An Outlook for Introduction of Nuclear Power Generation in Southeast Asian Countries [1]

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Executive Summary

Several Southeast Asian nations such as Indonesia, Malaysia, the Philippines, Thailand, or Vietnam are planning to introduce nuclear power generation eying generally at completion around 2020, under the government initiatives derived in the light of growing electricity demand and the need for securing energy supply. In reality, however, these plans may experience delays by several years or more due to numerous challenges and obstacles each of the above countries has in implementing such plans. Furthermore, if a closer examination is made not just into the energy policies and forecasts as published by these governments but also into their respective politico-economic situations, infrastructure development status as well as social and industrial foundations, it reveals that the situations widely vary among these countries. A general outlook drawn from the above examination and analysis for each of the countries mentioned could be summarized as follows:

- In Vietnam and Thailand, where the system for the policy implementation is well prepared, nuclear power projects will likely make progress relatively smoothly albeit some possible delays.
- Concerning the Philippines, although there is a possibility of resuming the nuclear power plant construction that was suspended in the past, it appears that a brisk and prompt development is less likely from the implementation system point of view.
- For Malaysia, it is rather unlikely that nuclear power will be introduced at an earlier timing since their immediate necessity to do so is limited.
- With respect to Indonesia, it is possible to see substantial delays in implementing the current plans due to an insufficient degree of infrastructure development as well as constraints in investment environment.

Japanese nuclear power industry, with her abundant business experience and excellent performance records, can play an important role to contribute to nuclear power plans in the Asian countries. At the same time, however, the Japanese industry does not necessarily have overwhelming competitive advantages over the competitors in the other nuclear-advanced countries. A satisfactory G to G relationship including a bilateral nuclear cooperation agreement is regarded as a prerequisite for promoting private sector participation in this field from the policy ground as well as the practicality. In this connection, it is reasonable for Japan for the time being to focus on the current efforts of continuing modest but steady cooperation in such areas as manpower development (capacity building), system design, and information sharing.

Introduction

The attempts to reevaluate nuclear power generation from the viewpoint of energy security and global

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warming prevention are intensifying throughout the world and, along with such a trend, the market for the nuclear power generation business is also about to enter a period of rapid expansion. Particularly in recent years, a noticeable trend observed in countries where fossil fuels such as coal or natural gas have been the main electricity source is the move to introduce nuclear power generation as a key source of electricity for the future, in order to preserve fossil fuels as a strategic export resource or diversifying domestic power sources to disperse the risk of resource cost inflation. However, any country considering newly introducing nuclear power generation will have to deal with uncertainty factors such as the change in their energy policy, the future of the framework for the nuclear nonproliferation, or the status of other energy development and so on. In addition, a number of other constraints related to human resources, technological capability, funding, fuel procurement, development of safety and security regulations as well as the site selection issues come into play. All these factors make it difficult to accurately predict viability of projects for newly introducing nuclear power plants in the respective countries.

The first commercial nuclear power plant in the world was built in the United Kingdom in the 1950's. Following the UK, nuclear-capable nations such as the United States, Soviet Union (now Russia) and France constructed and commissioned commercial nuclear power plants in succession over the 1960's. From then and over the 1980's, these countries transferred the technologies to Western countries such as Germany, Spain, Belgium, Sweden or Switzerland as well as Asian nations including Japan, Korea and Taiwan, helping them construct and put numerous commercial nuclear power plants into operations. Although new construction of commercial nuclear power plants took place mainly in North America and Europe up to the 1980's, in the 1990's and thereafter, the number of new constructions grew remarkably in the East Asian countries such as Japan, Korea or China, while Europe saw a sluggish growth in new constructions.

For the future, reflecting the high growth rates in energy and power consumption, a considerable number of new plant constructions are projected for the Asian region - particularly in China and India. Meanwhile, in several Southeast Asian countries who presently do not own a nuclear power plant, moves toward the introduction of nuclear power generation are taking shape in hopes to reduce the dependency on fossil fuels as well as to cope with rapidly increasing demand for electric power.

This paper attempts to provide an analysis on five Southeast Asian countries among those endeavoring to introduce nuclear power generation for the first time in their respective history, chiefly because they have the following features in common: (1) Significant increases in energy demand are expected; (2) Growing expectation exists for nuclear power from viewpoints of energy security considerations, etc; (3) Specific projects are currently under consideration for the introduction of nuclear power plants; (4) Close relationships exist with Japan in the economy and energy fields; and (5) They are situated in a strategically important region for Japan's energy cooperation efforts.

Our analyses focus on the viability of their new nuclear power projects including also the trends in energy policies and moves toward development of other energies pursued in the respective countries. At the same time, it also addresses the challenges to be solved before any nuclear power plant project can succeed and describes the possibility for the Japanese nuclear industry to make contributions concerning the introduction of nuclear technology into these countries.

1. Indonesia

1-1 Factors driving nuclear power development

Indonesia has a population of about 222 million (as of 2006) and a GDP growth rate of 5.5% (net growth for

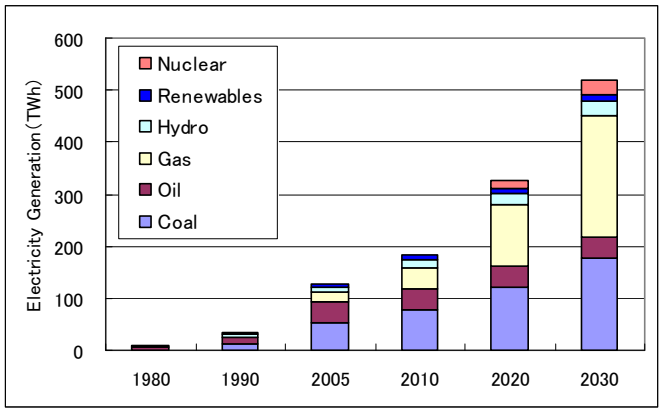
2006)[2], and is the largest consumer of primary energy among the Southeast Asian region. Power consumption is also growing rapidly in pace with the economic growth. Accordingly, it is forecasted that both the population and GDP of Indonesia will continue to grow at a brisk rate, which will bring about a growth of primary energy supply at 3.9% annually and that of power generation at 5.8% through 2030[3].

Indonesia is endowed with abundant natural resources such as oil, gas and coal, coming in second for oil production and in first for LNG production in Asia. In recent years, however, outputs of oil and gas have sharply dropped due to aging of oil and gas fields. In particular, the decline in crude oil production combined with the increasing domestic demands turned Indonesia into a net oil importer in 2004. Although the Indonesian government is tackling the challenges to improve the investment environment through revisions to the production sharing system and duty exemptions on imported equipment and materials used for upstream development, major improvements have not been forthcoming. Under these circumstances, it is Indonesia's major challenge in her energy policy for the future to encourage investments in exploration and development of mineral resources. Lack of available electricity caused by shortages in gas and coal supply for power generation has already been noticeable. To aggravate the situation, the infrastructure has been underdeveloped as seen in the inadequacy of ships and dock facilities required for coal transportation as well as power generation and transmission facilities. As a result, even the capital city of Jakarta now experiences frequent power outages.

Indonesia's major power sources are coal and oil. The total electricity generated in fiscal 2005 was 128.6 TWh. By sources for power generation, coal supplied 41% of the total, whereas oil did 32%, natural gas 14%, hydropower 8%, and geothermal 5%. For the future, the total power output is expected to grow to 326 TWh by 2020 or about 2.5 times that of 2005, and to 519 TWh by 2030 or four times that of 2005. Among those power sources to grow, the most promising is natural gas. Power generated from natural gas is expected to grow from 18 TWh in 2005 to 120 TWh by 2020, and to 234 TWh by 2030, to become the major source of power replacing oil-fired thermal power that is expected to lose its share of the supply sources down to 8%.

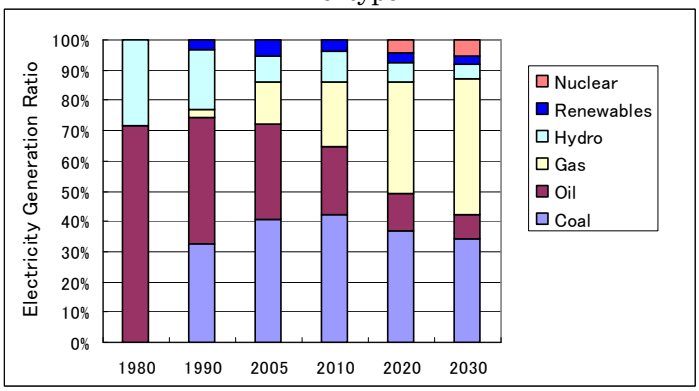
Faced with the challenge of securing natural gas supplies that can support the increasing demand for gas as a source of power generation, the Indonesian government has established a policy to aggressively develop new gas fields capitalizing on support from foreign enterprises, combined with a policy to regulate gas exports from the country. Given that, it is most likely that the government intends to preferentially allot the

Fig.1 Forecast of the electricity production by source



(Source) Asia/World Energy Outlook 2007, IEEJ

Fig.2 Prospect of the power source composition by fuel type



[2] World Economy Outlook Database, April 2008, by IMF, all demographic as well as GDP data hereafter to be quoted from the

additional availability of locally produced gas to domestic consumption and in particular to satisfy the gas demand for power generation. It should be noted here, however, that the development projects, including the Tangguh project under way since 2005 and other new gas fields such as the Block A project in the northern Sumatra and the Sapi project in the offshore East Kalimantan are several years behind plans. This situation leads to a prediction that the production increases may not materialize as planned, pointing to a substantial uncertainty for the gas production in coping with the sharp increases in electricity demand.

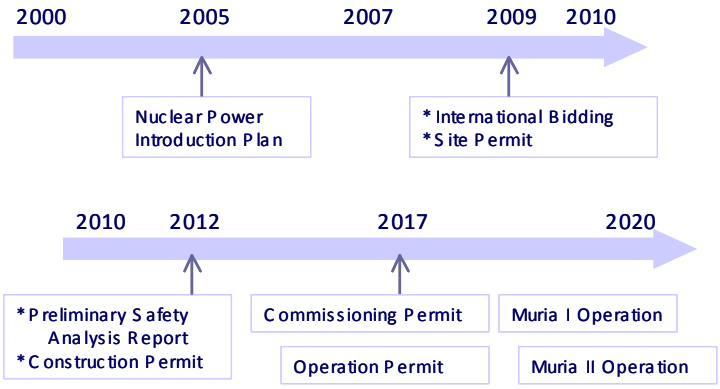
As described above, factors such as the tight power supply-demand situation and substantial uncertainty in Indonesia in the development of other energy sources (gas, in particular) seem to provide a reasonable ground for nuclear power generation to be recognized as a component of the nation's future power source mix.

Fig. 1 forecasts the electricity production by source, and Fig. 2 provides a prospect for the power source composition by fuel type on the basis of power generation.

1-2 Overview of nuclear power projects, system and environment for implementation

In Indonesia, debates have been continually held as to whether nuclear energy should be employed or not as part of the measures to cope with sharp increases in power demand, and also as an alternative energy source for reducing high dependency on fossil fuels. The state energy policy announced in 2004 made it clear that the government recognized nuclear power as one element of the energy mix. Based on this policy, "Power Demand Forecast up to 2025 and Power Source Development Guidelines" was announced in April 2005, wherein the government estimated that the required nuclear power generation capacity would be at 12 GW in 2025. Following up on the foregoing, the government announced its intent to resume the project for constructing a 600 MW-class nuclear power plant in the Muria Peninsula by 2016. Since February 2004, the government has been conducting a commercial feasibility study jointly with Korea Hydro and Nuclear Power (KHNP), a subsidiary of Korea-based KEPCO. According to the roadmap for introducing nuclear power generation which was developed by the Indonesian National Nuclear Energy Agency (BATAN) in 2007, the first plant with a capacity of 1,000 MW is to be brought on line by 2017, followed by four other plants to start operations around 2020. To that end, the government plans to float an international tender inviting nuclear reactor manufacturers, followed by official site selection and approval, and then by a preliminary safety examination before granting of construction permits in 2012 for the commencement of work, among other steps. Fig. 3 shows a roadmap for introducing nuclear power generation in Indonesia.

Fig.3 Nuclear power introduction roadmap in Indonesia



(Source) BATAN

In 2007, the Indonesian government organized an administrative system geared to implementing and promoting the policy toward introduction of nuclear power generation referred to as a “National Team”, which was comprised of representatives from the Ministries of Finance, Energy & Mineral Resources,

same source.

[3] Asia/World Energy Outlook 2007, October 2007, by IEEJ

Industry and Trade, the Environment Agency of the State Ministry, BATAN and other authorities concerned. The team has already started discussions on the roadmap mentioned above, studies on suitability of a number of candidate sites including the Muria Peninsula, funding plans, environmental assessments, etc. It should be noted, however, that the official launch of the team is unlikely to happen before the presidential election scheduled for October 2009. Additionally, in preparation for the introduction of nuclear power generation, the central Indonesian government, the Nuclear Regulatory Agency (BAPETEN) are receiving technical cooperation and assistance from the IAEA and various other countries individually. They have adopted a comprehensive program offered by the IAEA and received personnel skilled with power plant operations or operating know-how from the KHNP of Korea, as well as Russia, France, Japan, and Australia among others. Requirements for the reactor type to be adopted include proof that the technology has been established with a performance record of at least three years in service after the commissioning. While the most promising candidate for the moment is the pressurized water reactor (PWR) type as it is employed in by far the largest number of projects around the world. However, the selection will not be limited to this type depending on the technological innovation made in the future.

With respect to the investment environment in Indonesia, despite the fact that the current situation is stable compared to that in the 1990's, the government remains to be under a difficult financial condition and the investment climate is not particularly favorable for a new project requiring an extensive capital outlay. While it may be possible to induce capital investments from private enterprises including foreign interests if the retail electricity price is allowed to be set at market price, such measures alone would not be sufficient for hedging against the investment risks involved in a mega-project like a nuclear power station. Contributions from the government would therefore be required, but hard to come by under the current circumstances.

In the 2005 rating of political and country risks concerning oil and natural gas development investments as prepared by JOGMEC, Indonesia was ranked as a high-risk nation, placed at the eighth from the worst end among the 124 countries surveyed[4]. This appraisal seems to have stemmed from Indonesia's traditionally fragile socio-political foundation, the potentially negative impact of the recent spike in crude oil prices on Indonesia, now a net oil importer, and the continued shortage of electricity.

Another challenge in terms of investment environment is the underdeveloped infrastructure in the fields of transport and power transmission in Indonesia. The continued power shortage mainly in the Java and Bali districts is largely attributable not only to an insufficient availability of power generating facilities but also to a poor power transmission facility and inadequate development of infrastructure for coal transportation. This also adds to the high investment risk assessed at the present stage since a stable power supply essential for construction of a nuclear power plant is not guaranteed.

1-3 Challenges for nuclear power introduction

Based on the energy-related situations and prospects, the current state and the outlook of the nuclear power introduction plans and the investment environment in Indonesia as described in the foregoing, this section discusses challenges facing the introduction of nuclear power generation and possible approaches required for smooth implementation of the project.

As discussed in Section 1-1 above, the tight power supply situation in Indonesia is acute and the development of a reliable power source and arrangements for secure fuel supplies are urgently required. However, as there are numerous problems in most of the related areas which complicate the situation,

[4] JOGMEC, November 20, 2006

including underdeveloped infrastructure such as power transmission lines or port facilities, politico-economic circumstances, or structure of the energy industry, it appears a considerable amount of time is required to solve these issues.

One particular barrier against investment into power generation infrastructure has been the regulatory system under which the government determines the retail prices of electricity. As the electricity market was partially liberalized in 2007, it is expected that retail and wholesale electric utility operators will be allowed to buy and sell electricity in the retail electricity market without the brokerage of PLN, the state power company, encouraging participation of foreign capitals in the power industry. On the other hand, in the domestic electric marketing segment, prices are under the regulatory system where the government determines the prices and PLN is the exclusive marketer. Besides, partly due to the underdeveloped infrastructure of today, costs for power generation are comparatively high against the selling prices, which are often below costs, making the investment environment far from favorable for overseas electric utility operators. In the case of PLN, the government compensates for losses due to the negative margin between the selling price and the cost, protecting the management of PLN at the moment. However, this also is functioning as a negative incentive in their effort for improving business efficiency. Additionally, the power transmission and distribution segment is dominated and virtually monopolized by PLN and its subsidiaries PJB I and PJB II, which also form negative incentives in drives toward higher business efficiency and enhanced financial foundations.

Concerning the system for implementing and promoting nuclear power introduction, there remains a problem to be solved where the responsibility for the project is not defined clearly enough. As described earlier, the National Team has been organized and working to prepare for the start-up of the first commercial nuclear power station in 2017. For this project, PLN is supposed to be the project owner responsible for construction and operation of the plant. In January 2006, PLN concluded an agreement with KEPCO, the Korean state power corporation, for assisting in the nuclear power station construction project in Indonesia. However, PLN has made its stance clear in that the party responsible for the introduction policy is the government and the Nuclear Power Agency, even though PLN will participate in the project as the owner of the nuclear power station. PLN has not yet announced the specific phase of the introduction initiative in which it will actively take part in the project. Meanwhile, the Department of Energy and Mineral Resources as the nuclear power policy maker on the part of the government has issued statements that can be interpreted as their attitude that the government will determine particulars such as the reactor type and the construction schedule according to responses from overseas firms invited to the international tender in 2009, revealing a lack of genuine commitment toward developing project plans on their own.

Furthermore, public movements against the introduction of nuclear power emerged around the time of the government's announcement of an intention to seek a site in the Muria Peninsula and have since become active mostly among environmental organizations and universities in Indonesia from concerns over environmental impacts, safety, radioactive wastes and nuclear proliferation, and other issues. The government has been publicizing the economic advantages and safety of nuclear power generation through media and other means. While such effort has gradually promoted understanding among the public according to the government, it is still likely that the protest movements will intensify along with the actual progress of the project.

For a smooth advancement of the process to introduce nuclear power generation, it may not be wise for the government to place a priority on a forthright confrontation with these opposing parties. Instead, the government should before anything else firmly establish and announce a basic policy focused on securing a

stable energy supply, aiming at stabilizing social and economic conditions in general, while officially launching the National Team at an early opportunity to establish an accountable implementation system for the nuclear power policy. In conjunction with these priority efforts, initiatives are required to make the structure of power and energy industries more robust toward a more favorable investment environment, to facilitate higher business efficiency of electricity utilities and to promote the development of infrastructure including power transmission lines and so forth. As development of all these will take a considerable amount of time, this study must conclude that the realization of the officially announced target - the first nuclear power station to commence operations in 2017 - is unlikely in reality.

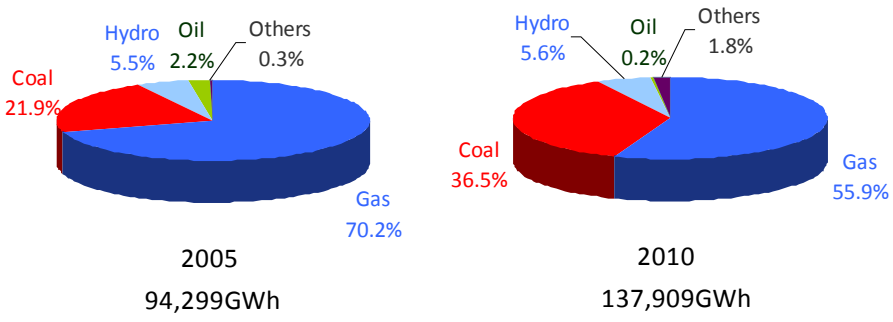
2. Malaysia

2-1 Factors driving nuclear power development

Malaysia has a population of about 26.4 million as of 2006 and a GDP growth rate of 5.9% (net growth for 2006). Among the five Southeast Asian countries surveyed in this study, Malaysia has the smallest population but its economic growth is as brisk as any other country and the primary energy supply per capita is the highest among the five. High rates of growth are expected for future energy as well as power consumption where primary energy consumption is expected to grow at an annual rate of 3.1% and power generation output at 5.8% until 2030.

Malaysia is endowed with rich energy resources. The size of its proven oil reserves comes in fourth in the Asia-Pacific region after China, India and Indonesia as of 2007. Its natural gas reserves are the third largest after Indonesia and Australia. The government has established a policy to place the highest priority on development of renewable energy directed toward diversification of the power sources for the future. In particular, large-scale development is under way for hydropower generation mainly in Sarawak. The government is also promoting the introduction of new energies derived from sources such as wind power, biomass, general wastes and solar energy but is not considering the introduction of nuclear power generation for the moment. Fig. 4 shows an outlook of the power generation shares by sources in Malaysia.

Fig.4 Power generation shares by fuel type in Malaysia



(Source) The 9th Malaysia Plan

In 1980, Malaysia established a "National Depletion Policy" to ensure sustainable exploitation of natural resources within Malaysia while avoiding their premature depletion. Under this policy, gas supplies from Kerteh on the east coast of the Malay Peninsula is limited to 2,000 mmscfd (million standard cubic feet per day) at the maximum, looking to maintain the operation of the gas field for another 70 years to come. The capacity of the natural gas refineries located in the peninsula is 2,300 mmscfd, which is a sum of the supply capacity from Kerteh and additional 300 mmscfd supplied from the Malaysia-Thailand Joint Development Area (JDA). The supply volume from this pool has already reached an average of 2,128 mmscfd as of 2007 resulting in a very tight supply-demand situation today. In order to cope with this increasing demand, natural gas is being imported from Indonesia and Vietnam in addition to the JDA, which has reached 497 mmscfd or about 23% of the total. Out of the gas supplies, 63% goes to the power generation sector, 31% to the industrial sector

other than power generation, and 6% for exports to Singapore. As oil prices are hovering at a high level, the demand for natural gas with a controlled low price has intensified. Under these circumstances, industrial gas demand such as from petrochemical plants, for example, increased to 665 mmscfd or by 20% from the previous year. Thus, there are calls for measures to improve efficiency in natural gas utilization and use of other fuels including coal.

The gas demand on the peninsular Malaysia is expected to grow at an annual rate of about 4.3% to reach 2,647 mmscfd in 2010, of which 1,653 mmscfd will be the demand from power generation, leading to a forecast that imports from JDA and Indonesia will grow even further.

The possible factors behind the increasing gas demand include not only the growing demand for electricity driven by economic development but also the government's policy to control energy prices within Malaysia at low levels. Since the state oil corporation Petronas has requested the government to review the gas utilities prices, it is likely that prices will be raised in the near future. While electricity tariffs are controlled under a governmental approval system, in the event that Petronas raises the price of natural gas for power generation, the government is likely to tolerate shifting of the portion equivalent to the cost increases to electricity charges. It is uncertain whether such a change in pricing policy will function as a restraint against demand increases or when and how much the government may allow the price shifting.

Given the above circumstances, with the high level of current reserve capacity and the on-going hydropower development efforts, the need for newly introducing nuclear power generation to Malaysia is not very high as far as short-term electricity demands are concerned. However, the tight gas supply-demand situation is already a reality, and while the Malaysian government is promoting a fuel shift to coal-fired power generation, the bulk of the coal used has to be imported from Indonesia or elsewhere, exposing the country's economy to a considerable impact from the recent coal price increases. Moreover, from the viewpoint of long-term energy supply and demand beyond 2020, a proposal for an early introduction of nuclear power could emerge depending on the progress achieved in the introduction of alternative energies.

2-2 Overview of nuclear power projects, system and environment for implementation

As described above, blessed with rich natural resources, Malaysia has no plan at the moment to introduce nuclear power generation with the highest priority placed on development of renewable energy in the process of power source diversification for the future. However, fundamental research using research reactors designed principally for radiation application has been undertaken continuously since the foundation of the Malaysian Institute for Nuclear Technology Research in 1972. The research reactor TRIGA (1 MW) built by General Atomics (GA) of the U.S. was introduced in 1982, and has been accumulating solid operating records for more than 20 years to this day at the Malaysian Institute for Nuclear Technology Research (later renamed to Malaysian Nuclear Agency). This research reactor was built with cooperation of the IAEA, for the first time in any of the ASEAN member countries. The reactor has been developed, constructed and operated on the condition that the use of nuclear energy should be limited to peaceful objectives only. Also, an irradiation reactor SINAGAWA was introduced from Atomic Energy of Canada Limited (AECL) in 1989, and has since been used for studies of applied technology for radiation in the medical field, etc., as in the case of TRIGA.

Although there presently is no plan for introducing nuclear power as an energy source, the government intends to develop an energy master plan by 2010 to cover the period from 2010 to 2030. In this exercise, the issue of introducing nuclear power under this master plan is being examined in consideration of an increasingly tight supply-demand situation for natural gas and the need for measures to preserve domestic

resources. In February 2008, the Nuclear Power Planning Division was launched within the government, and started studies for the energy master plan.

Taking such moves by the government into consideration, Tenaga Nasional Berhad (TNB), the leading electricity utility located in the peninsular Malaysia, is developing a plan for long-tem power supply and demand balance on the assumption that nuclear power generation will be introduced after 2020. Their plan includes a preliminary survey, site selection and human resource development (including 30 to 40 nuclear engineers) to start in 2008, environmental impact assessment and design work to start around 2011, international tender in 2012, conclusion of agreements in 2013, commencement of construction work around 2015, and commissioning of the first plant in 2020. The second and subsequent plants are planned to follow the first until the share of nuclear power reaches 8% or about 2,000 MW around 2025. Fig. 5 shows the estimated power source composition for 2030 (with and without nuclear power introduction) and Fig. 6 provides a roadmap for the nuclear power introduction.

Fig.5 Estimated power source composition for 2030

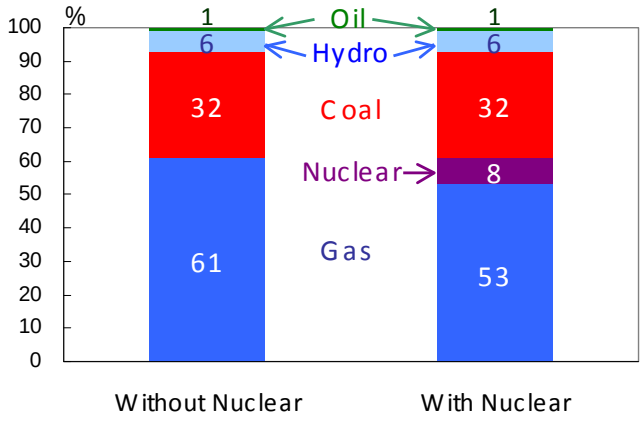
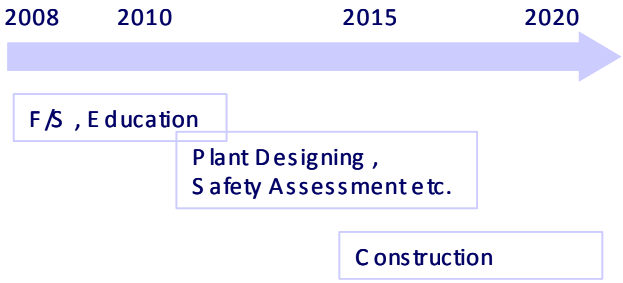


Fig.6 Nuclear power introduction roadmap in Malaysia



(Source) TNB

The investment environment in Malaysia is generally favorable. Although its economic growth rate in terms of GDP fell into a negative figure during the 1997 Asian currency crisis, it quickly headed toward recovery, achieving a level between 5 and 7% in recent years. Also, a current account surplus in international balance of payments is firmly in place and the deficits in the fiscal balance have been reduced, indicating the government's sound management of economy. Supported by a strong electricity demand, business performance of the leading power company, TNB, as a promising candidate for the owner of the nuclear power projects has been robust as well.

Meanwhile, the government has hammered out a scheme to make Malaysia an Islamic financial center, and is already offering privileges to Islamic financial institutions. For this reason, the Nuclear Agency apparently is eyeing at the possibility of financing obtained from Islamic financial institutions in the event that the country introduces nuclear power in the future.

As for the status of infrastructure development essential for construction of nuclear power stations, certain surveys were conducted in the 1980's concerning the nation's industrial capabilities, a result of which indicated that the scale of the civil engineering and construction industries was about one third of that of French counterparts and the number of enterprises in the manufacturing sector was about one seventh of the same. Government officials regard these figures as still being applicable to present conditions, concluding that the industrial infrastructure of Malaysia is at an adequate level for the introduction of nuclear power generation.

2-3 Challenges for nuclear power introduction

As mentioned earlier, the Malaysian government is considering incorporating the introduction of nuclear power generation into an energy master plan being developed for the period of 2010-2030. The point of focus at the moment is the scope of specific targets for nuclear power introduction to be set forth in the plan. The minimum requirements for the first plant to be commissioned in 2020 include the explicit citing of numerical targets corresponding to "about 8%" mentioned in the chart given in Fig. 5 and timelines for the roadmap given in Fig. 6. Moreover, it is essential for the Nuclear Power Planning Division to take the initiative in developing specifics for the plan in cooperation and having clear demarcation of responsibilities with TNB as the project owner and the operator of the power station.

The major challenges also include financing and obtaining public acceptance (PA). On the former point, it is likely that the government's guarantee on liabilities is required even if TNB is the project owner. However, in the case of a nuclear power plant project involving huge initial investments, the investors would hesitate to accept a form of guarantee if the scheme is similar to those devised for gas- or coal-fired projects, regardless of whether the client is TNB or overseas power companies. In addition to the above, risk factors include the fact that electricity price is subject to government approval, which could force TNB to absorb potential cost overruns, or a scenario with a lower level of electricity demand than projected. When developing a financing program for a nuclear power project, it is essential to have sufficient discussions and agreement among the government, TNB and other organizations concerned and to develop a plan so that risks will not be borne by a limited number of participating parties.

The investigation for the introduction of nuclear power by the government is still at its initial stage, and the technological issues such as the reactor type are to be discussed in the future. The economic aspects such as the utility factor and the unit cost of generation are attracting strong interests, and the overall price competitiveness (i.e. the total cost of power generation) measured as a sum of the initial investment amount and the maintenance and operation expenses naturally is regarded as a critical point. In light of this, much attention is being paid as to what proposals will be made, and what selection the Malaysia government will make, in the international tender for reactor type selection expected in or about 2011.

3. The Philippines

3-1 Factors driving nuclear power development

With a population of about 87 million, the Philippines registered a net GDP growth of 5.4% in 2006. Along with the growth in its population, the country is expected to continue its high pace of economic growth and expansion in primary energy consumption. The same trend applies to its electricity consumption, leading to a forecast that the power generation will reach 132 TWh in 2020 and 215 TWh in 2030, up from the current level of 57 TWh as of 2005.

Traditionally, the main fuels for the thermal power generation in the Philippines were coal and oil. However, while coal consumption rapidly increased at an annual rate of 38.8% from 1995 over 2000, consumption of petroleum fuels such as gas oil or heavy oil sharply dropped along with the trend of shifting of fuels for power generation. After 2000, the input of not just oil but also coal started declining, and gas-fired thermal power generation has been expanding in the wake of a full-fledged introduction of commercial (independent) thermal power stations.

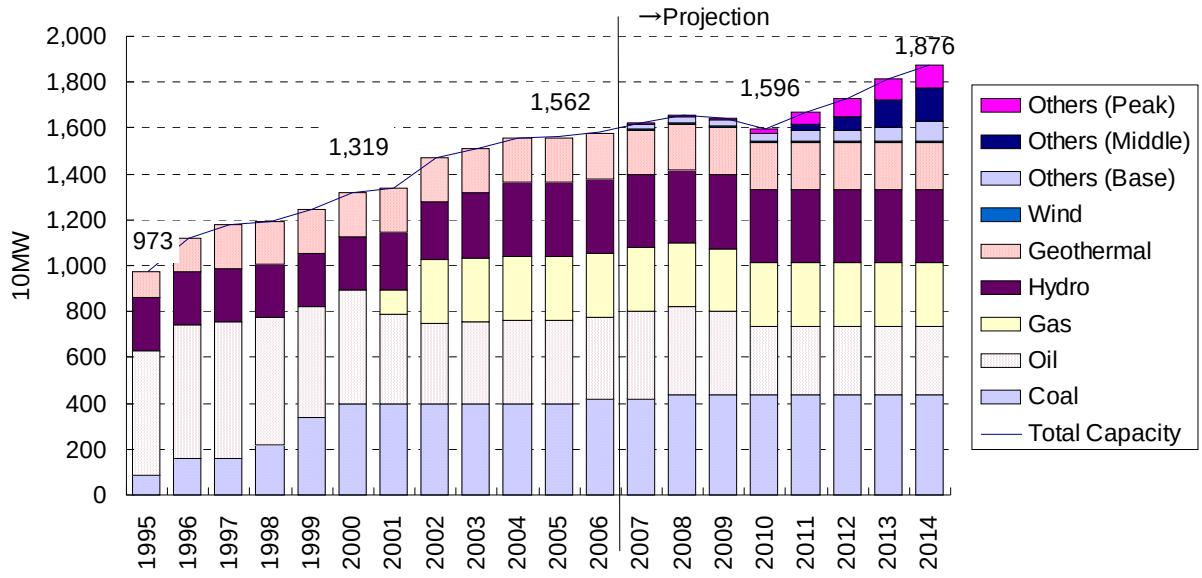
The installed power-generating capacity stood at 15,800 MW as of 2006 or approximately 1.6 times the

1995 figure. By power source, while oil accounted for 50% or more of the installed capacity up to 1997, its share rapidly dropped to 22.8% as of 2006 along with the growth of the share of natural gas. On the other hand, the use of coal expanded and in 2006 increased to a level about 4.9 times the figure for 1995, accounting for about 26% of the total.

The government expects that the power-generating capacity for the entire Philippines will grow to 18,761 MW by 2014. Fig. 7 shows the government's outlook for power source development up to 2014. According to the outlook, power source development up to 2014 will be mainly based on natural gas-fired thermal power, hydropower, and renewable energy, looking to reduce greenhouse gas emissions, while no thermal power from oil or coal is included in the future power source development.

As a result of this and also because the development plan is undecided for periods after 2014, it is expected that coal with abundant reserves in the country will play a major role in power source development. While the development of renewable energy may progress further, its growth in terms of the share in the total energy appears to be modest. Furthermore, after 2010, electricity shortage is likely to occur again in Luzon embracing the capital city of Manila where electricity demand is increasing at a particularly high pace. It is a pressing challenge for the Philippines to secure stable supply of fuels as well as the development of new power sources.

Fig.7 Outlook for power source development up to 2014



(Source) "Philippine Power Statistics ,"Philippine Energy Plan 2006 update:Power Demand And Supply Outlook"

Concerning the fuel supplies, both coal and natural gas are also imported to supplement the domestic production. Eyeing at the envisaged increases in the future natural gas demand in particular, the government is actively engaging in gas development as well as import projects for pipelined natural gas and LNG. Major pipeline projects include the "Bat-Man I" (between Batangas and Manila, 80 - 100 km), the "Bat-Man II" (between Batangas and Manila, 130 - 150 km), and the "Bat-Cave" (between Bataan and Cavie, undersea, 40 km). The government aims to complete the "Bat-Man I" project in 2009 and the "Bat-Man II" by 2012. The Department of Energy (DOE) made it clear in October 2003 that they might consider construction of LNG import terminals. Additionally, the government is actively promoting development of renewable energy including geothermal power, which at 1,970 MW as of 2007 is the second after the U.S.

and accounting for about 20% of the world geothermal power output[5], as well as other renewable resources. However, the capacity and share of this energy category are expected to grow only modestly.

From 1992 over 1993, the Philippines experienced extensive power shortages. During those periods, the government tried to remedy the power shortages by actively introducing IPP projects relying heavily on foreign funds. With the top priority placed on power supplies, concluded contracts were largely advantageous to the IPP operators, resulting in increased power generation cost and sharp rises in electricity charges. The above development explains the background of the high electricity cost in the Philippines - as of 2006, the electricity charge in Manila is 0.1 US$/kWh whereas the rate in Bangkok, Jakarta, Hanoi and other major Southeast Asia regions is around 0.05 US$/kWh.

As described above, as the Philippines are to continue to depend upon imports for major portions of coal and gas supplies, there is no guarantee that required fuels will be secured to meet the increasing energy demand in the country, pointing to a significant need for domestic large-capacity power sources that can assure stable supplies of energy.

The government at the moment sees a significant potential in renewable energy for which development plans are in place. However, it is uncertain if the development will proceed as planned and its impact does not seem to be large enough to lead to a significant reduction in the share of oil or coal. On balance, there appear to be good grounds to conclude that nuclear power generation will have a certain position in the future power source composition in the Philippines as in other Asian nations.

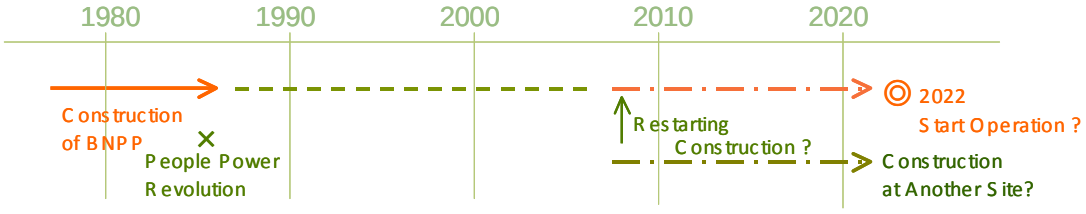
3-2 Overview of nuclear power projects, system and environment for implementation

In the Philippines under the Marcos administration, construction of a 620 MW-PWR called BNPP with Westinghouse technology started in 1976 in the Bataan Peninsula, no less than 90% of which was completed by 1985. However, approval for the commissioning of this reactor was later suspended under the Aquino administration due to possible safety problems, economic concerns and alleged corruption, and the plant has never been operated to this day. Although there was a proposal made in the past to convert this nuclear power plant into a coal-fired thermal power plant, the idea has been shelved because of the large expenditures involved. The BNPP project imposed heavy liabilities on the government over the ensuing years, which were cleared finally in 2007.

Along with sharp increases in crude oil prices in recent years, nuclear power generation has emerged again as an option for power source development for the country and to become a focus of debate.

The incumbent President Arroyo has once clearly affirmed that the government would not construct a nuclear power plant during her tenure up to 2010. However, the media have reported that the administration has started developing human resources as a future option. In the meantime, IAEA officials visited the BNPP site on January 29, 2008 to study the operability of the suspended plant. Furthermore, Minister of Energy Reyes has made comments that utilization of the BNPP plant is one of the promising options. While it is

Fig.8 Nuclear Power Introduction Roadmap in the Philippines



[5] *World Geothermal Generation in 2007,* September 2007, by GEO-HEAT CENTE

said that a period of 17 to 20 years would be required normally before the commissioning, the government is reportedly expecting to bring the plant on-line in 2022 or even earlier. Fig. 8 shows the development and a future outlook of the issue.

For the possible future introduction of nuclear power generation in the Philippines, two options are conceivable: (i) to repair the BNPP reactor for active service, or (ii) to newly construct a reactor at another site. On July 12, 2008, IAEA issued a report on feasibility of the BNPP, which gave no conclusion nor recommendation on whether it can be approvable or not, only suggesting that it must be thoroughly evaluated by technical inspections conducted by a committed group of nuclear power experts. However, as the BNPP project itself is already past twenty years after the suspension it would probably incur a considerable sum of expenditures just to repair it and bring it on-line as a light-water reactor meeting the world standards of today.

As of April 2008, no official system for promoting nuclear development program exists in the Philippines.

3-3 Challenges for nuclear power introduction

Before they can introduce nuclear power generation in the Philippines, there are a range of problems as mentioned below:

(1) Public policy implementation system

While the DOE seems to be the party in charge of developing and executing a power source development plan under the present establishment, the DOE itself was once abolished in the wake of the suspension of the BNPP project, and currently does not have an adequate budget or the expertise required for carrying out the nuclear power generation initiatives. Furthermore, the Philippines as a nation has a character such that the administrative system and public policies could drastically change along with a regime change, thus making it difficult to steadily pursue a long-term plan. Unless some more impending need arises concerning nuclear power generation in the future, it seems difficult for an implementation system to be established for planning and executing a nuclear power generation project.

(2) Financing environment

Given the history that the BNPP project ended up imposing a huge burden on the government, and also due to the size of the national budget and the current political establishment, it seems difficult to allot any portion of the national budget to the construction of a new nuclear power plant in the near future. Also, as the National Power Corporation ("NPC") is to be reduced in scale and IPP operators instead will become the major suppliers of electricity, it is virtually impossible for the private sector to construct and operate a nuclear power plant on its own financing. Consequently, it will be difficult for the Philippines to independently raise funds, allowing it no choice other than to depend upon funds from overseas financing including ODA programs.

(3) National consensus

The BNPP project is widely recognized as a negative legacy from the Marcos administration, and the public sentiment toward a nuclear power project is not particularly positive. In order to overcome this reluctance, an active educational campaign aimed at the general public will have to be organized.

(4) Securing human resources

Since already more than 20 years have passed since the suspension of the BNPP project, the country is in

short of the expertise required to implement nuclear power generation. While the government intends to institute a human resource development program to provide required training, the challenge is indeed huge as the program is only at its initial stage of educating personnel.

(5) Domestic industrial system

In order for overseas machinery manufacturers to construct a nuclear power plant in the Philippines, they need to be able to locally procure at least some of the equipment and components required. In the Philippines, however, since industries that can satisfy such needs are not sufficiently developed, considerable quantities of components need to be imported from overseas. This could lead to serious delays in the construction project, also complicated by the deficiency in the local subcontracting system to support such a project.

Solving the above-mentioned problems to clear the road for the introduction of nuclear power seems to require a considerable amount of time. It is not very likely for the Philippines to be able to construct and commission a nuclear power plant before 2030.

While a feasibility study is essential for the country's nuclear power project to take off, there also is a voice arguing that financial assistance from overseas should be sought. It may be useful for the nuclear development of the Philippines if Japan as a similarly earthquake-ridden country provides knowledge concerning the possibility of nuclear power generation or conducts a more elaborate inspection of the BNPP site to see the serviceability of the reactor that has been abandoned for more than 20 years. However, assistance in the area of software such as education and training of personnel, systems development, and many others would probably be required before anything else.

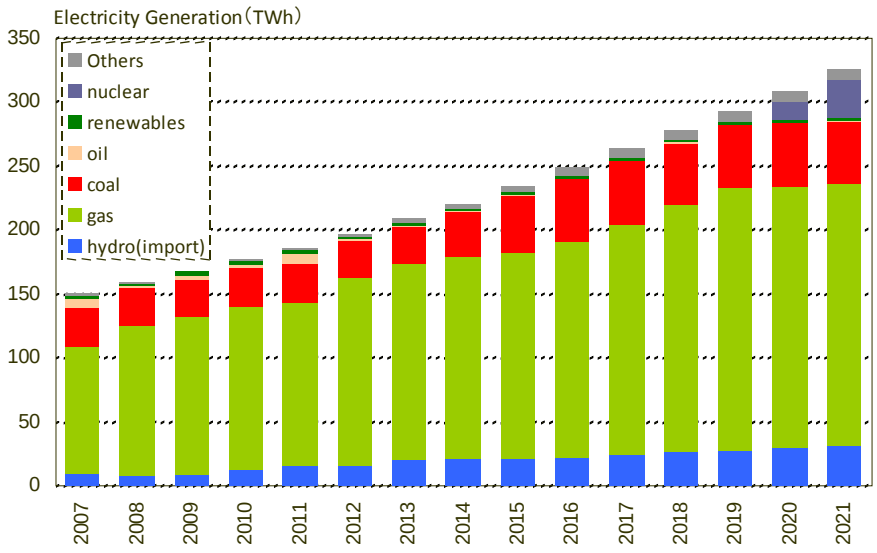
4. Thailand

4-1 Factors driving nuclear power development

With a population of about 65 million, Thailand registers a net GDP growth of 5.1%, and is an industrial country that is home to numerous plants funded with foreign capital. For the future up to 2030, while its population growth rate appears to be modest, it is projected that the GDP will grow at an annual rate of 4.7%, accompanied by a growth rate of 4.1% for primary energy consumption.

Along with the economic growth, its growth in electricity demand is also substantial. During the decade from 1997 to 2006, the power generation output grew at an annual rate of 4.9%. According to the Power Development Plan 2007 ("PDP 2007") covering a power source development plan up to 2021 and announced by the Electricity Generating Authority of Thailand ("EGAT") in 2007, the country is expected to maintain a high growth rate of 5.7% after 2007 until 2021.

Fig.9 Power generation forecast up to 2021 by fuel type



(Source) EGAT "Power Development Plan (PDP) 2007

The main source of supply that has shouldered the growing electricity demand is natural gas, which accounts for about 70% of the current power generation output. However, the natural gas reserve in the Gulf of Thailand has started declining since around 2004. As it is presumed that the gas production in the Gulf of Thailand will eventually run dry, efforts are made to diversify energy sources while reducing natural gas-fired thermal power generation. The most promising candidate for such diversified sources is coal. However, the introduction of coal power is not progressing as construction of coal-fired thermal power plants tend to suffer serious delays in the face of strong opposition from local residents concerned over the environmental issues such as NOx and SOx emissions. The PDP 2007 predicts that the introduction of coal-fired thermal power generation will not move forward until 2021, and despite the declining natural gas production, its share will remain at a high level as ever. Fig. 9 provides a power generation forecast by fuel up to 2021 based on the PDP 2007.

The introduction of nuclear power is considered as a second option for coping with the growing electricity demand. In the PDP 2007, it is planned to start commercial operation of nuclear power stations to produce 2,000 MW each in 2020 and 2021, totaling to 4,000 MW. According to this plan, it is projected that the share of natural gas will then be lowered to 62.8% by 2021.

As described in the foregoing, natural gas is considered to be the most promising source of power generation in Thailand since additional construction of coal-fired power plants are faced with a number of problems. However, as the government rightfully fears, it is not desirable to further increase dependency upon natural gas from a viewpoint of securing a stable power supply. Therefore, with continued high prices of natural gas envisaged for the future, it seems there are good grounds to conclude that nuclear power generation will have a certain position in the future power source composition in Thailand as well.

4-2 Overview of nuclear power projects, system and environment for implementation

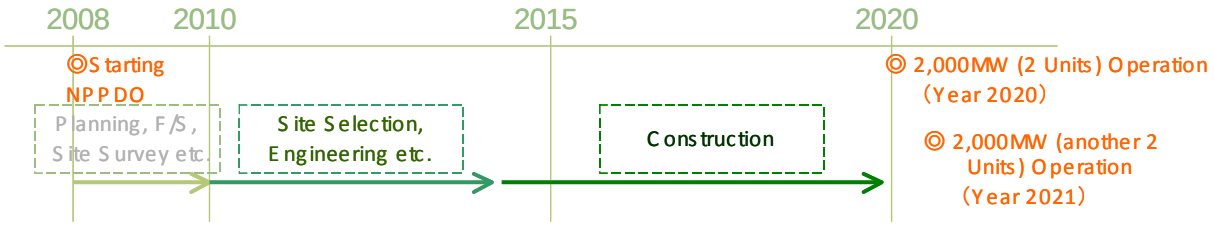
In Thailand, the Law for Peaceful Use of Nuclear Energy was enacted in 1962. In 1967, the then Power Agency (presently EGAT) developed a plan for construction of nuclear power stations, based on which the government granted approval to construct one around 1982. Subsequently, however, offshore natural gas fields were discovered in the Gulf of Thailand, leading to the suspension of the plan due to the economic disadvantage of nuclear power generation against natural gas-fired power generation. At present, only the research reactors installed at the Ongkharak Nuclear Research Center are running.

While electricity demand is expected to grow rapidly, the domestic natural gas output is likely to decline, increasing the urgency of energy diversification. As part of the effort, with skyrocketing fossil fuel prices in the backdrops, the move toward the construction of nuclear power plants is rapidly regaining momentum. There reportedly are strong calls for acceleration of the nuclear power project in the industrial circles as well.

In April 2007, the Nuclear Power Infrastructure Preparation Committee ("NPIPC") was commissioned. In December the same year, the cabinet approved the Nuclear Power Infrastructure Execution Plan ("NPIEP") developed by the NPIPC. At the same time, approval was given to the launch of the Nuclear Power Program Development Office ("NPPDO") as an organ charged with the preparation for nuclear power generation as well as to a budget for that purpose amounting to Baht 1.8 billion (about 6 billion yen) for a three-year period. This action was followed by a decision to recruit requisite personnel from the EPPO, EGAT, OAP (Office of Atoms for Peace) and other organizations concerned. The NPPDO was launched officially in January 2008 and has already started its activities.

Following the PDP 2007, the NPPDO is now proceeding with the preparation for the introduction of 1,000-MW class reactors, aiming to introduce two units in 2020 and another two in 2021. According to the plans, all of the four reactors will be constructed at the same site. Construction is to start from 2015 after completing a feasibility study, environmental impact assessment and site selection, along with other work. Fig. 10 shows an outline of the plan for the nuclear power introduction into Thailand.

Fig.10 Nuclear power introduction roadmap in Thailand



In the electricity utilities industry in Thailand, domestic and foreign IPP and SPP (Small Power Producer) operators have been actively introduced. As a result, the combined power output by IPP and SPP operators accounts for 50% of the total power generation. Concerning the state power corporation EGAT, which supplies the remaining 50%, the government has been trying to privatize the organization since 1992. While it was converted into a joint-stock corporation in 2005, protests were made against the privatization from the EGAT union members and citizen groups fearing for evasion of the responsibility for the adverse impact on environment caused by the EGAT in some of its hydro- and thermal power plants in the past. In March 2006, the Supreme Court issued an injunction, after which the privatization issue has been pending in uncertainty.

Power generation capacities in the IPP segment are growing with gas-fired and coal-fired thermal generation, and with co-generation and biomass-fired power generation in the SPP segment. For the electricity generated by IPP and SPP operators, a system is in place under which the EGAT purchases and then transmits the generated power. It is expected that this system will be maintained in the future with the EGAT meeting about half of the demand and independent power utilities supplying the remainder. Foreign capital is positively encouraged to join the IPP/SPP business, and Japanese players such as Electric Power Development Company or Chubu Electric Power Company are also participating.

In the event that nuclear power generation is introduced in the future, the EGAT will take the initiative. When the previous nuclear power plan was developed, a number of candidate sites were nominated. However, it is likely that the site for the present scheme will be selected from candidates on the coastal area near Bangkok, even if the site selection is totally open at present. Although the project funding may depend upon the move toward the privatization of the EGAT, the introduction of nuclear power generation is a national project and is likely to proceed without seeing any major obstacle.

4-3 Challenges for the nuclear power introduction

The nuclear power project in Thailand has just embarked on a fresh start. As the engineers engaged in the previous nuclear power project are about to reach their retirement age, the new project must start from scratch to develop human resources that can promote the introduction of nuclear power. Although there were some candidate sites discussed in the planning phase of the previous project, it is intended to make selection anew for the present project. In this regard, nothing specific has been decided except for a condition that the site should be along the coastline near Bangkok. Given these circumstances, it looks all the more difficult to commission the first plant in 2020 as planned.

Despite such difficulty, the government leaders fully recognize the need for nuclear power generation and are promoting the project toward its realization with solid planning. The plan addresses not only site selection and plant construction aspects but also human resource development, recognizing its impending need, and incorporates considerations for other key issues such as public acceptance. Moreover, Thailand today is regarded as an industrialized nation with a well-developed automotive industry among others, and its subcontracting systems for work such as machinery assembly appear relatively sound. Power transmission networks essential for installing bulk power supply facilities are centrally managed by the EGAT, allowing hardly any power outage cases attributable to faulty transmission lines or shortage of power generating capacities. Thus, it seems safe to conclude that the required infrastructure is adequately in place in Thailand.

Having learned about Thailand's intent to introduce nuclear power generation, representatives of nuclear plant manufacturers are currently visiting Thailand from all over the world including those from Japan, the U.S., France, and Russia, looking to conclude business deals. Given such circumstances, it is likely that the introduction of nuclear power generation will be seen by around 2030 even though some delays may occur.

5. Vietnam

5-1 Factors driving nuclear power development

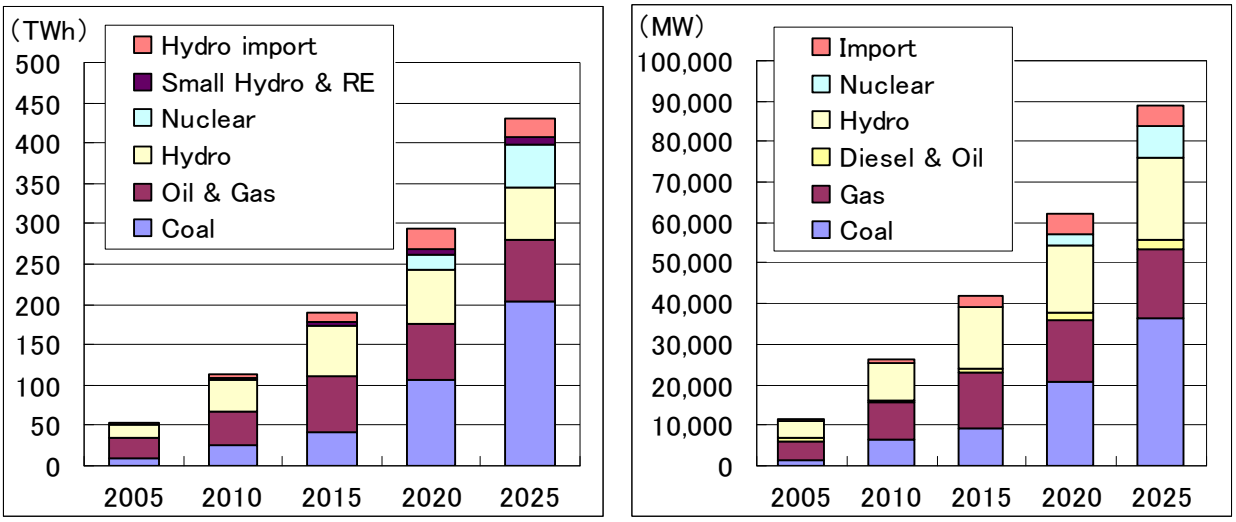
Vietnam has a population of about 84 million as of 2006 and registers a net GDP growth of 8.2%, which is the highest among the five Southeast Asian countries surveyed this time. Its GDP growth is likely to stay at around 8%, and an even longer-term forecast up to 2030 points to an annual average growth rate of 6.3%. Along with the high growth rate, primary energy supply is also expected to grow at an annual average rate of 5.5%.

Electricity demand is also increasing, going from 13.4 TWh in 1996 to 45.6 TWh in 2005, with an average growth rate of 15% or about 240% over the period. The peak power consumption has increased from 3.20 GW in 1996 to 10.5 GW in 2005, or 3.3 times the 1996 figure.

In order to cope with these sharp increases of power demand, the Vietnamese government has introduced the IPP and BOT (Build-Operate-Transfer) schemes to promote private sector investments into the electricity utilities segment. As a result, the power generating capacity of Vietnam as of the 2005 year-end reached 11,340 MW with the IPP segment accounting for 22.2% of that.

According to the "Master Plan for Power Sector Development in the Period 2006 - 2015 with Perspective to 2025 (a.k.a. PDP6)", a power source development plan officially approved by the government in July 2007, Vietnam's power generation output will grow from 52.05 TWh in 2005 to 431.69 TWh in 2025, and the power-generating capacity from 11,340 MW to 88,848 MW, projecting that both indicators will grow eight-fold in 20 years. With regard to the power source type, the power generation output and installed generating capacity are generally increasing for hydropower, coal and natural gas. However, in terms of source composition, the share of coal-fired power generation is increasing while shares of natural gas-fired generation and hydropower are somewhat decreasing. Fig. 11 shows an outlook of Vietnam's power generation output and installed generating capacity by source up to 2025.

Fig.11 Outlook for power generation and installed capacity by fuel type up to 2025



(Source) STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE HYDROPOWER MASTER PLAN IN THE CONTEXT OF THE PDP Ⅵ, Asian Development bank

Vietnam has abundant resources of coal, natural gas and oil. As its coalmines mostly produce high-quality anthracite coal, Vietnam has been the world's leading producer/exporter of anthracite coal. According to the "Master Plan for Coal Development 2006 - 2015 (provisional)" prepared by the VINACOMIN, the state-run Vietnam National Coal-Mineral Industries Group, the coal demand is expected to grow at an annual average rate of 10.6 to 10.8% over the period from 2006 to 2025, against which coal production is predicted to increase only at a low level of 2.2 to 2.8%. Because of this, the country plans to control export at a minimum level after around 2015 while making up the supply shortage with import from Indonesia and Australia. Although there is a potential for renewable energy development, which is in fact making progress, the objective is mainly to make electricity more available to rural areas rather than to secure bulk power supply sources. That means renewable energy is unlikely to substantially increase its share in the entire power source mix of Vietnam.

As discussed above, Vietnam is one of the nations endowed with rich coal and gas resources in Southeast Asia and, unlike Indonesia and Thailand, it has not yet become a net importer of natural resources. However, even with such a propitious situation, Vietnam faces uncertainty when it comes to satisfying the growing domestic energy demand for years to come. Accordingly, the significance of nuclear power development for Vietnam lies perhaps in the mid- to long-term power source mix rather than in the current or short-term supply-demand situation.

5-2 Overview of nuclear power projects, system and environment for implementation

It was in the 1990's that Vietnam began looking into the introduction of commercial nuclear power stations. In 1996, the Ministry of Industry and the Ministry of Science and Technology conducted an "Overview Study on Possibilities of the Introduction of Nuclear Power into Vietnam 1996-1999". For this work, cooperation was sought from experts in nuclear research institutes and nuclear energy companies based in Japan and other foreign countries. Following the above study, preliminary comprehensive feasibility studies called "Pre-FS" were undertaken from 2001 to 2003, the findings of which were compiled into a report in November 2003. Again for this survey project, the Vietnamese government received cooperation and advice from countries with advanced technology for nuclear power generation, such as Japan, Korea, France and Germany. Almost concurrently with the Pre-FS work, a "Strategy of Peaceful Uses of Atomic Energy up to the Year 2020" was developed, in which a specific goal was established for the first

time to introduce nuclear power plant targeted for completion around 2020.

In August 2005, the Office of the Prime Minister received recommendations based on the Pre-FS conducted up to 2003. In preparation for the introduction of nuclear power generation in Vietnam, the recommendations discussed the following 12 items: (1) safety and regulatory control, (2) international cooperation and agreements, (3) human resource developments, (4) public acceptance ("PA"), (5) nuclear power generation technology, (6) fuel handling and waste disposal, (7) necessity for nuclear power generation, (8) site selection, (9) environmental assessment, (10) construction management, (11) operation and maintenance, and (12) economic and financial analyses. For the first commercial nuclear power plant the Vietnamese government has cited two locations as candidate sites, i.e. Phuoc Dinh and Vinh Hai, in the Ninh Thuan Province in southern Vietnam.

Subsequently in January 2006, the Prime Minister endorsed a "Long-term Strategy concerning Peaceful Uses of Nuclear Energy up to 2020," which can be summarized as follows:

· The construction of the first nuclear power plant will start by 2015, targeting for commissioning by 2020.

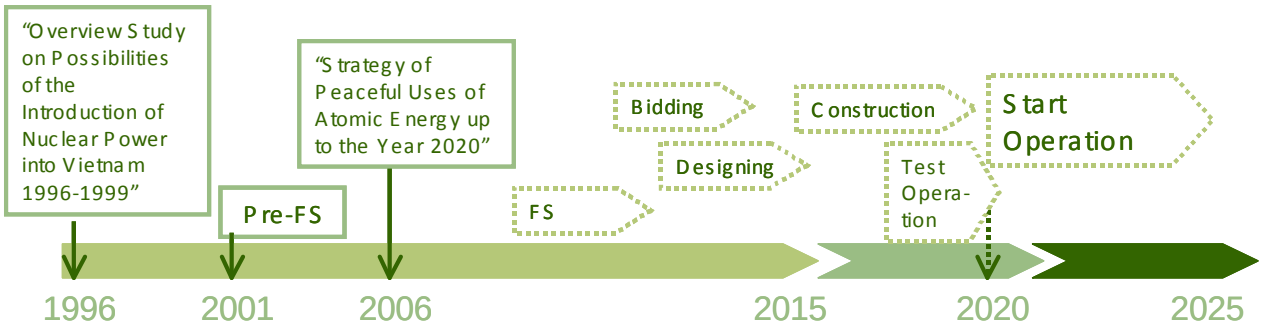
· Project partners will be selected in the light of both construction and operation aspects. This process will be carried out under the state leadership in three phases: (1) technical survey, (2) technology transfer from partners, and (3) technological development during ten years after the commissioning.

· Domestic production of nuclear plants and the fuel should be included in the perspective (including procurement of uranium for fuel production).

· The Ministry of Science and Technology will take the initiative in the actual execution of the state strategy and obtain cooperation of other ministries and offices concerned.

In July 2007, the Prime Minister gave approval to the "2007-2020 Atomic Energy Plan" developed based on the above strategy. According to the plan, the Vietnam Atomic Energy Institute will be developed into a research-application center to lead the application of nuclear power while the Ministry of Industry would also start efforts to facilitate human resource development and fundamental studies. In September 2007, the Vietnamese state power corporation EVN (Electricity of Viet Nam) launched a "Committee for Preparation of Nuclear and Renewable Energy Investment" within its organization to start preparing a framework for the project promoter which is deemed as the future owner of the nuclear power station. Fig. 12 shows the outline of the nuclear power introduction to Vietnam.

Fig.12 Nuclear power introduction roadmap in Vietnam



As discussed above, Vietnam aims to commission the first commercial nuclear plant in 2020, having started extensive studies toward the goal. They are in the phase of discussion concerning cooperation and assistance to be obtained from cooperating countries. Decision on the reactor type to be introduced and the plant manufacturer to be adopted is yet to be made.

In the next section, an overview will be provided on the infrastructure development and financing and

investment environment related to the power generation business.

In a nation such as Vietnam where power supply shortage and insufficiency in infrastructure are aggravating along with economic growth, infrastructure development assisted with foreign capital is essential. In particular, there are strong calls for enhancement of coal-fired or natural gas-fired thermal power generation facilities. As systems are established to allow fully foreign-owned operations in the form of the IPP business or under the BOT system, Kyushu Electric Power Co. Inc. and Tokyo Electric Power Company are already developing IPP businesses jointly with BP or EdF utilizing these systems. Concerning renewable energy production, Japan and other countries have already started research-phase efforts in the areas of wind and photovoltaic power generation, biomass, hybrid fuel cells and the like. As for the financing framework, there are available programs such as the yen-loan schemes offered by the Japan Bank for International Cooperation intended for projects concerning power transmission facilities, rural electrification, micro hydropower or environmental protection measures for coal-fired power generation. The foregoing indicates that the business environment required for the entry of foreign capital is by and large set for now.

To promote the infrastructure development, the Vietnamese government intends to facilitate foreign capital inducement through means such as yen loans, use of ODA funds, and financing at low interest rates rather than using own funds from the national treasury. The government is making active efforts to improve the investment environment for Japan as represented by the "Japan-Vietnam Investment Agreement" effected in December 2004, and the "Japan-Vietnam Joint Initiative" signed in December 2003, followed by the conclusion of an action plan based on the said initiative. All these efforts have contributed to increases of foreign direct investment (FDI) into Vietnam from year to year.

Summing up the foregoing, from a viewpoint of enterprises in foreign countries including Japan, Vietnam can be considered as having generally developed investment as well as business environment, whether the means used is utilization of yen loans or ODA framework, or FDIs. However, careful judgment is required for individual business risks and, in particular, for those related to the power generation business as attention must be paid to the fact that power transmission infrastructure is underdeveloped.

5-3 Challenges for nuclear power introduction

As discussed in the preceding sections, the Vietnamese investment environment in the power generation segment is favorable from the perspective of overseas enterprises. With a number of past foreign investment cases on record including those from Japan, its economic condition can be regarded as stable and the investment risk relatively low. Uncertainty exists, however, concerning the future outlook of the power transmission infrastructure, requiring close investigation on location, timing, and capacity of the transmission network to be prepared before constructing a large-capacity nuclear power station.

Having been considering the introduction of nuclear power generation since the 1990's in cooperation with Japan and other foreign countries, Vietnam is one of the countries in Southeast Asia where the introduction plan is at the most advanced stage. As such, the country is expected almost certainly to introduce nuclear power generation. The issue here is when it will happen and how mature the plan is. More than ten years after the preliminary studies in the 1990's and seven years after the start of 2001 Pre-FS, approval has not been given to execution of a full-scale feasibility study, which indicates that a required policy implementation system has not been established yet.

The Vietnamese government says it will float an international tender and make decision on partner

selection in parallel with implementation of a full-scale feasibility study, followed by detailed studies on technical specifications and design work. However, when there are only seven years before 2015 or the scheduled starting year of the construction, it is highly questionable if there is enough time left for completing all the work mentioned above as well as human resource development involved. For any country to assist and collaborate on the nuclear power introduction program in Vietnam, it should be a priority task to make swift but not hasty investment decisions in working out the financing plans and technological assistance, based on knowledge obtained through technology and personal exchanges achieved so far.

6. Possibility of introducing nuclear power generation in the five Southeast Asian countries (Summary)

The preceding chapters have discussed the need for nuclear power generation, its background, the overview of the introduction plan and its progress and challenges for the introduction for each of the five Southeast Asian countries that are considering the introduction of nuclear power generation by or around 2020. This chapter summarizes the above discussion points and provides a perspective for the driving factors, present state of the introduction process and outlook for the introduction of nuclear power generation in each of the five countries in Southeast Asia. At the same time, this chapter discusses possible contributions that Japan's nuclear energy industry can make to those countries, taking into consideration specific situations in each of the respective countries.

These countries plan to introduce nuclear power generation more or less eying at completion around 2020, with Indonesia targeting at 2017, Malaysia at 2020 or later, the Philippines around 2022, and Thailand and Vietnam at 2020. One common factor for introduction of nuclear power generation among these countries is increasing electricity demand accompanying rapid economic growth, where their largest motive is the fact that they will need large-capacity power sources soon. Since Malaysia has a relatively high capacity margin of 44%, introduction of nuclear power generation is not officially planned at the moment, and the need is not urgent either. Yet nuclear power is considered to be among important power sources for meeting demand increases expected after 2020, and they have just started investigation on the introduction of nuclear power to that end.

Another significant factor for nuclear power introduction besides the need for securing power generating capacities is the need for diversifying power sources to enable reduction of dependency on coal or natural gas as well as to control their consumption or to use them as resources for strategic export. Nowadays, along with the skyrocketing crude prices, escalation in both natural gas and coal prices are becoming increasingly marked. It can therefore be argued that not only preserving but utilizing those resources for export also constitutes an important policy measure for maintaining the economic growth at a high level.

Challenges common to all these countries in introducing nuclear power include human resource development, introduction and development of the technological readiness, development of a system for the policy implementation, and development of power transmission networks and related infrastructure. Of these elements, the level of nuclear technology is more or less the same in any of the countries discussed. They all own research reactors and have a history of fundamental research undertaken at their nuclear technology research institutions. All of them are in the phase of a fresh start for nuclear power development, except for the Philippines with the suspended BNPP reactor, where the task of human resource development is universally a major challenge.

Issues appearing significantly different among these countries are the state of implementation system development, the circumstances around the electricity utilities business, investment environment and the

state of infrastructure development. Those with relatively advanced system for the policy implementation within the government or related organizations, if not perfect, are Vietnam and Thailand, for which comparatively smooth execution of the plans may be expected. By contrast, Indonesia does not have an established implementation system, clear demarcation of responsibility nor identification of the owner of the project. Similarly, Malaysia has only recently launched a system for the policy implementation within the government whereas the government of the Philippines does not even have such an institution within itself.

As for investment environment and the state of infrastructure development, the situation is relatively favorable in Malaysia, Thailand and Vietnam. In particular, Thailand and Vietnam having good records of foreign investment received in the power generation industry can safely be deemed as the best of the five in terms of investment environment. Malaysia is also advantageous in that the economic condition is good and the investment risk level is comparatively low. However, the lack of a legitimate position for nuclear power generation in the official energy development policy, along with the rigid domestic regulatory control over electricity prices act as an adverse factor at the moment.

In any case, the plans by the respective countries to introduce nuclear power generation by or around 2020 should be the fastest scenario technically achievable, and they are likely to experience delays of at least several years considering time required for site selection, systems design, human resource development, etc. Based on the above, a general outlook for each of the countries analyzed could be summarized as follows:

· For Vietnam and Thailand, where the system for the policy implementation is well prepared, nuclear power projects will likely make progress relatively smoothly albeit some expected delays.

· Concerning the Philippines, while the BNPP project may be reactivated at an earlier stage, the state of the implementation system appears to suggest that substantial delays could occur.

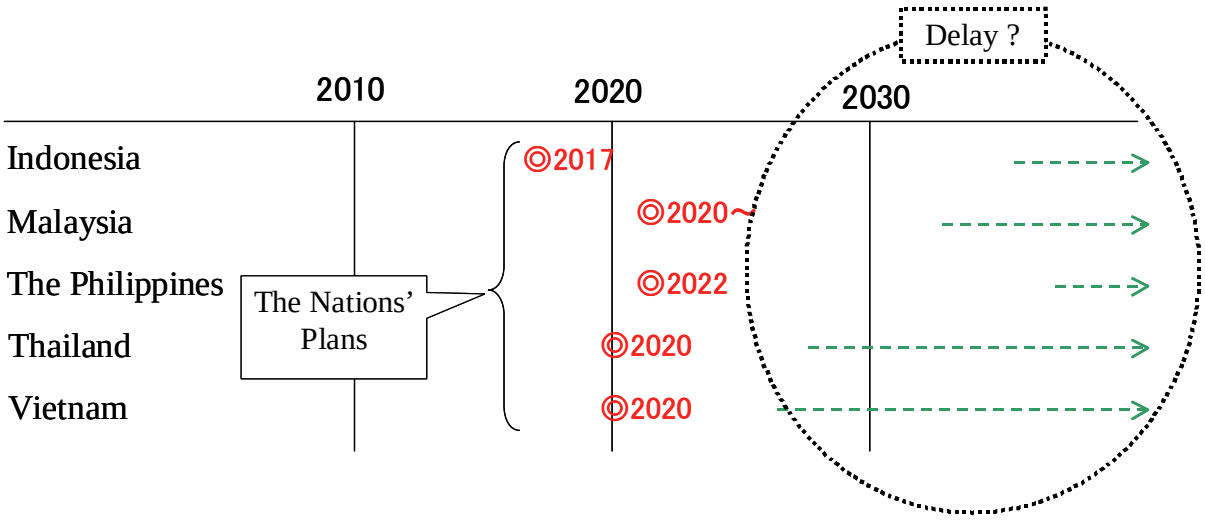
· For Malaysia, where there is no urgent need for nuclear power introduction, early introduction is not likely to occur.

· Indonesia is highly likely to see significant delays, given the state of infrastructure development and investment environment.

Fig. 13 shows an outlook for the nuclear power introduction plans in the five countries in Southeast Asia.

Fig.13 Nuclear power introduction plans in the five countries

7. Potential participation and contribution of Japan's nuclear energy industry



In the field of nuclear energy applications, Japan has been active in providing technology exchange and

assistance with Southeast Asian countries since around the 1990's both at the governmental and private sector levels. Inter-governmental exchanges started when the Atomic Energy Board organized the "First International Conference for Nuclear Cooperation in Asia" in March 1990. Japan has continued to provide assistance actively ever since the above Conference was turned into the "Forum for Nuclear Cooperation in Asia" (FNCA) later in 1999, arguably earning a position of a helper that has been assisting the Southeast Asian countries from the earliest stage and in the broadest scope of areas among the advanced nations. Elsewhere, NEWJEC, a Japan-based consultancy firm in the power generation field, initiated a feasibility study on nuclear power introduction on commission from the Indonesian National Nuclear Energy Agency (BATAN) in August 1991 and completed a report in 1993.

However, the foregoing does not directly lead to the prospect of Japanese nuclear energy companies being picked up as partners for promoting nuclear power introduction to the Southeast Asian countries in the future. Around the same time that Japan was engaged with the related projects, France, Russia, the U.S. and others also offered cooperation in conducting preliminary studies for nuclear power introduction. In recent years, Korean and Chinese governments as well as private enterprises have also been active. For example, the Indonesian government concluded a cooperation agreement in the field of energy development with China in November 2006 and another with Korea in December the same year. The latter has led to joint site surveys for nuclear power plants under partnership between the Korean state-owned KEPCO and the Indonesian power company PLN. Also in Vietnam, France has been assisting the government from the Pre-FS phase, leading to the July 2007 revision of the Bilateral Agreement Concerning Peaceful Uses of Atomic Energy, an inter-governmental agreement converted from an agreement previously concluded between the Vietnam Atomic Committee and the French Atomic Committee, to confirm 11-point cooperation activities covering such items as human resource development and plant construction[6]. Later in July 2007, Vietnam also launched a platform for bilateral talks with Korea aimed at future introduction of commercial nuclear power stations[7]. This is an extension of the Memorandum of Understanding concluded in 2006 between the two countries for nuclear cooperation, accompanying the signing of another MOU covering a wide range of topics including bilateral trade insurance and exchanges in technology and other energy-related fields. Furthermore, the U.S. and Russia have respectively announced their willingness to collaborate with Vietnam on construction of nuclear power plants at the occasion of meetings between top-level government leaders[8], followed by similar developments in Thailand.

Japan owns the third largest nuclear power-generating capacity in the world and has a relatively long history of commercialization dating back as early as the 1960's. However, France and the U.S. have even longer histories and larger installed capacities backed by rich operational experiences. Under such circumstances, some of the notable advantages Japan has in facing these competitors may include, first of all, the numerous successful records in economic as well as technological assistance achieved through ODA and similar programs, long and ongoing nuclear cooperation especially in Asia provided through the FNCA framework, and a high level of manufacturing technology proven through deliveries of nuclear facilities even to France and the U.S. with the world's greatest nuclear power capabilities. In particular, the high performance level of Japan's power generation facilities in general that are not necessarily limited to those nuclear power-related has an established reputation from around the world.

On the other hand, one obvious disadvantage of Japan against France, the U.S. or Russia is the lack of technology and facilities in the front-end of the nuclear fuel cycle such as uranium production and enrichment facilities. Although France also lacks the domestic uranium production facility, there are

[6] Vietnam News Brief Service, July 12, 2007
[7] BBC – Monitoring Asia Pacific, July 3, 2007
[8] RIA Oreanda, June 28, 2007/Inside Energy, September 13, 2007

French-invested uranium mines in a number of uranium producing countries of the world, and France has the entire front- and back-end processes from conversion, enrichment and re-conversion as well as reprocessing facilities all within the country. The same is true with Russia, especially where its enrichment capacity is the world's largest. The U.S. also has enriching facilities and quantities of enriched uranium in stock. When nuclear power generation was introduced into Japan, South Korea and Taiwan in the past, a supply guarantee for enriched uranium was also included in the introduction package. Should these countries develop marketing strategies targeted at the Southeast Asian market by bundling fuel supply guarantees into the introduction packages, they are likely to gain considerable superiority over Japan not having such a chain of business resources.

On the matter of exchanges in non-nuclear business fields, ethnic Chinese communities have strong influence in economic worlds in Thailand, Malaysia and elsewhere in Asia although the history of Japan's involvement is not minimal at all. Should China insist that its proprietary technology for nuclear reactors be employed, such influence can never be ignored. Additionally, the technological level of South Korean companies has been catching up recently to be comparable to that of Japan besides their price competitiveness. It therefore cannot be taken for granted that the high performance level Japan is proud of will indefinitely remain at a top level in the world.

Given all the circumstances described above, while it is likely that Japan will be able to make significant contributions to nuclear power development in Southeast Asia, its position should not be regarded as "exceptionally advantageous" vis-à-vis other competitive countries.

In the diplomatic policy making in the Southeast Asian nations, there are strong desires for establishing a bilateral partnership with any country that can assist in export, investment and economic recovery aspects. As part of requirements for the partner for cooperation in introducing nuclear power generation, it is also expected that such a partner is willing and capable of engaging in a lasting relationship with a perspective for further economic development, rather than ending the relationship upon completion of the main project.

One of the requirements for Japan's participation in any future nuclear power project will be to try to demonstrate willingness and intention to make contribution to the economic development, technological improvement and upgrading of the social infrastructure of such a country. Japan can offer proprietary technologies it owns as being the first country in Asia to introduce and implement nuclear power generation and being the third in the world in regard to performance in nuclear power generation as well as arguably having the world's highest level of technologies concerning proliferation prevention and inspections. In that instance, it should be kept in mind that the political or economic conditions or social systems may significantly vary from country to country even though they all belong to the same Southeast Asian region, necessitating Japan to take a flexible posture in responding to the needs of the respective countries. For example, for a country with advanced systems for policy implementation, well developed infrastructure and in a progressed stage of project execution, greater emphasis can be placed on assistance with state-of-the-art technologies including plant design and machinery manufacturing, while more comprehensive assistance such as infrastructure development may be offered for a country with an underdeveloped infrastructure and unstable socio-economic conditions.

8. Summary and implication

In the previous sections, this paper has analyzed feasibility of nuclear power introduction schemes in five

Southeast Asian countries where the introduction plans are taking shape in recent years, based on their moves and trends in energy policies and other energy developments, while at the same time identified and clarified the challenges to be tackled toward the goal, along with the possibility of Japan's nuclear energy industry to contribute to these countries.

This chapter summarizes the discussions and analysis results, along with their implications for the Japanese nuclear policy makers and those in the nuclear energy industry, from a viewpoint of suggested things to be kept in mind in the context of international development in the future nuclear energy industry.

Several Southeast Asian nations are planning to introduce nuclear power generation eying generally at completion around 2020, under the government initiatives derived in the light of growing electricity demand and the need for securing resources. However, these plans are likely to experience delays by several years or more due to numerous challenges and obstacles each of the above countries has in implementing such plans. Furthermore, if a closer examination is made not just into the energy policies and forecasts published by these governments but also into their respective politico-economic situations, infrastructure development status as well as social and industrial foundations, it reveals that the situations widely vary among these countries. In providing cooperation and assistance to these countries, therefore, it is necessary for Japan to exercise adequate judgment to grasp the individual circumstances and characteristics of the respective countries and also to recognize risks and opportunities as accurately as possible.

While there supposedly are broad potentials for Japanese nuclear industry to make contributions to these countries, drawing upon the wealth of experience and the performance record they have accumulated, that prospect does not necessarily mean Japan has an outstanding advantage over other countries. In reality, there are no immediate plans to construct nuclear plants, and the number of units to be constructed is limited, calling for private enterprises in particular to carefully examine if the profitability would justify the investment involved. Since the private sector participation into this field also requires a satisfactory inter-governmental relationship including a bilateral nuclear cooperation agreement as a prerequisite, from the policy ground as well as the practicality, it appears advantageous for the time being to focus on continuing modest but steady cooperation efforts such as manpower development, systems design, or information sharing. For private enterprises dealing in the nuclear power business, it would become important to closely examine the details of international tenders in the respective countries in terms of technological maturity, viability of projects, state of infrastructure development and other aspects of the investment environment, while providing the above type information as much as allowed for the time being in order to make quick but not rash decisions for investment.

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