Comprehensive Fuel Recycling for Sustainable Development of Nuclear Energy in Japan

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Thank you Mr. Chairman for your kind introduction.
Good afternoon Ladies and Gentlemen.

It is my great pleasure to be given an opportunity to talk about Japan's nuclear fuel cycle policy.

Today, first, I touch on our new "Framework for Nuclear Energy Policy" and talk about present status of nuclear power generation in Japan.
Then, I would like to focus my talk more or less on debate and conclusion of fuel cycle policy which we made during the stage of preparation of the framework.

We finally chose comprehensive fuel recycling policy for sustainable development of nuclear energy. Therefore, I touch on the current status of feasibility study of Fast Breeder Reactor systems and also transparency of plutonium utilization in Japan.

Finally, I summarize my talk briefly.

The Atomic Energy Commission was founded in 1956, and one of the roles of the Commission is to plan, deliberate and decide a long-term program for research, development and utilization of nuclear energy.
The AEC decided new "Framework for Nuclear Energy Policy" in October, 2005, adopting the draft prepared by the New Policy Planning Council of the AEC based on its elaborate discussion including public comments. The Council was composed of not only leading experts in the nuclear energy field but also leaders and well-informed persons from various sectors of society, in addition to the Commissioners.
The Framework consists of basic measures for promotion of nuclear activities, nuclear energy utilization and radiation application, research and development in these fields, international coordination and cooperation, and review of policy implementation.
Among them, today, my talk is focused only on nuclear energy utilization.

Here, I would like to describe the present status of nuclear power generation in Japan. We have 55 nuclear power plants in operation with total power capacity of 49 GW currently, which produce about one-third of total electricity generation in Japan. That contributes to increase in the ratio of self-sufficiency of primary energy supply from 4 % to 19 % and stability of electricity price in spite of the recent extreme rise in price of fossil fuels and so on. Furthermore, 2 plants are under construction, 3 plants are under safety review by the licensing authorities and 8 plants are in preparation for the application of construction permission within coming 5 to 10 years.

Fuel cycle policy is very important, and increasing concerns have been raised about the former fuel recycling policy due to the delay in development of FBRs mostly resulting from the Monju's accident and use of plutonium in LWRs, which accordingly brought a question of necessity of reprocessing and fuel recycling and so on.

Then, the New Policy Planning Council initiated their discussion first on fuel cycle option and spent nearly half a year. The Council assumed representative four scenarios for handling of spent fuel in the future and evaluated respective advantages and disadvantages from ten viewpoints. The assumed four scenarios are ① full fuel recycling ② partial fuel recycling within the capacity of the Rokkasho reprocessing plant ③ direct disposal of spent fuel, and ④ to postpone the decision. Ten viewpoints are Assurance of Safety, Technical Feasibility, Economical Viability, Energy Security, Environmental Protection, Nuclear Non-Proliferation, International Trends, Issues resulting from Policy Change, Social Acceptability and Adaptability to Future Uncertainty.

Unfortunately, the presentation time is very limited, so, I can't tell you the evaluation results of respective advantages and disadvantages to four scenarios in detail. The conclusion of debate on fuel cycle option which is closely related to nuclear energy utilization policy in Japan is as follows.

① Japan needs to use nuclear energy as one of the major means of electricity generation for a long term in accordance with Japan's Energy Basic Policy Law enacted in 2002 which requests three principles for future energy sources, namely, stable supply, harmonization with global environment and economical competitiveness. Therefore, it is appropriate to aim at maintaining or increasing the current level of nuclear power generation of 30 to 40 % of the total electricity generation.

② In order to achieve this, it is also appropriate to reprocess spent fuel and to use effectively the recovered plutonium and uranium, namely, fuel recycling which provides significant merit from the viewpoints of energy security, reduction of potential harm from radioactive waste disposal, adaptability to future uncertainty and so on, while ensuring safety, nuclear non–proliferation, and paying due attention to economic viability. So, it is realistic for Japan to devote herself to fuel cycle for LWRs for a while before FBR cycle will become commercial.

Figure 1 shows Mid – and long-term prospect of nuclear power generation capacity in Japan as illustrative image.

In the first place, the existing nuclear power plants should be used efficiently and as long as possible, possibly 60 years as their life times, and strenuous efforts in constructing new plants under planning should be continued.

With respect to replacement of the existing nuclear power plants starting around 2030, advanced model of the current LWRs should be developed.

Another epoch-making time is the timing of introduction of Fast Breeder Reactors. We are striving for commercialization of FBRs by around 2050. The FBR capacities will increase depending on plutonium inventory in this figure. The development of commercial FBR and related reprocessing of spent fuel and fuel fabrication is a big challenge and an international issue, while Japan has been devoted in this field so far as described later.

Figure 2 is a typical figure of nuclear fuel cycle. So, I don't think I need to explain in detail. In our case, the recovered plutonium and uranium by reprocessing of spent fuel from LWRs will be used in LWRs until around 2050, and then, in FBRs if FBR becomes commercial at that time.

③ The entities should steadily promote the realization of nuclear activities planned through rigorous risk assessment and management under the liberalization of electric market.

④ On the other hand, the Government should start from 2010 deliberation of the future fuel cycle strategy to be followed after the retirement of Rokkasho Reprocessing Plant, taking into consideration the progress in the R&D for FBR and its fuel cycle systems.

Figure 3 shows the existing and preparing nuclear fuel cycle related facilities in Japan. We have Rokkasho uranium enrichment plant and reprocessing plant. On the other hand, an interim storage facility of spent fuel and MOX fuel fabrication plant are being built by 2010 and 2012, respectively. As concerns plutonium utilization in LWRs, the utilities have planned to start to use plutonium in 16 to 18

LWRs by 2010. However, the first program was suspended due to falsification of the MOX fuel fabrication data several years ago. Currently, two plants are waiting MOX fuel after having received permission of MOX fuel utilization from the licensing authorities, and several other utilities are preparing to receive permission of MOX fuel use in LWRs.

Now, I would like to touch on the progress of Feasibility Study of FBR Cycle Systems a bit. The study was initiated by the joint program of mainly utilities and former JNC in 1999. In the first two years, they made screening of feasible candidate concepts of commercialized FBR cycle systems which include reactor type, reprocessing and fuel fabrication method with development targets which are quite common now, as in Generation IV, for example, as shown in Figure 4. In the Phase 2, they have studied more in detail their feasibilities of several promising FBR systems for 5 years. Currently, MEXT, METI as well as AEC are evaluating the results of Phase 2 study. In the Next Step starting from this fiscal year, the feasibility study will be much concentrated on the most promising FBR cycle system to develop basic design and confirmation of their technological feasibility by necessary R&D in order to make an appropriate picture of commercial FBR cycle system and R&D program leading up to commercialization.
Figure 5 shows a couple of examples of FBR cycle system proposed by the JAEA and JAPC. The first one is a rather conventional sodium-cooled, oxide fueled, loop-type reactor. However, reprocessing method is advanced aqueous one with low decontamination factor to enhance nuclear non-proliferation and reduce the cost, therefore, fuel fabrication plant should be adjacent to the reprocessing plant, may be in a same building, and operation is made remotely. The second one is also a sodium-cooled reactor, but metallic fuel is proposed to obtain higher breeding ratio and pyroprocess is considered to reprocess spent fuel. The third one is a high temperature helium gas-cooled fast reactor with nitride coated particle fuel. A hexagonal block dispersed of coated fuel particles is a fuel element in this case.

Coming back Japan’s policy of fuel recycling, here, I would stress on transparency of plutonium utilization in Japan. In the first place, the Atomic Energy Basic Law was enacted in 1955, and in which the research, development and utilization of nuclear energy are strictly limited to peaceful purposes as shown in Figure 6. Furthermore, Japan declared to the international community in 1967

that we, Japan obey three principles for no nuclear weapons, that is, not to have, not to make nuclear weapons and not to allow anyone to bring nuclear weapons in Japan. Secondly, Japan has fully accepted all of the IAEA non-proliferation and safeguards schemes. The IAEA appreciated our full transparency of nuclear activities and applied the integrated safeguards to Japan in 2004. Thirdly, specifically as for transparency of plutonium utilization, we report annually plutonium inventory to IAEA. Atomic Energy Commission also requests utilities to report prospect of usage of plutonium before reprocessing spent fuel at Rokkasho plant and opens these data to the public.

As for plutonium, Japan's policy is not to possess plutonium without any peaceful utilization purpose. The quantities of plutonium which we have currently, future production and utilization are shown in detail in Figure 7. So, you can easily understand that the quantities of plutonium of production including current possession will meet the quantities of utilization plans. Furthermore, when we start the operation of a demonstration fast breeder reactor, we need much amount of plutonium.

Let me conclude my presentation.

① The comprehensive fuel recycling is very important to sustainable development of nuclear energy in order to use effectively the limited uranium resources as much as possible and minimize high- level radioactive waste.

② In order to accomplish comprehensive fuel recycling, the development and establishment of FBR fuel cycle system which is safe, reliable, economical, proliferation-resistant, etc. is a key issue internationally.

③ Japan has been devoted in feasibility study of advanced FBR cycle systems for the last several years and is going to proceed to the next step, collaborating with the international framework such as GIF, GNEP, meanwhile, LWR fuel cycle is progressing in Japan.

④ These works must be strictly limited to peaceful purposes and transparency of plutonium utilization and non-proliferation are indispensable, as Japan has shown ever since the beginning.

Thank you for your kind attention.

Fig.1

Mid- and Long-term Prospect of Nuclear Power Generation Capacity in Japan (illustrative image)

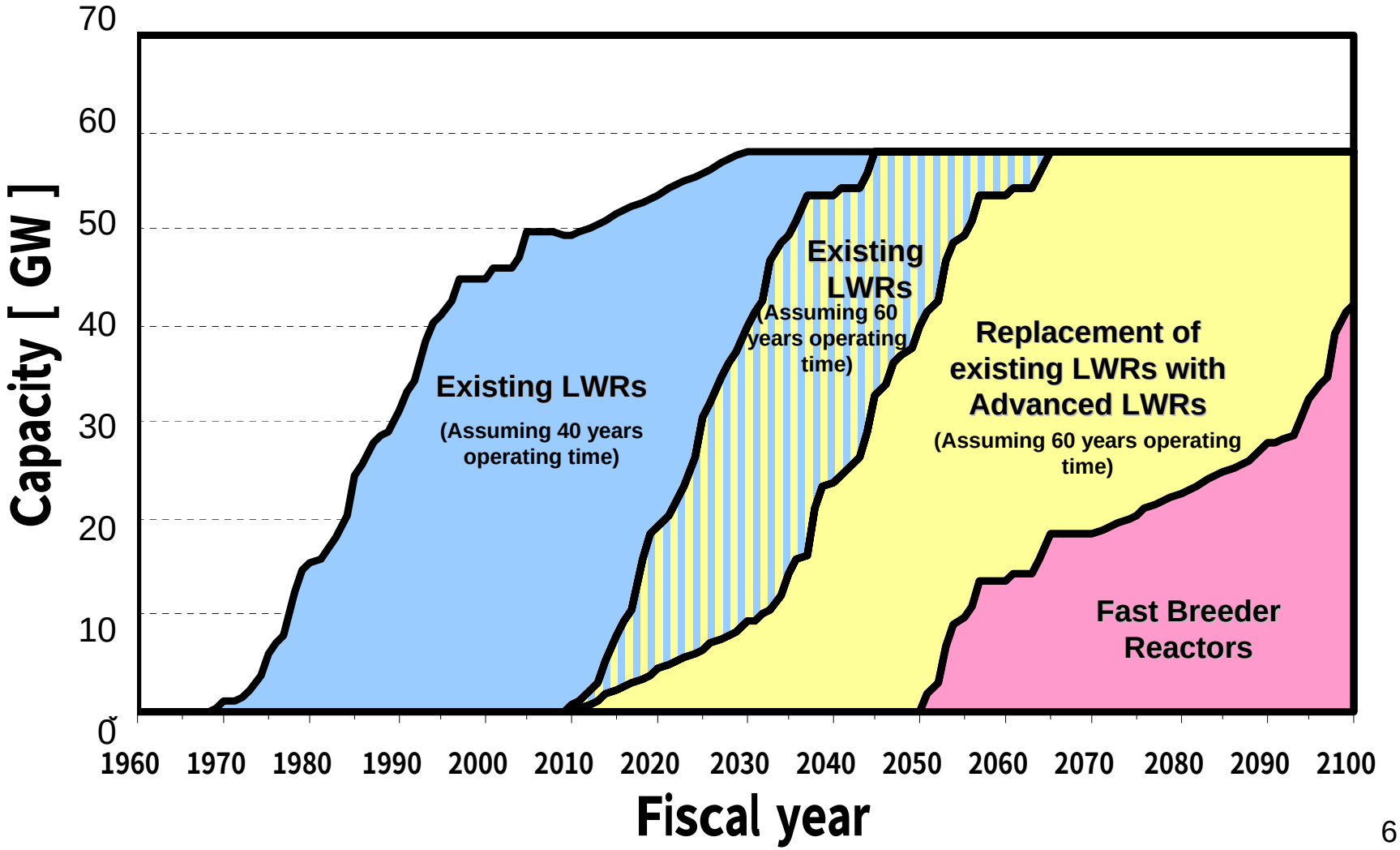

Fig.2

Nuclear Fuel Cycle

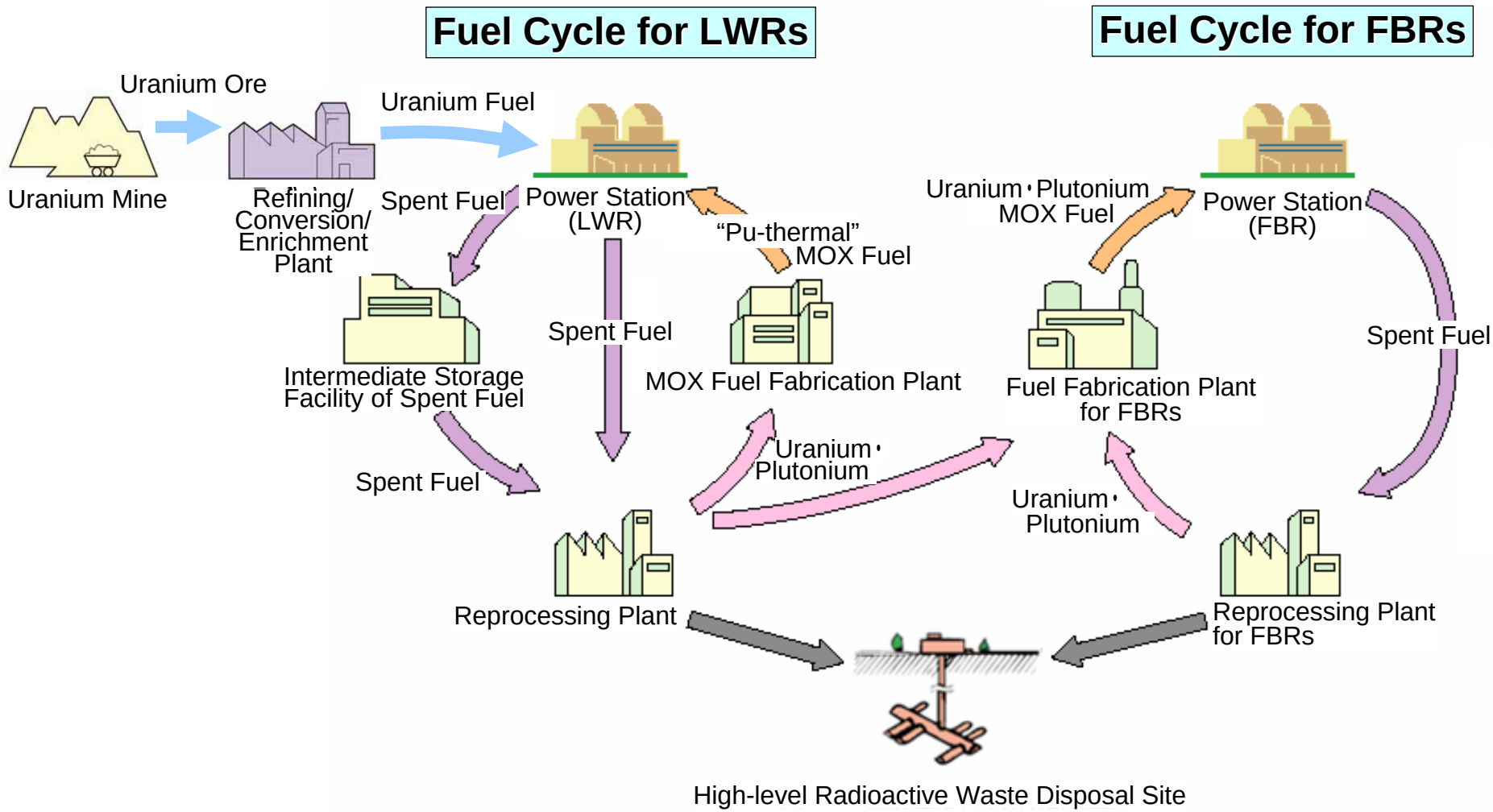

Fig.3

Existing and Preparing Nuclear Fuel Cycle Related Facilities

Uranium enrichment

Rokkasho uranium enrichment plant	1,500 tSWU/y

Spent fuel reprocessing

Rokkasho reprocessing plant	800 t/y

Interim storage of spent fuel

Recycling fuel storage center (Mutsu/Aomori) to be constructed by 2010	5,000 t

MOX fuel fabrication

Rokkasho MOX fuel fabrication plant to be constructed by 2012	130 tHM/y

MOX fuel utilization in LWRs (Pu-thermal)

planned in 16～18 LWRs

Fig.4

Feasibility Study of FBR Cycle Systems

Appropriate picture of commercialization for FBR cycle and R&D plans leading up to commercialization

Evaluation of a wide range of technical options

- Reactor, Reprocessing, Fuel fabrication as a system

Phase 1
(FY1999-2000)

Screening of highly feasible candidate concepts of commercialized FBR cycle (sodium, gas, water, Pb-Bi)

Phase 2
(FY2001-2005)

Presentation of the promising commercialized FBR cycle candidates (two or three)

Next Step
(FY2006-2015)

Basic design of commercialized FBR cycle candidates and confirmation of their technological feasibility

Development Targets of commercialized FBR cycle systems

- Ensuring safety
- Economic competitiveness
- Efficient utilization of resources
- Reduction of environmental burden
- Enhancement of nuclear non-proliferation

Fig.5

Technology Candidates of FBR Cycle System raised by JAEA and JAPC

	Coolant	Fuel	Reprocessing	Fuel fabrication (remote operation)
1	Sodium	Oxide	Advanced aqueous reprocessing (Low DF)	Simplified pelletizing
2	Sodium	Metal	Pyroprocess	Casting
3	Helium gas	Nitride	Advanced aqueous reprocessing (Low DF)	Hexagonal block dispersed of coated fuel particles

Fig.6 Transparency of Plutonium Utilization in Japan (1)

Law and Declaration

- Atomic Energy Basic Law
- Three Principles for No Nuclear Weapons

International Schemes

- NPT
- IAEA Safeguards

Report Plutonium Inventory to IAEA

- "Guidelines for Plutonium Management" (INFCIRC/549, since 1997)

Plutonium Guideline by Japanese Government

- Basic Position on Japan's Use of Plutonium (August, 2003)

Fig.7 Transparency of Plutonium Utilization in Japan (2)

< Japan's Policy >

Not to possess plutonium without any peaceful utilization purpose.

< Reserves >(as of December 31, 2004)

Japan : 4.0 tons of Puf

Overseas : 25.3 tons of Puf

< Production >

Rokkasho RP : 4 tons of Puf / y (at full operation)

Tokai RP : 0.2 tons of Puf / y (in 2005)

< Utilization plans>

- 16-18 LWRs (including Ohma (ABWR)) will use MOX fuel
  5.5 -6.5 tons Puf / y
- Monju, Joyo: 0.6 tons Puf / y