1. INTRODUCTION

In a trend known as the “Nuclear Renaissance”, many nations have turned their attention to promoting nuclear energy, due to its advantages as a stable supply of energy that emits no greenhouse gases during the generation process.

In 2005, the Atomic Energy Commission of Japan established the “Framework for Nuclear Energy Policy.” The basic policy of the Framework is to promote nuclear energy, including the nuclear fuel cycle. The government subsequently adopted it as its basic principle on nuclear energy policy and to promote research, development and utilization of nuclear science and engineering.

Specific measures for implementing the basic policies set out in the Framework were explored and deliberated at a Nuclear Energy Subcommittee, involving representatives from both the public and private sectors, and were compiled into the “Nuclear Energy National Plan” in August 2006.

This Paper summarizes changes in the environment surrounding nuclear energy, and outlines the Nuclear Energy National Plan as well as initiatives for achieving the plan.

2. CURRENT CIRCUMSTANCES OF NUCLEAR AND OTHER ENERGY SOURCES AROUND THE WORLD

2.1. Rapid increase in global energy consumption

The global population continues to grow, primarily in developing countries, and by 2050 it is expected to reach 9.3 billion, a figure 1.5 times above the current level. Economic growth will bring the per-capita energy consumption of developing countries close to that of industrialized nations. Global energy consumption will triple by 2100 and in developing countries the increase will be six fold (Fig.1). In China, which is enjoying notable economic growth, demand for electric power has been increasing by Japan's total annual electricity demand for the past few years.

In terms of the supply of energy sources, the price of crude oil is hovering at around 60 dollars per barrel. Some estimates say that the oil price will remain high for now, backed by an international race for securing energy resources.

Fig.2 CO2 Emissions Outlook

Source: Nuclear Energy National Plan [2]
2.3. Nuclear Renaissance

In terms of energy security, nuclear power can produce a large amount of energy using a small amount of fuel and generate for over one year without refueling (Fig.3). Uranium is not as concentrated in certain regions as are fossil fuels, and is therefore less affected by political issues. In addition, we can reuse spent fuel from nuclear power plants by reprocessing. Uranium supply, if used only for light-water reactors, would last less than 100 years. However, if fast-breeder reactors are commercially developed, uranium utilization efficiency will be drastically increased, enabling the use of nuclear energy for more than several thousands years.

Fig.3 Comparison of Various Fuels Required to Operate 1GW Power Plant per year

2,210,000t

21t

930,000t

1,430,000t

Natural Gas

Uranium

Coal

Source: Graphical Flip-chart of Nuclear & Energy Related Topics [3]

Furthermore, nuclear energy is an effective measure against global warming. There are two notable academics that explore the issues of nuclear power and the global environment. One is Dr. James Lovelock, a British scientist famous for his Gaia Theory. According to Dr. Lovelock, the Earth has exercised its self-adjusting mechanism just like humans adjust their own body temperature, but the impact of human activities, such as CO2 emissions, has strained the mechanism beyond the planet’s natural capacity. In his view, nuclear energy is the only realistic alternative to fossil fuels that has the capacity to both fulfill the large-scale energy needs of mankind while also reducing CO2 emissions.

The other academic is the Canadian environmentalist, Dr. Patrick Moore. As a founding member of the environmentalist group Greenpeace, he once held a negative view on nuclear energy. However, he now holds the view that nuclear energy is necessary to sustain economic growth while preserving the global environment. He predicts that countries that dispose of spent fuel will be recycling it in future.

Based on these facts, many countries have turned their attention toward nuclear energy. The most notable example is the United States. The construction of nuclear power stations stalled in the country following the economic recession and the stagnation of demand growth in the wake of the Oil Crisis (1973), and the accident at the Three Mile Island nuclear power station (1979). In recent years, nuclear power stations are being operated at a high capacity factor, and have become a power source with economic advantages. As a countermeasure against global warming and to boost energy security, the Bush administration announced the “National Energy Strategy” and “Nuclear Power 2010” program, promoting a partnership between the public and private sectors to introduce policies such as subsidies for new plant sites and tax incentives, with the aim of building new nuclear power plants by 2010. In February 2006, the U.S. Department of Energy (DOE) announced the Global Nuclear Energy Partnership (GNEP) scheme as a comprehensive strategy to increase U.S. and global energy security, reduce the risk of nuclear proliferation, encourage clean development around the world and improve the environment. In the United States, which for decades has followed a policy of direct underground disposal of spent fuel from light-water reactors rather than reprocessing, the government is now turning the policy toward the active development of the nuclear fuel cycle and fast-breeder reactors.

2.4. Simultaneous achievement of expansion of nuclear industry and nuclear non-proliferation

The increasing attention given to nuclear energy can be interpreted as a move toward expanding the peaceful use of nuclear energy. On the other hand, there is a growing concern about nuclear proliferation. More specifically, it involves the existence of a nuclear black market linked to Pakistan’s Dr. Khan, nuclear development issues in Iran and North Korea, and the potential for nuclear terrorism.

In order to ensure nuclear non-proliferation while using nuclear energy for peaceful purposes, new frameworks, such as the nuclear fuel supply guarantee mechanism and multilateral nuclear approaches, were suggested. For example, the U.S. suggested at the IAEA’s General Conference in 2005 that an international framework should be developed to ensure supplies of nuclear fuel to the countries that abandon enrichment and reprocessing technology. In 2006, President Putin of Russia also suggested creating an “International Nuclear Center” to provide uranium enrichment and a spent fuel reprocessing service. These proposals were discussed at an IAEA General Conference Special Event titled “New Framework for the Utilization of Nuclear Energy in the 21st Century: Assurances of Supply and Non-Proliferation” in September 2006.

Japan, which has ratified the Nuclear Non-Proliferation Treaty (NPT), has been recognized as the only country without nuclear weapons that operates commercial-scale nuclear fuel cycle facilities. Throughout its history of nuclear energy development, Japan has firmly upheld both peaceful use and nuclear non-proliferation. With these experiences, Japan is contributing to establish a new framework on nuclear non-proliferation.

3. NUCLEAR ENERGY NATIONAL PLAN

3.1. Current status of nuclear energy in Japan

In Japan, 55 nuclear power plants are in operation (with capacity of approx. 30,000MW). Another 13 reactor units are either under construction or in the planning stage (with capacity of approx. 17,000 MW) (Fig.4). These plants play an important role as one of the nation’s
core energy sources, providing about one-third of the total power generation.

![Fig.4 Nuclear Power Plant in Japan](source: Graphical Flip-chart of Nuclear &Energy Related Topics [3])

Japan also promotes the nuclear fuel cycle program, which makes effective use of uranium, plutonium, etc., extracted from spent fuel. The nation plans to introduce the Plu-Thermal Program to use MOX fuel in thermal reactors. The Rokkasho Reprocessing Plant, a reprocessing facility for preparing LWR fuel, is conducting its final start-up test (active test) using actual spent fuel from March 2006. The commercial operation of the reprocessing plant is scheduled to start by the end of 2007. In order to use MOX fuel in LWR we are also planning to launch the operation of the Rokkasho MOX Fuel Fabrication Plant in 2012.

3.2. The “Framework for Nuclear Energy Policy” and the “Nuclear Energy National Plan”

The Atomic Energy Commission of Japan, which defines the nation’s basic policy on nuclear energy, established the “Framework for Nuclear Energy Policy” in 2005. The Framework set forth the following principles:
1) Maintaining or increasing the current level of nuclear power generation (30% to 40% of total electricity generation) after 2030,
2) Using nuclear fuel resources as effectively as reasonably achievable, to reprocess spent fuel and to efficiently use the recovered plutonium and uranium,
3) Consistently promoting research and development toward the commercialization of Fast-breeder reactors beginning around 2050.

Specific policies for achieving the basic principles defined in the “Framework for Nuclear Energy Policy” are studied and deliberated by the Nuclear Energy Subcommittee, which was convened under the Electricity Industry Committee of the METI (Ministry of Economy, Trade, and Industry) Advisory Committee for Natural Resources and Energy for the first time in four years. The Subcommittee, consisting of representatives from government, utilities, manufacturers, local communities, academics, consumers and the media, compiled a report titled the “Nuclear Energy National Plan” in August 2006. The Plan set out specific policies for promoting the government’s nuclear energy principles with long-term consistency and defined an action plan accordingly, while also mandating that the government allocate the necessary budget. The Plan communicates the government’s approach of focusing on nuclear energy to secure energy supply.

The Plan is positioned as the core of Japan’s Basic Energy Plan (revised in March 2007).

3.3. Policy objectives in the “Nuclear Energy National Plan”
1. Building new plants and expanding existing facilities under a liberalized electricity market
2. Appropriate use of existing nuclear power plants while ensuring safety
3. Promoting the nuclear fuel cycle and strengthening strategic associated industries
4. Early commercialization of the fast-breeder reactor cycle
5. Securing uranium resources
6. Securing and developing technology, industry and human resources necessary for future generation
7. Support for the international expansion of Japan’s nuclear energy industry
8. Actively contributing to the creation of an international framework that both allow the expansion of the nuclear industry and supports nuclear non-proliferation
9. Building increased confidence between the national government and local communities
10. Steadily promoting a program for radioactive waste

4. INITIATIVES BY ELECTRIC UTILITIES FOR ACHIEVING THE “NUCLEAR ENERGY NATIONAL PLAN”

Electric utilities are recognizing that the “Nuclear Energy National Plan” identifies steps to be taken to achieve the basic principles set forth in the “Framework for Nuclear Energy Policy”, and the plan is valuable in that it defines the roles of the government, research and development institutions, and electric utilities. We are steadily working to achieve the targets set forth in the “Nuclear Energy National Plan”.

4.1. Ensuring safety and restoring the public’s trust

The understanding and trust of the public and local communities are indispensable for the use of nuclear energy. Electric utilities will take all possible measures to ensure the safe operation of nuclear power plants, as well as work to increase the confidence of the public by increasing transparency of operations, and promoting publicity and communication activities based on the opinions obtained from public hearings.

When the scandal of data falsification for power plants surfaced in November 2006, the government ordered electric utilities to inspect all activities to ensure safe operation in power plants. We conducted a thorough inves-
tigation to determine the causes of inappropriate activities in the past, and developed preventative measures. In order to regain the public’s trust, we are working to enhance compliance with laws, regulations and other safety rules, establishing strong communication and information sharing with regard to quality assurance.

4.2. Effective use of existing reactors

It is necessary to use the full potential of existing nuclear power plants in order to achieve the policy target of supplying 30% to 40% of the total power production in 2030 and beyond. The capacity factor of Japanese nuclear power plants increased to 84.2% in FY1998. More recently, however, the capacity factor has been in decline since peaking above 80%.

On the other hand, the capacity factors of nuclear power plants in Europe, the United States and South Korea have been rising to approximately 90% (Fig.5).

Fig.5 Historical Trend in Nuclear Power Plant Capacity Factor

The capacity factor depends in part on the frequency of unplanned shutdowns, the operating period and the length of inspection outages. In Japan, while the frequency of unplanned shutdowns is shorter and the length of inspection outages is longer than in other countries (Fig.6).

Fig.6 Average Operation Period and Outage Duration (1999-2000)

The government subcommittee’s forum, which includes representatives from the public and private sectors, discussed inspection systems for new maintenance approaches. The new system is to be introduced in FY 2008. We are developing new maintenance programs with the RCM (Reliability-Centered Maintenance) approach, making use of knowledge from the United States and other countries. Under the program, we will be expanding the scope of equipment status monitoring and on-line maintenance.

Another challenge is to steadily enhance and implement measures against facility aging, in response to the increasing number of plants operating over 30 years. In our system for addressing facility aging, we conduct an assessment for signs of aging, such as pipe thinning, insulation degradation of electrical cables, etc., and establish a long-term maintenance plan based on the assessment.

4.3. Steady promotion of the Plu-Thermal Program

Under the Plu-Thermal Program, plutonium is mixed with uranium to produce mixed oxide fuel (MOX fuel) for use at thermal reactors (Fig.7). The Plu-Thermal Program is expected to reduce uranium use by 10% to 20%. Electric utilities are aiming to introduce the program in 16 to 18 reactors by FY 2010. In September 2005, Chubu Electric Power Company announced the plan to introduce the Plu-Thermal program to Hamaoka Nuclear Power Station Unit No. 4 in FY 2010. We received the government’s safety permit in July 2007 and are preparing to begin the program. Kyushu Electric Power Company and Shikoku Electric Power Company also have plans to introduce the Plu-Thermal Program in their plants.

Fig.7 Nuclear Fuel Cycle

4.4. Securing and developing technology and human resources necessary for future generation

In order to promote nuclear energy, it is essential to maintain a solid technological capability and secure/foster human resources. One of the initiatives is to develop a Japanese version of next-generation light-water reactors. A number of Japan’s nuclear power plants were
built in or after the 1970s, and will enter the replacement phase around 2030. Since the fast-breeder reactor technology will not have reached the practical application stage by then, light-water reactors must be built as replacements. In order to prepare for building replacement reactors, the government, electric utilities and plant manufacturers have launched an initiative to develop a next-generation reactor, with possible introduction to the international market.

Another important theme is to provide education support to future generations. Japan is developing a tentatively named “Nuclear Energy Human Resources Development Program”. It includes an internship program at electric utilities and research laboratories to promote understanding of the industry and R&D sites, and support human resource development at universities and postgraduate schools by compiling and enhancing the curriculums.

4.5. Enhancing efforts to select a candidate site for final disposal

High-level radioactive waste is vitrified waste produced from liquid waste remaining after spent fuel is reprocessed. The basic policy is that high-level radioactive waste will be disposed of underground, in a deep geologic repository, after a 30- to 50-year cooling period (Fig.8).

The Nuclear Waste Management Organization of Japan (NUMO) was established in 2000 as the entity responsible for final disposal of high-level radioactive waste. In 2002, NUMO called for volunteer municipalities willing to consider hosting a final disposal facility across the nation. Opposition campaigns succeeded in stalling the process at the initial selection stage, despite there being inquiries from some local governments. The first application came from Toyo-cho Town of Kochi Prefecture in January 2007, but the application was later withdrawn because of opposition campaigns. The next couple of years are crucial for securing a final disposal site in keeping with the schedule established in the Final Disposal Plan. With this in mind, all interested parties should maximize efforts to increase public understanding. Electric utilities, aware of our role as producers of high-level radioactive waste, make great efforts to support NUMO in coordination with the government in addressing the situation.

4.6. Early commercialization of the FBR cycle

The fast-breeder reactor (FBR) cycle has the advantages of dramatically improving the efficiency of using uranium, and significantly contributing to energy security. FBR can also reduce the amount of high-level radioactive waste because it uses long half-life radionuclide contained in spent fuel.

The Nuclear Energy National Plan outlines the scenario for commercial application of the FBR cycle. In the scenario, Japan aims to achieve a demonstration reactor by 2025 and introduce a reactor for commercial operation by 2050, in view of the development schedule of GNEP in the U.S. and other organizations (Fig.10). The concerned parties (government, R&D organizations, manufacturers and the electric utilities) established the forum to achieve smooth transition from the R & D phase to commercialization. Electric utilities as the users are continuing to support the “Study of the Commercialization Strategy for FBR Cycle,” and participating in the forum.
5. Conclusion
The content of this Paper is summarized in the following points:
1) The endorsement of nuclear energy is a worldwide trend, resulting from the need for energy security and concerns for the global environment.
2) In Japan, the government, energy industry and other parties have launched initiatives to implement the policy objectives set forth in the “Nuclear Energy National Plan”.
3) As electric power companies, we will steadily work toward achieving the goals in the “Nuclear Energy National Plan”, while at the same time ensuring nuclear safety.

REFERENCES