukushima reactors, making use of knowledge accumulated from in and outside Japan, minimizing risks in the process, and securing the understanding of local and the general Japanese public. It is important that the work of reactor decommissioning, the handling of the contaminated water, and the processing and disposing of radioactive waste, is carried out safely and steadily, making use of existing technology, and developing new technologies as needed. The experience and technology thus acquired should be disseminated for the other decommissioning works in and outside Japan.

Since the expenses arising from the compensation paid for the Fukushima Accident and the reactor decommissioning and decontamination works are expected to increase, the Japanese public should be informed appropriately about these matters, including updates on the progress of decommissioning and the handling of contaminated water, while keeping the financial burden that ultimately falls on the public to a minimum.

(2) Decommissioning of nuclear facilities at nuclear power plants, R&D institutions, and universities

Decisions to decommission some of Japan's nuclear power plants have already been made, and work has already started in some cases. In implementing these works, nuclear industry need to make appropriate use of financial systems such as the Reserve for Decommissioning Nuclear Power and the Decommissioning Account System.

Some nuclear facilities, such as research reactors at R&D institutions and universities, have been scheduled for decommissioning or have reached advanced age, and the operators should proceed with decommissioning systematically securing a source of funding that is stable over a long term.

In performing the decommissioning work, it is necessary for the National Government, nuclear industry, and R&D institutions to make skillful and appropriate use of existing technology, and to take full advantage of unique knowledge and experience which were acquired through design, construction, operation and maintenance inspection of the plant to be decommissioned, as well as all the experience accumulated in the decommissioning of other facilities, both in and outside Japan. Decommissioning work takes a long time. So, while it is in progress, it is important to take the opportunity to transfer technology and expertise smoothly to a younger generation, as well as to train personnel. The work of disassembly and decontamination generates radioactive waste. So, when engaging in decommissioning, it is necessary to systematically examine and implement appropriate processing and disposal of the radioactive waste.

(3) Steady implementation of radioactive waste disposal as the responsibility of the present generation

In processing and disposing of radioactive waste, it is essential to recognize that the disposal of the radioactive waste should not be left to future generations; it is the responsibility of the current generation who have enjoyed the benefits of nuclear energy use.

It is known that some nuclear industry and R&D institutions are running short of waste storage capacity. To ensure the smooth implementation of full-scale decommissioning in the years ahead, it will be necessary to secure suitable waste disposal sites and to expand their capacity

by means of clearance process[12]. A pressing challenge here is securing of the understanding of the general public and local residents that is a prerequisite for these steps.

To suitably address this challenge, the nuclear industry that has generated the radioactive waste needs to take more prominent and active role in accordance with the "polluter pays principle." If nuclear industry has apprehensions, they should actively engage in exchange of views with the regulatory agency. At the same time, the National Government needs to strengthen its overall progress management.

For this purpose, the National Government should set up a centralized monitoring system for determining the storage, processing and disposal conditions for various types of radioactive waste; and for promoting comprehensive waste disposal policies. It should also accelerate the efforts of nuclear industry and R&D institutions to secure disposal sites.

The National Government should take the lead in tackling the challenge of geological disposal of high-level radioactive waste, e.g. by guaranteeing reversibility and retrievability, fostering public understanding, and providing a "map of scientific characteristics," and by continuing to pursue R&D aimed at improving the safety and reliability of geological disposal, based on the "Basic Policy on Final Disposal of Designated Radioactive Waste." In doing all this, it should actively share its knowledge and experience with other countries using nuclear energy.

If it is considered more effective and efficient to process and dispose of the waste centrally in accordance with the properties of the waste, without arguing the generator or source of the waste, it is desirable for the National Government or nuclear industry to examine the necessary measures to be taken.

5.2.7 Expanded use of radiation and radioisotopes

Radiation and radioisotopes have common scientific and technological foundations as nuclear energy. They are used in a wide variety of fields, including, advanced science and technology, industry, medicine, agriculture, environmental conservation, and nuclear security, thereby making a substantial contribution to improving national welfare and livelihoods. In Japan, radiation and radioisotopes are generating economic activities of around the same scale as nuclear energy technology. Further, as a result of significant advances in particle accelerator technology, a new field is emerging as powerful tools for innovation which is known as quantum beam technology.

In the years ahead, in addition to making strategically effective use of existing infrastructure, R&D institutions and universities are also expected to develop necessary infrastructure (including addressing the problem of deterioration and properly assigning necessary human resources) so as to enable further use of radiation and radioisotopes including the use of quantum beams. Furthermore, along with uncovering new technology "seeds" and advancing existing technologies, it is important to pour energy into research on the impact of radiation on health and the environment. Also important is making it widely known that the use of radiation and radioisotopes is contributing to the improvement of nation's livelihoods.

Through these steps, much new innovation can be expected that may include previously unexpected new fields.

[12] Excluding radioactive substances or radioactive objects whose radiation level is low and whose human health effects are negligible from subjects of radiation protection regulation

5.2.8 Solid foundation for nuclear energy use

(1) Improving R&D management and enhancing functions of R&D institutions

It is now necessary to formulate R&D plans, set up new management systems and develop new knowledge and technology, reflecting lessons from the Fukushima Accident, changes in the environment surrounding nuclear energy, and the need for adapting to globalization.

The Japan Atomic Energy Agency (JAEA) needs to pursue concrete organizational management improvements, not just reforming attitude, but introducing management by objectives, and other management techniques and systems, for maximizing its outcomes while considering precisely on changes in environment and global trends. The JAEA, as the comprehensive nuclear energy-related R&D institution in Japan, should be playing the role of a driving force for strengthening the whole foundation for Japan's nuclear energy use and its international competitiveness breaking away from its traditional approach of emphasizing project selection and implementation and in turn carrying out R&D that addresses real needs. To this end, the JAEA should be transforming itself into an organization that guides the creation of "seeds" through industry-academia-government collaboration; improves fundamental technology; constructs a knowledge base by means of the collection, systemization, and sharing of scientific information and knowledge; and the provision of facilities, equipment, and services that serve as the foundation of R&D.

(2) Promoting partnership and collaboration between R&D institutions and nuclear industry

While it is mainly the nuclear industry that introduces new technology to the market, it is the R&D institutions and universities that generate the new knowledge and value necessary for technological innovation. Partnership and collaboration between the two sides is, therefore, important. The first step in taking effective, concrete action involves the development of a knowledge base that transcends the barriers between nuclear industry and R&D institutions, as well as partnership and collaboration on rapidly introducing new technology to the market. In the nuclear power field in Japan, these kinds of initiatives tend to be insufficient so scientific information and knowledge is held tightly within each organization as a result of strong silo effect.

Consequently, nuclear energy-related organizations such as R&D institutions, universities, and nuclear industry should set up a platform for partnership and collaboration, where they can exchange information, recognizing and respecting each other's roles. Their first initiative should be the development of a deep and broad knowledge base, through the collection, systemization, and sharing of scientific information and knowledge. In doing this, they should clearly ascertain worldwide trends that offer benefits to the public, and select fields of inquiry accordingly. Some specific examples of fields at this time would include long term operation of the LWR service life, severe accident countermeasures and disaster prevention, and decommissioning and radioactive waste disposal. At the same time, this collaboration and joint initiatives would hopefully offer opportunities for training specialist personnel.

(3) Upgrading infrastructural facilities and equipment that support R&D activities and human resources development

Basic facilities and equipment, such as research reactors and radioactive substance experimentation labs, serve as an indispensable foundation for R&D and personnel training. However, the quantity of usable basic facilities and equipment at universities and R&D

institutions is decreasing due to new regulatory standards and to the aging and deterioration, thereby impacting R&D and personnel training adversely. Therefore, upgrading and improving basic facilities and equipment in Japan is a pressing issue. The, National Government, JAEA, and universities, therefore, should select and focus on required functions, based on a long-term perspective, and construct and operate the basic facilities and equipment that are needed, based on the kind of research functions that Japan should possess. Towards this end, it is necessary to deal with restarting research reactors, to address the problem of aging, deteriorating facilities, to ensure safety in accordance with the scale of facilities, and to meet new regulatory standards, and to urgently undertake an examination of the nuclear energy research and education infrastructure needed in the medium- to long-term, including new equipment installations.

Additionally, the basic facilities and equipment possessed by R&D institutions such as the JAEA, are expected to contribute not only to the advancement of R&D, but also to the effective and efficient generation of findings, resulting from the exchange, partnership and collaboration of the diverse personnel in different fields, through the R&D. Thus, it is necessary to promote broad industry-academia-government collaboration, to set up a usage service for this purpose (including relevant personnel and technical support), and to enrich joint research.

(4) Securing and developing human resources

Due to such factors as change in the environment surrounding nuclear energy use and generational change, there is an anxiety about the fast declining number of personnel and the difficulty passing knowledge to the succeeding generation. There has been, for example, a drop in the number of students enrolled in nuclear energy-related courses at universities, and in the number of employees hired by nuclear industry in the mechanical and chemical engineering-related fields necessary for running the facilities of a nuclear power station. The rate of turnover has also risen markedly. Yet, such nuclear energy-related personnel will be needed for as long as there is nuclear energy use—including the need for decommissioning. Thus, nuclear energy-related organizations need to keep trying to secure qualified human resources in and out of Japan.

An effective approach in this respect would be for the National Government, nuclear industry, R&D institutions, and universities to engage in PR campaigns emphasizing the importance of nuclear energy field as a vital form of public infrastructure; the potential and excitement of the frontiers of nuclear science and technology and its application; and the diversity of available career opportunities in the fields of power generation, radiation use, and other nuclear-related fields.

At the same time, since education in the field of nuclear energy is in decline at universities, it is important to upgrade and expand core subjects in nuclear energy-related fields and to effectively foster fundamental skills, e.g. by ensuring that students systematically absorb the knowledge they study, through basic practice and experiments, to develop practical capabilities.

Recognizing that, once employed, on-the-job training including field experiences is a basis of human resources development, nuclear industry, R&D institutions, and universities need to engage in their own form of personnel training in accordance with their respective purposes and goals. In doing this, special attention should be paid to management roles, as well as to personnel already equipped with similar knowledge and experience, and to the fact that the work environment factors such as R&D facilities also have an impact. To supplement all this, it is necessary to improve continuous education and training, which should be methodical and systematic, and take into account personnel mobility, e.g. by providing for job switchers. To foster personnel who can engage in dialogue with a variety of stakeholders and can deal with

the emerging issues in the changing environment surrounding nuclear energy, it is essential to foster comprehensive capability sets, including social skills in addition to technical and regulatory competences.

On top of these efforts to implement personnel training and the transfer of knowledge and technology beyond the framework of the organization and the field, there needs to be exchange and collaboration among a diversity of personnel from different fields. In view of increasing globalization, it would also be useful to pursue personnel development initiatives aimed at internationalizing systems and R&D activities, or providing work experience at overseas R&D organizations, to help foster more Japanese people capable of thriving in both domestic and international settings.

The importance of efforts in personnel training is not limited to R&D institutions and nuclear power enterprises; it is also important to improve and maintain the skills of personnel on the regulatory side, involved in safety regulations and radiation protection.

(5) Promoting fundamental research and innovation of nuclear science and technology

The domain of nuclear science and technology includes both fields of pure science for the search of fundamental knowledge, such as nuclear physics, particle physics, quantum mechanics and cosmology; and fields of applied science, including technologies that use radiation and quantum beams for engineering, life sciences, medicine and agriculture, as well as nuclear fission and nuclear fusion technologies for generating energy. All of these fields are deeply and mutually related to one another. Overviewing the state of nuclear energy science and technology, which relates to such a wide variety of fields, from the origins of the universe to medical application, efforts should be made to advance appropriate utilization of these technologies. Also, considering the recent changes in the environment surrounding nuclear energy and actual needs for nuclear technologies, basic research should be promoted as sources of innovation, R&D focusing on the technologies aiming at industrial applications, and technical standardization in this area.

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