

Japan's Long Term Nuclear Power Policy and Rising Need for Energy in East Asia¹

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Thank you Mr. chairman for your kind introduction. Good Morning Ladies and Gentlemen.

It is my great honor and pleasure to be invited to this conference and to talk about Japan's Long Term Nuclear Power Policy and Rising Need for Energy in East Asia. I am a little bit afraid that my presentation will harmonize with the conference theme "An East Asian Community? Global and Regional Dynamics". The energy issue is, however, very important and inevitable subject to each country, as well as regionally and globally. In this sense, I am very happy if my presentation can contribute for distinguished guests and participants to consider on this issue even a little.

Today, first, I talk about perspective of worldwide energy demand and present status of electricity generation by nuclear power briefly as introduction. Then, I go on today's my major topic of energy demand and role of nuclear energy in Japan. And, I will move to talk about energy need in East Asia, especially China and India. India is not an East Asian country, but, if you discuss energy issue, you can't miss this huge country among Asia. Furthermore, I would like to touch on an issue of energy consumption and global warming which is very important and serious problem. Finally, I summarize my talk briefly.

The progress of science and technology in the 20th century was unexpectedly remarkable in various fields such as electronics, communication, home electric appliances, transportation system, medical treatment and so on. The people in the developed countries such as United States of America, many European countries and Japan have enjoyed these fruits and their living standards have been improved so much. On the other hand, amounts of energy consumption in these countries have greatly increased.

Now, we are in the 21st century. The population and amounts of energy consumption in the developed countries are being rather stabilized. On the other hand, the population in the developing countries is expected to increase enormously and energy consumption surely increase with increase of population and improvement of living standard in these countries. According to the statistical review of world energy 2004, the population in the world is currently 6.3 billions and it will increase to 9.3 billions in 2050, namely, 1.5 times of the current. Among them, the population in the developed countries will not increase, besides, the developing countries, specifically in Asia and Africa will increase their population. The energy demand in 2030 will increase by 60% compared with that in 2002, and more than 60% of increment of energy demand are due to increase of population and economic growth in the developing countries, specifically, China, India and other Asian countries.

The primary energy consists of coal, oil, natural gas, nuclear energy, hydro-power, new

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energies such as solar energy, wind power, biomass, etc. As concerns nuclear energy, 16% of total world electricity are generated by 441 nuclear power plants in 30 countries in the world and another 24 nuclear power plants are under construction at present. The role of nuclear energy is very important, and a significant change in attitudes towards nuclear power has been witnessed in many countries where fast growing global energy demands, an increased emphasis on the security of energy supply, and the risk of climate change are driving a reconsideration of investment in nuclear power.

These are quite brief survey on perspective of worldwide energy demand for a few tens years and present status of nuclear energy utilization in the world.

I move on a topic of energy demand and role of nuclear energy in Japan.

Japan started research and development on peaceful use of nuclear energy 50 years ago, and the first electricity generation by nuclear power was attained in the Japan Power Demonstration Reactor in 1963. The first commercial power reactor, Tokai No.1, commenced its operation in 1966. Japan, other countries as well, faced the first oil crisis in 1973, and tremendous efforts were initiated to construct numbers of nuclear power plants in order to reduce the share of oil in energy consumption. The installation of nuclear power plants has progressed continuously for 20 years after the oil crisis, and today, the total number of nuclear power plants operated in Japan is 53 with total installed capacity of about 47,000 MWe. Nuclear power contributes to one third of the total annual electricity generation at present although it supplied only 2.4% of the total in 1973. On the other hand, the share of oil for electricity generation decreased from 71% to 10% in the same period. As for nation's primary energy source, oil shared 77% of the total at the first oil crisis time, however, the contribution of oil is slightly less than 50%. Nuclear power and natural gas compensate the gap at present. The ratio of electricity consumption to primary energy supply became double during this period.

Taking into account change of population structure due to progress of population decrease and aging society, gradual change of industrial and social structure, economic structure, etc., an increasing rate of energy demand is foreseen to be very low and energy demand will be its peak in 2021 and then, change to decrease.

However, energy self-sufficiency in Japan is only 4% and it becomes 19% at most even if nuclear energy is included. In case of France, it becomes more than 50%, because electricity generation by nuclear power contributes to around 80% of the total electricity generation. China is currently almost self-supporting, but, will face lack of oil, natural gas and uranium in very near future.

The years of resource availability of oil and natural gas in the world are 41 and 61 years, respectively, and uranium is available for another 85 years as far as consumption quantities per year of these energy resources are the same as the current quantities. However, uranium resources will be used for another several hundreds or a thousand years if fast breeder reactors (FBRs) become available, which I will talk later.

Taking into account these situations, the Atomic Energy Commission (AEC) of Japan decided recently the long-term nuclear policy called by "Framework for Nuclear Energy Policy" which was authorized by the cabinet. Today, I am going to talk about two major issues in the Framework, namely, nuclear power generation and nuclear fuel cycle.

First, I talk about nuclear power generation. In pursuit of the best mix of energy resources for Japan in accordance with the characteristics of various energy sources and in order to fulfill the expectations that nuclear energy contributes for stable energy supply and significant restraint of global warming, it is appropriate to aim to maintain or increase the current level of nuclear power generation, that is, 30 to 40% of the total electricity generation from now on. In order to achieve this,

1. The existing nuclear power plants should be used efficiently and as long as possible, possibly 60 years of life time on the premise of ensuring safety, and strenuous efforts in constructing new nuclear power plants under planning should be continued on the basis of understanding and consensus of the public including local residents.
2. With respect to replacement of existing nuclear power plants starting around 2030, advanced model of the current light water reactors (LWRs) with large output power and/or some medium-sized LWR in accordance with demand outlook should be developed.
3. Commercial FBRs will be adopted from around 2050. A time much depends on progress of nuclear fuel cycle program for light water reactors, tremendous efforts for commercialization of FBRs, operation of proto-type reactor, “MONJU”, development of reprocessing of FBR spent fuels, international situation including uranium supply and demand, and so on.

Now, my talk moves on nuclear fuel cycle. Before I talk about nuclear fuel cycle, I think that it is better to touch on composition of nuclear power plant shortly for the audience who are not so familiar with it. The energy is obtained by fission chain reaction of U-235 by collision of a neutron, and generated energy, namely, heat is removed by water in LWRs. The heated and pressurized water produces high pressure and high temperature steam at a steam generator, and electric power is generated by steam turbine as in a thermal power plant. The core in a nuclear power plant consists of nuclear fuel, cooling water and control system to control magnitude of chain reactions, namely, level of generated power. As concerns nuclear fuel, low enriched U-235 of 3 ~5% is used and a fuel rod contains about 370 uranium oxide fuel pellets in a metallic cladding pipe. Large numbers of fuel rods, 8 x 8 to 17 x 17, make up a fuel subassembly and there are about 400 subassemblies in the core in a large scale nuclear power plant. The content of fissile isotope U-235 in natural uranium is only 0.7% and the rest is U-238, therefore, it is necessary to enrich U-235. U-238 captures a neutron in a reactor core and changes to fissionable plutonium. Therefore, spent fuel contains fissionable plutonium and still about 1% enriched uranium which can be separated by fuel reprocessing. In LWR fuel cycle, recovered plutonium and uranium are used again in LWRs. In FBR fuel cycle, plutonium and uranium mixed oxide (MOX) fuels obtained from spent fuels of LWRs as well as FBRs are used in an FBR.

The breeding ratio which means a ratio of quantity of fissile material produced to that of fissile material consumed during reactor operation becomes around 1.2 in FBRs, although the ratio in LWR is around 0.6. Therefore, FBR fuel cycle can drastically improve efficiency of uranium resource utilization as described before. Then, Japan’s basic policy to attain the goal of using nuclear fuel resources effectively is to adopt nuclear fuel cycle, namely, to reprocess spent fuels and use the recovered plutonium and uranium in LWRs, and possibly FBRs in the future, while ensuring safety, nuclear non-proliferation, environmental compatibility, and

paying due attention to economic viability. The policy has not changed from the beginning of nuclear energy utilization in Japan. Therefore, we have accumulated a lot of experiences in the field of fuel reprocessing, MOX fuel fabrication, preparation of MOX fuel utilization in LWRs and radioactive waste management and disposal as well as FBR development.

If I could add shortly another possibility of utilization of nuclear energy, nuclear energy can be used as process heat, hydrogen production, for example. The JAERI developed a high temperature gas-cooled reactor which produces helium gas of 950 °C, and demonstration of hydrogen production will be made in near future connecting the reactor with a hydrogen production plant. When this system becomes commercial, nuclear energy can contribute to not only electricity generation but also non-electricity generation such as hydrogen production, refining crude oil, sea water desalination, etc.

Now, I would like to move on a topic of energy need in Asia.

It is often said that the 21st century is a century for Asia. It means that population increase, economic growth and energy consumption in Asian countries, particularly in the developing countries become the largest among the world.

I show you several figures related to them in 2020 estimated mainly by the Institute of Energy, Economics of Japan (IEEJ). Population in Asia will increase from 3.3 billions in 2000 to 4.1 billions in 2020. The populations of China and India are already over 1 billion, respectively, as you know. GDP growth rate in Asia excluding Japan is expected to be 5.4 %/y on average in the period of 2000 to 2020, while it is 1.3 %/y in Japan, besides, 7.2 %/y in China. Reflecting these figures, primary energy consumption will become nearly double in 2020. Particularly, oil consumption in China will increase by 170% due to mainly considerable progress of motorization. The share of total energy consumption in Asia will change from 38% to 45% for China, from 13% to 15% for India, besides, 22% to 12% for Japan.

Among various energy sources, coal and oil are major energy sources in Asia and hold about 80% of the total. Coal will be used much more for electricity generation in China, India and Indonesia where there are plenty of coal resource. If we look at energy balance of production and consumption in Asia, the ratio of import has increased gradually and it was 30% in 2003, and particularly high in oil.

As concerns electricity generation, it will increase at rate of 4.2 %/y on average in Asia. In 2020, coal and natural gas will contribute to 50%, 20% of the total electricity generation, respectively. Electricity generation by nuclear energy is gradually increasing, while China has currently 9 nuclear power plants with capacity of 7,000 MWe and is planning to construct another 27 nuclear plants with total capacity of 30,000 MWe by 2020, and India has a plan to increase electricity generation by nuclear energy to ten-fold of the current capacity of 6,000 MWe.

Related to increase of energy consumption, amounts of carbon dioxide (CO₂) to be emitted will increase to 3.7 billion tons in carbon in 2020, half of them by China, 16% by India and 9% by Japan. The issue of CO₂ emission and global warming is discussed later. There is another environmental problem connecting to use large quantities of fossil fuels, that is, emission of nitrogen oxide (NOX) and sulfur oxide (SOX) which bring acid rain to make trees die and asthma to people. The SOX, NOX and small cinders can be carried to several

thousands km by Jet stream. These damages appear not only in the country itself but also other countries.

For every country, stable supply of energy is an extremely important issue. Japan has pursued the best mix of energy supply considering not only stable supply but also harmonization with environmental protection, economic viability as well. Therefore, we have changed the attitude to depend so much on oil and continue to make still less dependence on oil from the view points of CO₂ emission, limited resources and high dependence on the Middle East. As I already described, we will adopt more nuclear energy, natural gas and new energies. As concerns new energies, major electric power companies are legally obliged to use and buy them, and electricity generation capacity by solar energy in Japan is more than 1,000 MWe and the largest in the world although electricity generation cost is still very high. On the other hand, we have made tremendous efforts to save energy in various fields such as combined cycle in a thermal power plant, co-generation, electric machinery, home electric apparatus, fuel expense of gasoline drive cars, adoption of hybrid automobiles, etc. In fact, efficiency of energy use in Japan is extremely high compared with that in other countries. For example, energy unit which is the ratio of quantity of primary energy supply to GDP is 0.09 in Japan, 0.26 in USA and 0.97 in China.

China is currently seeking for all of the kinds of energy sources in the world. China is going to buy or reserve much more oil from the Middle East and other countries, natural gas from Russia and Africa, uranium from Australia and Canada, and so on, while increasing investment in investigation and development of natural gas and oil fields in the land as well as at sea.

India is also in the same situation as China, and has a plan to construct pipe-line to transport oil from the Middle East through Pakistan and to buy uranium from USA. Although President Bush and Prime Minister Singh agreed to conclude an agreement, there are many problems because India has not concluded Non-proliferation Treaty (NPT) prepared by the International Atomic Energy Agency (IAEA), besides, India has nuclear bombs. The NPT prohibits any countries except USA, UK, France, Russia and China from developing and having nuclear weapons. The trade of nuclear materials and parts related to nuclear plants are currently allowed only for the countries which concluded NPT and for peaceful use.

As the last topic, I would like to touch on an issue of energy consumption and global warming.

Recently, climatologists at NASA's Institute reported that 2005, this year is on track to be the hottest year on record. They are reporting other dramatic signs of global warming, such as the record shrinkage of the Arctic Ocean ice cover, and unprecedented high ocean temperatures in the Gulf of Mexico, which may have contributed to the intense hurricanes that struck the region this year. The Japanese TV also recently reported that the sea level rose 6 cm for the last 20 years and some damage such as erosion of marine coastal areas occurred already, and will rise another 88 cm in Japan in 2100 resulting in various serious damages.

Global warming is caused by increase of atmospheric concentration of CO₂, methane, etc. by emission of these gases. The influence of global warming is tremendous and irreversible. Global warming melts huge amounts of iceberg or ice cover of the Arctic Ocean, the Antarctic Ocean, etc. and raises ocean temperature resulting to raise sea level which brings

disappearance of islands and territories where numbers of people are living, besides, causing intense hurricanes, typhoons. Global warming also brings climate change resulting in a large quantity of precipitation in some regions and completely dry and drought in some other regions resulting in enlargement of desert areas, poor crop of agricultural products, death of many kinds of living things, etc.

The total quantity of CO₂ emission in the world is about 24 billion tons in 2002, in which about a quarter is emitted by USA, 13.7% by China, 31% by the countries obliged to reduce a quantity of CO₂ emission based on the Kyoto Protocol. Hereafter, the amount of CO₂ emission by the developing countries is estimated to increase enormously and share more than 60% of total increment in the world in 2030.

Needless to say, an amount of CO₂ emission depends on energy sources for electricity generation. New energies, nuclear energy and hydro-power do not emit CO₂ during electricity generation process, however, CO₂ emission by use of fossil fuels and electricity during fabrication of parts, construction and dismantle of plant, transportation of various materials, etc. should be also taken into account. An amount of CO₂ emission per kWh generated by fossil fuels is larger by one order than that by renewable energies and nuclear energy, in which solar energy emits the largest amount of CO₂. Electricity generation by nuclear energy contributes to reduction of CO₂ emission by about 15% in Japan.

Coming back the issue of global warming, many institutes and specialists have estimated its magnitude and influences for future. I would like to show you the result reported in the third assessment report by Intergovernmental Panel on Climate Change (IPCC). An amount of CO₂ emission was evaluated for several scenarios. CO₂ concentration in the atmosphere is currently 380 ppm and will increase in any scenario and will be 540 ~970 ppm in 2100, which is 2 ~3.5 times larger than that in 1750 when the Industrial Revolution occurred. That brings the increases of atmospheric temperature of 1.4 ~5.8 °C and sea level of 30 ~40 cm on average in 2100 which will bring serious influences globally.

Mr. Chairman and distinguished participants,

We, Asian countries should recognize that we are falling into trilemma of economic growth, energy consumption and environmental protection, namely, trilemma of 3E. We need much more energies for economic growth, however, as far as we use fossil fuels, it causes global warming, acid rain and asthma, etc.

It is quite difficult to solve this issue, but Japan has been struggling to resolve this difficult problem. These are to remove strictly poisonous materials in exhaust gases from power stations and automobiles, to adopt nuclear energy and new energies, to promote through saving of energy in various sectors, and so on.

Let me conclude my presentation.

1. Utilization of nuclear energy in Japan where self-sufficiency of energy is very small is indispensable in order to keep stable energy supply with harmonization of environmental protection. We aim to maintain or increase the current level of nuclear power generation, that is, 30 to 40% of the total electricity generation from now on. We also aim to adopt nuclear fuel cycle to attain the goal to use nuclear fuel resource effectively and to minimize radioactive wastes. The recovered plutonium and uranium by reprocessing spent fuels will be used very soon in LWRs, and possibly in FBRs in

future, while ensuring safety, nuclear non-proliferation, environmental compatibility, paying due attention to economic viability. Furthermore, we pay deep attention to keep transparency of plutonium utilization for international community not to arouse suspicion of military use.

2. Increases of energy consumption in Asian countries, specifically China and India, are and will be enormously large in the world due to increase of population and economic growth of several percents per year.

The reservation of energy sources such as oil, natural gas, uranium, etc. is a serious issue, and every country is negotiating with the Middle East asking for oil, for example. However, an extreme competition among the Asian countries brings damage on security of energy in these countries. The Asian countries had better to collaborate in negotiation, for example, with the oil-producing countries on an equal footing showing bargaining power, while stockpiling oil for emergency.

3. Nuclear energy is now an indispensable energy to satisfy both stable energy supply and restraint of global warming. Japan is a leading country in using nuclear energy in Asia, then, can contribute to other Asian countries for utilization of nuclear energy as far as these countries conclude NPT and strictly limit for peaceful use.
4. Nevertheless, global warming induced by larger amounts of CO₂ emission resulting from burning of huge amounts of fossil fuels is a great threat at present as well as in future. The problem is what we should do now, and what we can agree and hold for further reduction of CO₂ emission after the period of Kyoto Protocol involving major CO₂ emission countries worldwide. It is very important for every country to do their best with a will to take all of the measures against global warming. Japan can collaborate and contribute to the East Asian countries as well as other Asian countries for transfer various technologies for saving energy, rising efficiency of energy use, conducting renewable energies, and so on.

That concludes my presentation. Thank you very much for your kind attention.