PRESENT STATUS AND FUTURE OUTLOOK OF NUCLEAR POWER GENERATION IN JAPAN

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1. ENERGY SITUATION IN JAPAN

Energy consumption in Japan, which had been decreasing for the three consecutive years since after the second oil crisis in 1979, was increased again after FY 1983 beginning with April 1983.

Japan's primary energy supply in CY 1985 was 376 Millions of tons of oil equivalent, 55% of which was from oil, 19% from coal, 10% from nuclear, 9% from LNG and 6% from hydro, geothermal and other types of energy resources.

It is evident with this scheme that the structure of energy consumption in Japan is heavily dependent on oil. This high dependency on oil is even tougher to Japan by the fact that 99.8% of supply of oil is imported and that approximately 70% of it is from the Middle East, giving a vulnerable economic base to Japan. Fraction of Japanese dependency on oil as its primary energy resource to the total energy consumption was at a level of 76% prior to the oil crisis in 1973, was decreased gradually after that. This decrease was attributed by industry's efforts to save energy consumption and to develop alternative energy source.

Japan is making utmost efforts to promote the energy policy as is listed in the following.

(1) Acquiring stable oil supplies
(2) Developing and introducing nuclear power, coal, natural gas and other alternative energy sources
(3) Promoting energy conservation.

2. PRESENT STATUS OF NUCLEAR POWER IN JAPAN

Japan, as it is poor in its energy resources, has been making its greatest effort in developing nuclear power among other alternatives of oil.

Compared with fossil fuel, it can produce higher energy per unit weight by the use of uranium and, accordingly, it is easier to transport and store.

And comparing power generating costs throughout plant life, nuclear power is more economical than oil, natural gas and coal fired power even in the recent situation of low oil prices and the appreciation of yen.

As of the end of March 1987, 33 nuclear power plants (25.7GW) were operating, 10 units (9.6GW) were under construction and 7 units (7.1GW) were under planning stage. The share of nuclear power generation in the total power supply was increased to 27% in FY 1986, exceeding the share of oil-fired power generation, which stayed at 24%.

The capacity factor of the nuclear power plants in Japan marked 76% in FY 1986, exceeding 70% level for the past several years.

And the scram frequency for power reactors has been less than one per reactor year, which is extremely low among other developed countries.

Thus, Japan has achieved the world's highest level of safety and reliability of nuclear power since the first commercial nuclear power plant operation in Japan in 1966, and Japanese nuclear power has now attained stability in energy supply.

Table 1. Nuclear Power Stations

(As of Mar. 1987)

Stage	Number of Units	Capacity (GW)
Operating	33	25.7
Under Construction	10	9.6
Under Planning	7	7.1

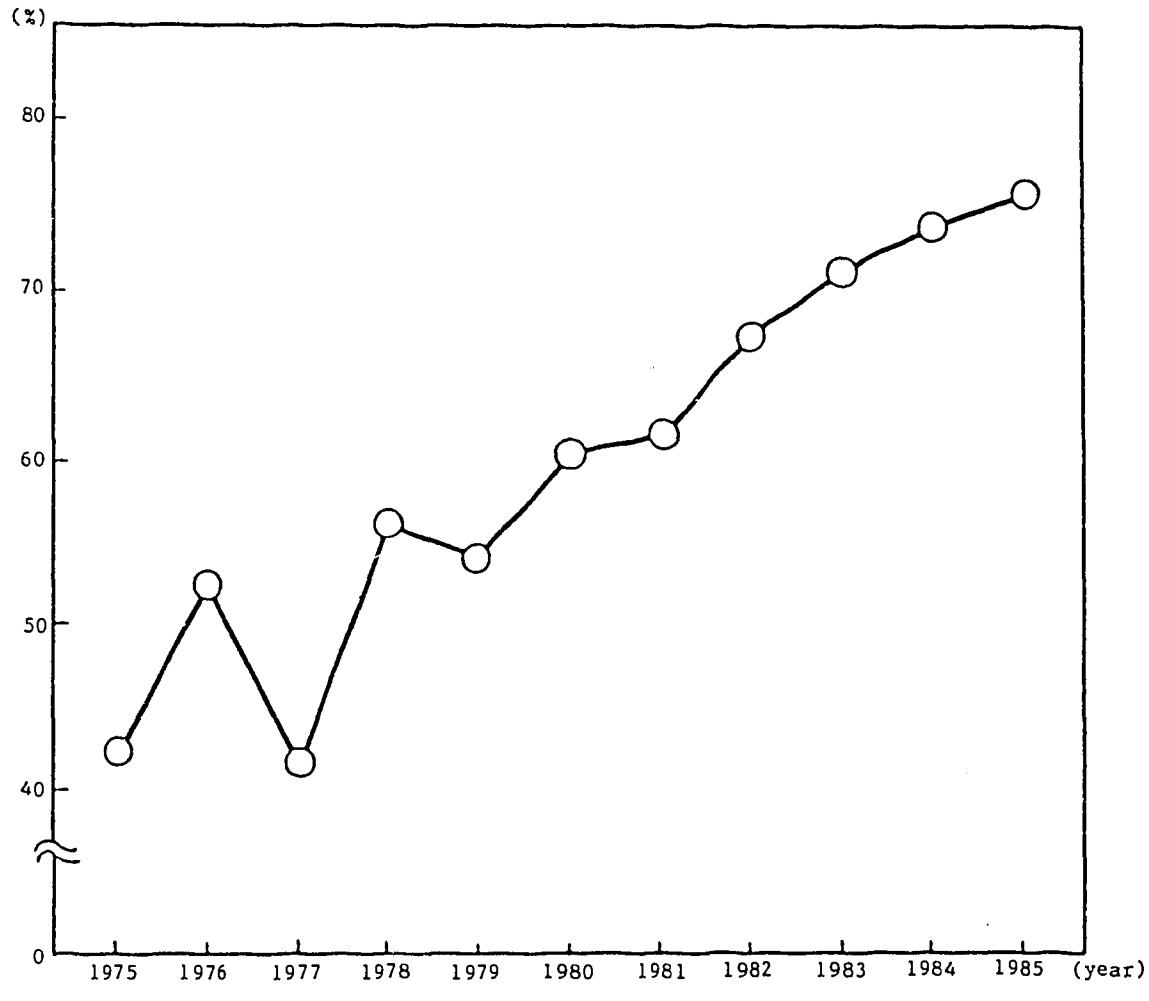


Figure 1 Capacity Factor

3. FUTURE PROSPECT

Japan has been introducing nuclear energy as a kernel energy source in supplying alternative energy to oil, the share of nuclear power is expected to increase steadily in the future. Future scale of the nuclear power generation is projected as 62 GW in year 2000 (Report of Supply and Demand Committee, Electric Utility Industry Council; November, 1983) and as 137 GW in 2030 (Report of Subcommittee on Nuclear Energy of Advisory Committee for Energy; July 1986). Nuclear power is expected to produce 58% of the nation's total power generation in 2030.

Table 2. Forecast on Capacity of Nuclear Power Generation

Item	(Actual performance) 1985	2000	Case 1 2010	Case 1 2030	Case 2 2010	Case 2 2030
Total Power Demand (Billion kWh)	592.8	899	1,130	1,590	1,010	1,240
Total Installed Capacity for Power Generation (MW)	154,250	232,000	269,000	343,000	244,000	267,000
Installed Capacity of Nuclear Power (MW)	24,520	62,000	87,000	137,000	77,000	107,000
Share of Installed Capacity of Nuclear (%)	16	27	32	40	32	40
Power Generated by Nuclear Power (Billion kWh)	159	370	550	900	480	700
Share of Nuclear Power Supply (%)	26	39	49	58	49	58

Note : 1. Figures for 2000 are taken from the report by the Supply and Demand Committee of the Electric Utility Industry Council (November 1983).

2. Case 1 : Estimated from GNP.
Case 2 : Estimated from per capita electric power consumption.

3. Capacity factor in nuclear power plants is estimated at 75% in 2030.

4. Total power demand is total demand in end use. (In-house generation of electricity included.)

5. The share of nuclear power supply is the ratio of electricity generating at the plants.

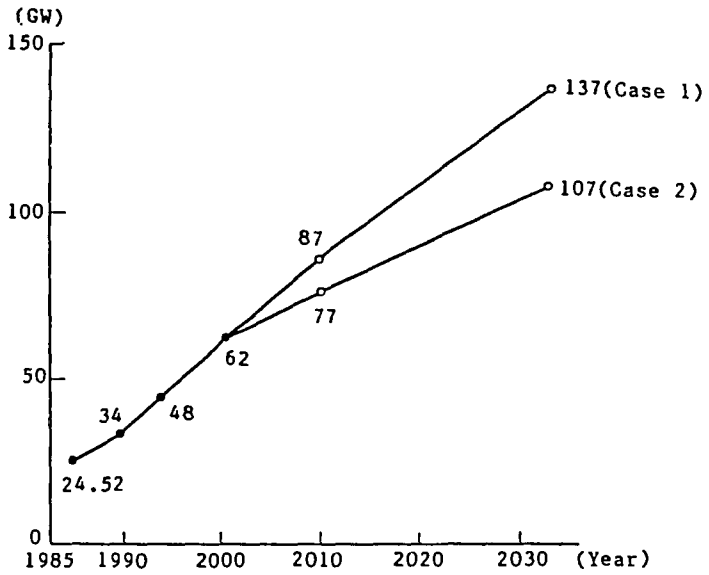
The accident at the USSR's Chernobyl nuclear power plant alerted everyone to the importance of taking every precaution in the development and operation of nuclear power plants as huge scale energy system, and how important it is always to maintain safety and to achieve even higher levels of safety in promoting nuclear power.

While demand exists for a steady increase in nuclear power, commercial use of FBRs seems to have come much later then is expected. The share of the FBR in 2030 is expected to be 5% in capacity, and the era of LWR will continue for a fairly long time.

Under the same circumstances, Japan is executing a nuclear energy policy based on the following guidelines.

(1) Promoting "Safety 21" - The Safety Advancement Program

By maintaining the major premise of assured safety, Japan has achieved the world's highest safety levels of nuclear power generation. Nevertheless, those involved in nuclear energy must never become complacent over the twenty years of safe operation; a careful attitude must always be maintained. Lessons from the Chernobyl nuclear power plant accident and other incidents both within Japan and elsewhere should be reflected properly in Japanese measures for safety assurance, with further efforts made to strengthen governmental regulations and for the electric power companies to enhance safety controls, develop technology and prepare emergency responses. To ensure that everything is done to maintain safety of nuclear energy, the "Safety-21" program has been adopted to achieve even higher levels of safety, a plan to be carried out with the unified cooperation of private sector, academia and the government.



Notes: 1. Figures for 2010 and 2030 are from the report by the Subcommittee on Nuclear Energy of Advisary Committee for Energy.

2. Case 1 : Estimated from GNP.
Case 2 : Estimated from per capita electric power consumption.

3. Figures for 1990, 1995 and 2000 are from the report by the Supply and Demand Committee of the Electric Utility Industry Council (November 1983).

Figure 2 Forecast on Installed Capacity of Nuclear Power

(2) Improving LWR Technologies

The apparently prolonged era of LWRs calls on the private sector to boost technological sophistication of LWRs, with safety as top priority. The efforts to be made should address improve the reliability and economic efficiency of LWRs and make effective use of uranium resources to help ensure Japanese energy security. Below are some of the suggested specific measures.

1. Technological development of existing LWRs should allow for a total life span of the plant, i.e., from design to construction and to decommissioning. This is aimed at higher reliability, operability, and economic efficiency of the LWRs to be installed.

2. Advanced LWRs are presently being developed. The first reactor of this kind will start operation in the mid-1990s.

3. As a long-term objective, development of the next advanced version of LWRs emphasizing effective use of uranium resources and higher economic efficiency should be promoted. The first reactor of this kind will be introduced around 2005.

(3) Program on use of Plutonium in Thermal Reactors

There should be no major technological problems with use of plutonium in thermal reactors since numerous achievements of its loading in thermal reactors have been operating successfully overseas for many years. However, the Japanese nuclear industry should proceed cautiously to accumulate expertise in verifying the technological characteristics of this set-up and in fabricating and handling uranium-plutonium mixed-oxide (MOX) fuel. Specifically, a small-scale demonstration program may be implemented first, followed

by a large-scale demonstration program, before the commercial use, which will start around 1997, of this setup.

Commercial use of the plutonium in thermal reactors should proceed cautiously in keeping with the domestic and overseas situation concerning the supply demand of plutonium, its economic efficiency, and plutonium-related technological developments.

(4) Advanced Thermal Reactors (ATRs)

ATRs burn plutonium very efficiently. As such, ATRs should be placed under demonstration reactor construction programs for establishing the technology of utilizing plutonium as soon as possible. Already, Electric Power Development C. (EPDC) is promoting the Oma demonstration reactor construction program with the aim of starting operation in mid-1990s. EPDC also intends to make design improvements from the viewpoint of an electric power company for better ATR performance and higher economic efficiency following the demonstration reactor phase.

(5) Promotion of FBR Development

Japan is totally dependent on overseas sources for the supply of uranium resources. In such a potentially vulnerable position, it is necessary for Japan to proceed steadily with the development of FBRs, the most efficient reactors to utilize uranium resources. If the development of FBRs makes headway, that will greatly enhance the world's efficiency in utilizing uranium resources.

Targets and setups of FBR development

1. It is expected to take a considerable time before FBRs can be developed and put to commercial use. The prototype reactor "Monju" (planned to reach critical in 1992, with electrical output of 280 MW) should be succeeded by the steady development of demonstration and commercial reactors. It is necessary to develop the technology of FBRs that can compete successfully with LWRs in economic terms.

2. Under the above program, the development of FBRs should be conducted toward the following targets for commercial implementation:

   (i) Demonstration reactor (800 to 1,000 MW class)

   A demonstration reactor should start operation around 2003. The construction cost should be about 1.5 times that of a comparable LWR.

   (ii) Initial stage of commercial reactors (1,300 to 1,500 MW class)

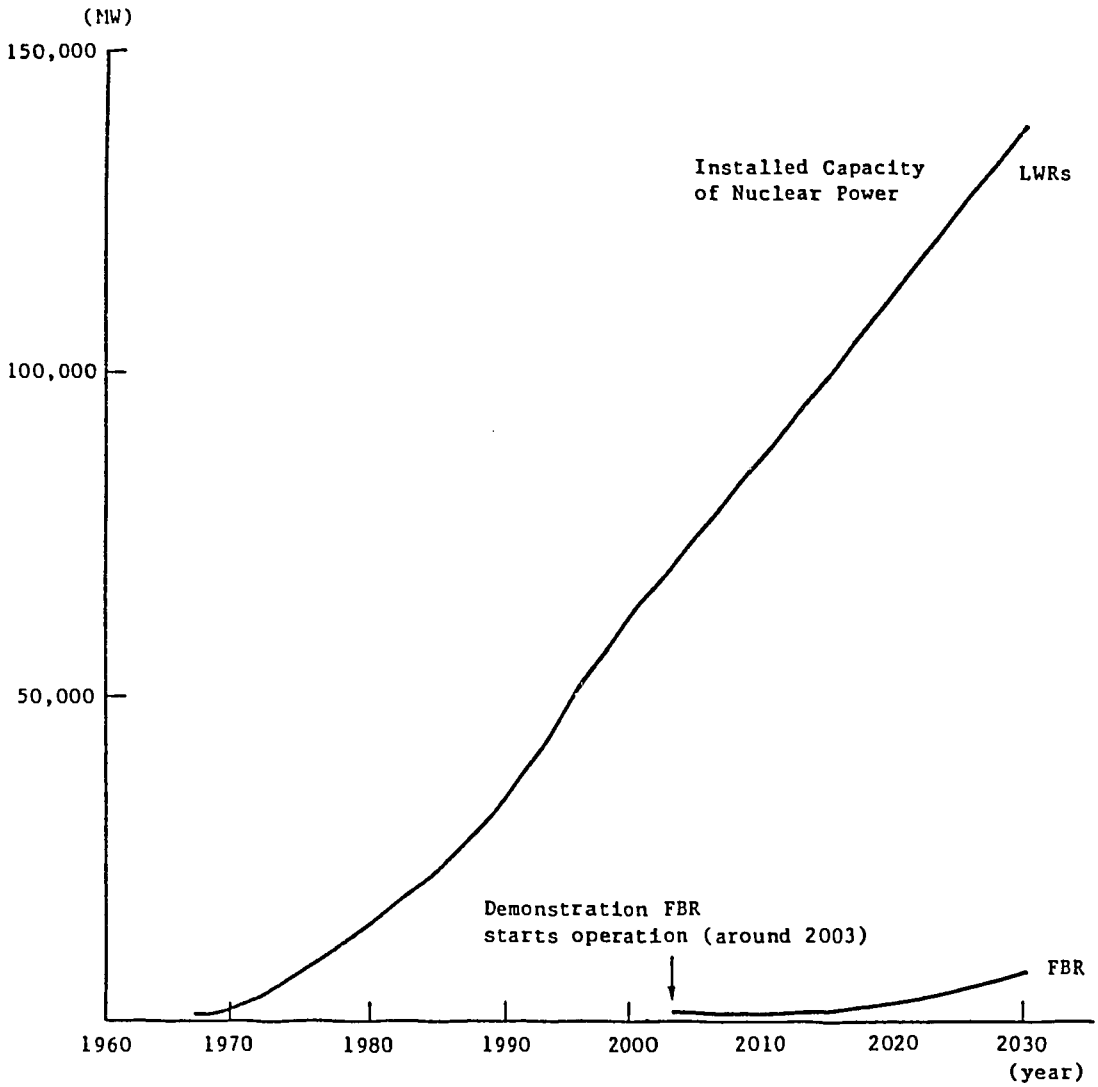
   The construction cost of an FBR in the full-fledged commercial stage should be about the same as that of a comparable LWR. Following the demonstration reactor, this target should be attained stepwise, i.e., by building two initial commercial reactors, which will start operation in first half of 2010s and first half of 2020s respectively.

3. FBRs following the demonstration reactor should be built and operated mainly by electric power companies under national support and guidance. The demonstration reactor is to be built and operated by the Japan Atomic Power Company.

(6) Nuclear Fuel Cycle

In the nuclear fuel cycle, Japan is now able to fabricate on its own all the nuclear fuel it needs, but depends on overseas facilities for such critical processes as enrichment and reprocessing. Japan is lagging behind the United States and European countries in implementing its nuclear fuel cycle.

To establish the entire nuclear fuel cycle in Japan, Japan Nuclear Fuel Service Co. (JNFS) and Japan Nuclear Fuel Industries Co. (JNFI) are planning to construct three key nuclear fuel cycle facilities in Rokkasho-mura, Aomori Prefecture. These facilities are a spent fuel reprocessing plant, a uranium enrichment plant and a low-level radioactive waste storage facility.



Note: This figure is prepared from Case 1.

Figure 3 Forecast on Projected Development of FBRs