

# Innovative Approaches to Financing Environmentally Sustainable Energy Development in Northeast Asia

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Innovative Approaches to Financing Environmentally Sustainable Energy Development in Northeast Asia

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# I. INTRODUCTION

Methods and sources for financing energy projects have changed significantly during the last 10 years. These changes which are expected to continue in the foreseeable future are due to two fundamental factors. First, the structural changes in the energy sector have resulted in greater role by private companies in the ownership and management of the sectors, and thereby affected the manner in which they would fund the required investments. Second, financial markets have significantly changed to provide a wider variety of instruments and a broader access to investment funds with a global context.

## 1. Sector Structure and Methods of Financing

Until the 1950s, most energy sector facilities in many parts of the world were owned and operated by private companies. These were in the form of small scale plants and networks. In the 1950's and 1960s there was a recognition that significant economies of scale could be achieved by consolidating these operations into large-scale and integrated systems. The subsequent expansions and integrations also raised further concerns towards protection of consumers against these "natural monopolies." The protection took the form of either assuming state ownership of the system, or allowing private ownership under stringent government.

The interest of the governments in the energy sector was substantially strengthened in the 1970s due to the concern for security of energy supply. Almost all the governments took a more active role in either managing or controlling the energy sector entities. By the early 1980s, energy supply had turned into a socio-economic and strategic matter. The price of energy was a politically sensitive issue. Therefore, there was little assurance that consumer prices would fully cover the cost of energy supply or would provide funds for future investments. At the same time governments took more responsibility for providing or mobilizing funds to ensure that energy supply capacity is expanded to meet the future demand. Thus, the method of financing energy projects was rather straightforward. The energy entity (utility or oil company) would provide part of the funds from its own resources. The remainder would be provided by the government or mobilized with government support.

Since the late 1980s the governments of most countries have reduced their involvement and their support in the energy sector. In some countries this has meant privatization of state entities, or partial deregulation of the sector if entities are already in private hands. In some other countries this has meant letting state entities take responsibility for investments, finance and eventually their own survival. As a result of this structural change, the financial aspects of the sector are being revamped

in two distinct areas. First, energy prices have become de-politicized. It has become widely accepted that energy prices, should reflect the cost of supply and should constitute the eventual source of financing future investments. Second, the confined boundaries of investment financing have collapsed, providing investors with the opportunity to seek funding from all possible sources in the domestic and foreign capital markets.

## 1. The Conventional and New Methods of Finance

The conventional sources of funding energy projects included: (a) domestic sources such as utility's internal cash, government contributions, and domestic borrowing from local banks; and (b) foreign sources such as multilateral and bilateral agencies, and to a limited extent, international commercial banks.

Funds from domestic sources were all in the form of local currency and were used to cover the local cost of a project. Funds from external sources were in the form of foreign exchange and covered the cost of imported components of a project. Also, all the borrowing from multilateral and bilateral agencies were usually mobilized by the government and under government guarantee.

The new methods of funding energy projects involve two distinct variations from the past. First, many of state companies now go to private capital markets (both domestic and abroad) to borrow funds. Often they do not offer government guarantee. They borrow on the account of the company or even the proposed project. Second, private companies which have entered the energy sector provide private equity funds and also borrow from private lenders.

The sources of funds still include the same general categories, i.e. domestic capital markets, foreign capital markets, and multilateral and bilateral financiers. However, in each area a wide range of facilities are introduced to deal with the new business environment. In the domestic capital markets, the role of commercial banks has been reduced by the emergence of bond markets and the direct participation of insurance and pension funds in financing investments. In the international capital markets, commercial banks continue their active involvement in investment financing while the bond market has become also an important source of finance. Even multilateral and bilateral agencies have introduced new facilities to provide funds to private ventures and to lend without government guarantee.

## 1. The Objective of the Study

In this report we analyze the financial aspects of energy development in North East Asia (Japan, China, Taiwan, South Korea and North Korea). The objectives of the analysis are:

- a. to assess whether there is sufficient finance available for future energy investments in the region;
- b. to examine the impact of finance on the energy mix and energy sustainability;
- c. to learn about lessons that can be transferred from the experience of one country to another;
- d. to explore the potentials for using innovative methods of financing which can reinforce sustainable energy development; and
- e. to identify the potential roles that Japan and the US can independently or jointly play in encouraging energy sustainability in the region through financial instruments.

The analysis concentrates on power investments because they normally represent the bulk of the

energy sector capital expenditures, and also because the electricity sector is the main vehicle for making any significant change to the energy mix of the countries in the region.

## 1. The Road-Map of the Study

The methodology of the study is devised to trace (a) the changes in the methods of investment financing in each country, and (b) the impact of these changes on energy sustainability. The analysis indicates that methods of investment funding are largely intertwined with a country's energy policy, and that the most serious impacts of financing are likely to be on the fuel mix of the power sector and on the energy conservation programs of the country. The study, therefore presents:

a. conventional methods of financing in each country. This section examines the government role in the power sector and the manners in which energy policy has affected availability of investment finance.

b. emerging methods of financing in each country. This section analyzes the sources of investment funds to assess the present and future patterns of financing power investments.

c. impact of finance on fuel mix. This section discusses the extent to which the fuel mix has been and is likely to be affected by emerging methods of finance. An important aspect of this discussion focuses on the impact of private power on the development of hydropower, nuclear energy and clean-coal technology.

d. sustainable finance for sustainable energy development. This section brings together the results of the study and summarizes the concluding remarks with regard to the questions which were set out in the objective of the study. It projects the future financial requirements of the power sector, and describes the manners in which innovative methods of financing can be used to meet the requirements, affect the fuel mix, and promote energy conservation.

## II. THE CONVENTIONAL METHODS OF ENERGY FINANCING

In all the countries of North East Asia the power supply has been traditionally dominated by integrated monopolies which own and operate the generation, transmission and distribution systems. In Japan, the ownership is in private hands. In all other countries the ownership has been vested in state companies.

Regardless of private or public ownership the governments of the region have played very critical roles in directing energy development. However, the reasons for strong government intervention, the form of intervention and the impact on financing vary from country to country. In this chapter we review the conventional methods of financing in each country in relation to the country's energy policy and the support of the governments for funding investment requirements of the power sector.

### Japan

Japan's energy policy aims at (a) ensuring sufficient and reliable supply of energy for its continuous economic growth, (b) maximizing the security of energy supply, and (c) minimizing the environmental impacts of energy production, transmission, conversion and consumption.

Considering the small size of domestic energy resources and the large amount of economic activity, the challenge of meeting those objectives is tremendous. Nevertheless, the country has been able to overcome the challenge in an impressive manner involving strong leadership by the government and very close cooperation between public and private sectors.

The above objectives and the public/private sector cooperation characterize every aspect of energy policy and implementation including financing of energy projects. The country's energy companies are mostly private. However, government keeps a strong role in strategic decision-making regarding the mix of fuels, developing suitable technologies and constructing the corresponding facilities. The Ministry of International Trade and Industry (MITI) oversees national energy policy. It is actively involved in all major energy affairs including approval of investment plans, setting of energy prices and supporting R&D on energy technologies.

The power sector is dominated by ten privately-owned regional electric companies, which supply 75 percent of the country's power consumption. The remaining 25 percent is supplied by 34 small public power generators (mostly municipally owned), 20 power companies which are joint ventures between the electricity industry and major consumers, industrial auto producers, the Electric Power Development Company and the Japan Atomic Power Company.

The bulk of investments in the power sector are made by the ten private companies. Their annual investment was \$24.5 billion per year during 1986-1990 and \$41 billion per year during 1991-95. From the total investment roughly 25 percent is spent on reinforcement of transmission and distribution, 26 percent on rehabilitation, 6 percent on nuclear fuel and 43 percent on new generating capacity. The capital expenditure for new generating capacity, is divided into nuclear (15 percent), coal and gas (15 percent) and hydro (3 percent).

The power sector's investments are almost fully funded by Japanese financial resources. Power companies contribute substantial internal cash to funding of investments. The average internal cash generation of the last 10 years is about \$24 billion per year. Nevertheless, the companies had to borrow about \$58 billion/year to meet financing needs particularly repay previous debts. About 92 percent of these funds were borrowed from Japanese sources. Only less than \$5 billion/year is borrowed from external markets, mostly in the form of bonds issued in the U.S. and European capital markets.

Table 2.1- Sources of Financing Power Sector Investments in Japan

## **China**

Until 1980 the power industry in China was completely owned by the national government. Local governments and power enterprises had no control over investment plans. Funding for capital investment was allocated by the State Planning Committee to the ministry in charge of the power sector (Ministry of Water and Power prior to 1985, Ministry of Energy between 1985 and 1993, and Ministry of Power Industry after 1993) and then to each enterprise according to national plans. Power enterprises were responsible for meeting production targets, but were not responsible for profit or losses. Indeed, there was no logic for holding these enterprises responsible for financial performance because electricity tariffs were set by the government based on a variety of social, political and economic considerations and with no direct relationship with cost of power supply. Standard nationwide tariffs remained basically unchanged for several decades. The rates for agricultural and industrial consumers were heavily subsidized. The overall electricity price was too low to cover the cost of supply or to provide sufficient funds for the required capacity expansion. Thus, investments were not only decided but also fully funded by the central government.

In early 1980s the government recognized that the huge investment requirements of the power sector could no longer be funded from government sources. Since then a series of institutional and policy reforms have been introduced to make the sector increasingly self-sufficient in financing its investments. These reforms have three main objectives:

(i) to let the provinces and enterprises take responsibility for their financial performance and their

ability to fund their investments;

(ii) to require the consumers to pay prices which cover the cost of power supply and provide funds for required investments; and

(iii) to facilitate investment and financing from private (internal and foreign) sources.

The reforms began by giving the power enterprises responsibility for funding their investments and treating government support as loans rather than grants. The institutional reform also included establishing 30 provincial power companies in China's 30 provinces. These companies prepare their investment plans with the cooperation of provincial governments and submit them to the national government, which prepares the national power investment plan, and its corresponding arrangements such as impact on transportation capacity, transmission network, electricity tariffs, etc. The establishment of provincial companies has also shifted substantial responsibility from national to local government. The institutional reform also included the formal opening of the power sector to private companies though it required that foreign investments in projects larger than 25 MW be reviewed and approved by the national government. Since 1993, foreign investment has been further facilitated but projects larger than 50 MW still need to be audited and approved by the central government.

Along with the above institutional changes the power pricing policy has also changed significantly. In particular, since the mid-1980s the government has allowed power produced from plants financed by "nontraditional" sources to be sold at prices that provide for adequate debt servicing and reasonable profit. Accordingly, prices for the electricity produced from all new power plants are now set by contract to cover financing and operating costs, on a plant-by-plant basis, and rolled into the average power tariff. The electricity tariff applied for plants built with grant financing before 1985 has also been rationalized to reflect variations in fuel and transportation costs. The average tariff for power from new plants is about 5 cents/kWh while the average for the plants in service is about 3 cents/kWh. The latter is scheduled to increase gradually so that tariffs can be unified by 2000.

Investments in the power sector amounted about \$12 billion in 1995, of which more than \$10 billion was spent on building generating capacity and less than \$2 billion on transmission and distribution facilities.

The institutional and policy reforms in the power sector have resulted in a fundamental change in responsibility for funding investment requirements. The share of central government financing, which was more than 90 percent until the early 1980s, has now declined to less than 6 percent. However, the most important development is that the tariff mechanism is set to provide the long-term source of funds for investments in the sector. The average electricity price in 1995 was 4 cents per kWh compared with 2 cents per kWh in 1980. The self-financing ratio, i.e., the share of capital expenditures financed by the company's internal cash generation, has increased (from nil) to almost 30 percent for most power companies. This is expected to increase to more than 35 percent by the end of the decade. It would then represent a healthy range by international standards.

Table 2.2- Sources of Financing Power Sector Investments in China

### **Taiwan**

With almost 80 percent dependency on imported energy, and tremendous economic growth over the past two decades, Taiwan has attached substantial importance to its national energy policy. The primary concern has been to ensure economic and reliable supply of energy to facilitate economic growth.

The power sector is dominated by Taiwan Power Company (known as Taipower) which is managed and operated as a commercial business utility under the general supervision of the Ministry of Economic Affairs (MOEA). Two thirds of Taipower's stock is owned by the central government, 27 percent by the Taiwan Provincial Government, and remainder by institutions and individuals. Taipower until recently has had sole responsibility for generating, supplying and marketing electric power to the whole of Taiwan Province and the metropolises of Taipei and Kaohsiung. Taipower still has sole responsibility for transmission and distribution of power, but its monopoly status in generation is expected to wane under the measure which have been now introduced to allow independent power plants.

The national power supply policy has under gone several radical shifts both in terms of aggressiveness in capacity expansion and the mix of generating capacity. An aggressive expansion program was launched in the second half of the 1960s which increased the installed capacity by a factor of 8 over 15 years - 1965 to 1980. This rapid expansion is largely based on oil-fired plants. After experiencing severe economic shocks from the oil crises of the 1970s, the energy policy shifted its emphasis from capacity expansion to diversification. Substantial efforts were then spent on developing nuclear power, coal-based plants and importing LNG, mostly to reduce reliance on oil; there was no concern about shortage of power capacity or the ability of Taipower to meet future power demand. In the 1990s, and particularly the last 2 to 3 years, Taiwan has experienced severe power constraints and the government has started to doubt if Taipower should remain the sole public monopoly in the sector. Accordingly, the government has opened up power generation to IPPs and has introduced various measures to encourage cogeneration. The government has also relaxed the fuel-mix targets which would maintain a major share for nuclear capacity. Instead, it wants to ensure that sufficient power capacity is built. The main avenues for building additional capacity are cogeneration (mostly for medium term) and private power (for long-term needs).

Taipower's investment in the power sector amounted to \$6.0 billion during 1991- 1995. An average of 33 percent has been spent on transmission and distribution, and the rest on generation.

Taipower's financing needs have been met with the direct or indirect support of the government. The most helpful support has been a flexible tariff policy which quadrupled between 1970 and 1980 to enable Taipower to cover the cost of power supply. Accordingly, financing of power investments were substantially (40 percent) dependent on Taipower's internal cash until 1980s. The share of internal cash has fallen in the 1990s basically because of sharp increase in investment requirements.

Table 2.3- Sources of Financing Power Sector Investments in Taiwan

### **South Korea**

The electricity industry in South Korea is dominated by Korea Electric Power Corporation (KEPCO) which owns and operates 86 percent of the country's generating capacity and all of the transmission/distribution facilities. The government holds 77.6 percent of KEPCO's shares. The remaining shares of KEPCO's stocks are held by the Korea Development Bank (1.4 percent), KEPCO employees (2.4 percent), other corporations (5.4 percent), individual investors (5.2 percent) and foreign interests (8 percent).

The power sector is regulated by the Ministry of Trade, Industry and Energy (MOTIE) which is actually in charge of setting the targets for expanding electricity facilities, and also the fuel mix. In practice, the decisions are made jointly by MOTIE and KEPCO as KEPCO prepares the demand forecast and proposes the initial expansion plans. Other government entities and research institutes also enter the decision-making process in an advisory capacity. This is particularly complex in the case of nuclear power. The overall direction for nuclear energy development is provided by a high level Atomic Energy Commission. The Ministry of Science and Technology is responsible for safety

issues and R&D. The Korea Nuclear Fuel Company specializes in uranium reconversion and nuclear fuel fabrication.

KEPCO is known as one of the most efficient power utilities in the world. The fact that it has been established and operated as a state entity is often seen as an exceptional case where a government owned corporation has performed very well.

KEPCO's power generation, transmission and distribution capacities have expanded very rapidly over the past two decades. This has required huge investments of about \$ 4.2 billion per year (average over 1985-95) of which about 50 percent is spent on transmission and distribution, and the rest on generating capacity.

Although KEPCO is solely responsible for financing the required investment, the government support and interventions play a critical role in accessing internal and external funds. The traditional methods of funding KEPCO's investments followed a classic model of public sector utility. Internal cash generation of the corporation represented only a small source for funding the required investments. The balance came from government contributions and particularly government-sponsored borrowing.

The reasons for limited internal cash generation were somewhat low power tariffs and a cap (8 percent) on KEPCO's financial return. Electricity prices are regulated by MOTIE and were until recently adjusted within the context of social and economic objectives and through a relatively long process. In particular, power prices for industrial consumers were kept low to help their competitiveness in the international markets. KEPCO's obligation to meet the country's power demand has turned into continuous pressure to expand the capacity rapidly. This pressure has been on KEPCO over the last two decades and continues to become even more serious in the future. It is indeed due to this pressure that KEPCO executives have now decided that the company can no longer access sufficient finance for building the required expansion and therefore should let private companies to build the balance.

Table 2.4- Sources of Financing Power Sector Investments in South Korea

### **North Korea**

For most of its history, North Korea has pursued a policy of self-reliance for achieving economic development. The energy policy also followed the same philosophy. As a result, the country depends for more than 90 percent of its energy needs on domestic coal, hydropower, wood and biomass. Oil imports constitute about 7 percent of energy consumption and are consumed only in unsubstitutable uses. Even in the case of oil, the country has built sufficient refining capacity though not sophisticated enough to meet the product mix of the demand.

Power sector's installed capacity is estimated at 11,000 MW and split nearly evenly between coal-fired and hydroelectric plants. Although there is no reliable information about the sources of financing of power investments, the general observation is that all the required funds are allocated from the government capital expenditures. In addition, North Korea receives some international assistance in building new nuclear plants. North Korea operates a 5 MW research reactor and was contemplating in 1993 to construct two nuclear plants with a combined capacity of 250 MW. The refueling of the research reactor and the plan to build new plants became of major concern for security in the region, since the graphite technology being developed has possible applications to nuclear weapons. In a 1994 framework agreement with the United States, North Korea agreed to freeze its nuclear program in exchange for two new light-water reactors (which are considered less capable of producing weapons-grade plutonium) and 500,000 tons/year of heavy fuel oil to meet its energy needs until the new reactors become operational. The Korean Peninsula Energy Development



Organization (KEDO), an international consortium led by the US government was established to implement the agreement. In December 1995, KEDO signed a \$ 4.5 billion deal with North Korea for 2 x 1000 MW light water reactors, expected to commission by 2003. South Korea and Japan are providing most of the financing. KEPCO (of South Korea) has been appointed as the main contractor for the project. The US financial support has been concentrated on providing the fuel oil promised under the 1994 nuclear accord. Even there, the US has raised concern about the budget and asked for international assistance. In early 1996, Japan announced that it would contribute \$ 20 million to KEDO for fuel oil assistance. Fuel oil supply met its promised target of 500,000 tons in 1996 and is expected to continue at this level during the period 1997 to 2003.

### **III. EMERGING METHODS OF FINANCING**

Methods of financing power investments in North East Asia are changing dramatically. The change has two distinct dimensions. First, all the power companies (whether private or public) have shifted reliance to private sources of finance and even there from bank loans to the bond market. Second all the countries in the region have opened the power sector to private power producers. Here also, there are two distinct developments: (a) private power means shifting ownership from the state to private companies, and (b) private power means introducing competition in power supply. Although there are some common reasons for the change in methods of investment funding, the fundamental factors behind the change as well as the speed of the change, vary country by country. In this chapter we review the underlying forces and the patterns of new methods of financing of power investments in each country.

#### **Japan**

Fortunately for the Japanese power companies, the financial constraints which are felt in almost every part of the world are not felt in Japan's power sector. In terms of market structure, the power sector in Japan is way ahead of that of other countries because it is already in the hands of the private companies. However, there has been substantial concern over the last few years about the monopolistic nature of those companies. It is in particular observed that power prices in Japan are higher than those in other industrial countries. It is argued that the high electricity prices is a reflection of lack of competition in the sector.

#### **Table 3.1- Sources of Borrowing for Power Investments in Japan**

The government of Japan has intended to introduce more competition into the power market but has been cautious not to jeopardize the effectiveness of the national energy policy. It initially introduced some marginal changes such as allowing power generation by non-utilities. Nevertheless an amendment to the Electricity Law was passed in 1995 and became effective in January 1996, which has the potential of changing the industry structure and behavior substantially. The new law allows generation by independent power producers (IPPs). IPPs can produce power and sell it to the grid, or sell it to major consumers in which case power companies have to provide wheeling services.

The change in the Electricity Law has been received well by potential investors in power generating capacity. Five of the 10 power companies have issued bids to buy power from companies which would be willing to invest in power generation. They have stated that they would buy power only if it is cheaper than their own generation cost. They have set ceiling prices of 8.7 to 11.4 cents per kWh. They have received offers which amount to four to five times their announced requirements. Most are offers by industrial facilities to construct new power plants to supply power to their own facilities and then sell the additional output to the corresponding power company in the region.

The IPP bidders are all Japanese firms. Thus, funding of these projects will be based on Japanese

financial resources. Also, since bidders are mostly industrial firms they are likely to fund the construction with higher equity/debt ratio than power utilities. Nevertheless, the methods of financing power investments will not change significantly. The sources of funding will remain internal, borrowing will remain corporate-based and utilities' cash generation will continue to supply a significant portion of investment funds.

Table 3.2- Private Power Projects in Japan

Although the financial structure and financing practices of the power sector in Japan are expected to remain stable, they provide lessons of great value for other countries which are adopting new methods of financing. The most important features in this regard are Japan's dependence on domestic capital resources and the eventual coverage of all capital costs through consumer prices. These features constitute the foundation of sustainable financing. One of the dangers in the countries which are moving to private supply of power is their increasingly heavy reliance on foreign investment and finance. For example, countries of Latin America which pioneered private sector participation in power generation are also considered bad risks because of their too heavy dependence on foreign resources and inadequacy of domestic power prices to cover the full cost of power supply. The Japanese case is by and large an ideal model of investment finance where private sector participation is fully embedded in the system, funding of capital expenditures is based on domestic financial resources, and consumer prices are sufficiently high to recover all the capital, as well as operating costs.

Electricity Prices In Japan, Fiscal Year 1995

|                          |               |
|--------------------------|---------------|
| Residential:             | 24.55 yen/kWh |
| Commercial:              | 22.11 yen/kWh |
| Small Scale Industrial:  | 20.33 yen/kWh |
| Large Scale Industrial:  | 12.85 yen/kWh |
| Agricultural and Others: | 11.51 yen/kWh |
| Average:                 | 19.25 yen/kWh |

**China**

In China the huge need for financing power investments has forced the government to revamp the decision-making process, the management and the pricing policy of the power sector. These reforms have been quite successful and have advanced self-sufficiency of power companies in mobilizing and utilizing investment funds. However, the reform agenda has been extended to advance further (a) commercialization of power companies, and (b) access to foreign technology, capital and finance.

The commercialization agenda aims at developing the country's power companies into efficient, commercial, autonomous entities, fully responsive to market forces. The process starts with separation of the regulatory function from the supply function. The new Electricity Law will provide the basis for the legal and regulatory aspects of power generation, transmission and distribution.

The regulatory functions will be undertaken at central and provincial levels, while separating government oversight functions from power company management. Also power companies will be incorporated into limited shareholding companies and will adopt modern accounting and financial services. A major experiment is being carried out in Hainan Province where transmission and distribution have been incorporated into a shareholding company, several generation companies (including a wholly foreign-owned one) have been created, and a separate regulatory agency has been formed. A more ambitious experiment is under preparation for Fujian Province. The lessons from these experiments will be taken into account in designing the sector structures in other provinces.

Access to foreign technology, capital and finance has underlain the power sector policy since 1985 when the Huaneng International Power Development Corporation (HIPDC) was formed to attract foreign capital and technology for power plants located in coastal areas. HIPDC, which now operates 15 plants (5,800 MW) had a mandate to raise funds from the international financial market. HIPDC has been able to tap bilateral and suppliers' credit, and commercial bank loans, and to raise foreign equity capital through an American Depository Receipt (ADR) issue in New York.

Efforts to access foreign capital and finance have been intensified since the early 1990s when the government made an assessment that domestic financial resources can at best meet about 80 percent of the investment requirements of the power sector. The government established in 1985 two power companies—the China Power Investment Corporation (CPIC) and its wholly owned subsidiary, the China Power International Holding Ltd. (CPIH), to raise overseas funds to fill the 20 percent gap in funding of the power sector. CPIC operates under the supervision of the Ministry of Power and began work in Hong Kong in 1995. Its agenda includes floating public power plant assets in international stock markets, issuing corporate bonds, establishing power development funds, and channeling foreign investment for BOT projects.

Financing of BOT projects has been facing many challenges most of which are common with those in other developing countries. However, there have been at least two serious constraints which are rather specific to Chinese situation. First, the lack of clear legal provisions for enforcing security interests has been of concern to project financiers. Since project-based financing depends on securitization of project assets, the legal framework should enable the financiers to take over the assets in the event of a loan default. Until 1995 there was no general legal provision in China and security interest matters were treated within the context of local laws. Some of the more industrial cities had more developed legal and administrative systems governing security interests but in most locales the project security was treated within the framework of real estate mortgages and secured loans. Since October 1995, the passage of the Guarantee Law has provided a uniform set of rules governing the taking and enforcing of security interests in China. The new law should facilitate project-based financing substantially.

Second, financiers have not yet felt comfortable enough to accept provincial government guarantees without endorsement of the central government. Financiers normally seek government guarantees for political and country risks over which project sponsors do not have any control. These guarantees are normally given by the central government. In the case of power projects in China, provincial governments have become the main relevant government bodies. Thus, the central government asks the financiers to deal with provincial governments independently. There is a serious movement on behalf of the financiers to deal with the issue of political risk through other avenues (e.g., insurance) and also to work with provincial governments in China.

The way for substantial private participation was further paved by the passage of the country's first electricity law which went into effect in April 1996. The law recognizes a role for foreign participation, including direct investment in power plants through joint ventures or foreign-owned

companies, provided these investments conform to national industrial policy and are in line with the Ninth 5-Year Plan and the long-term plan (extending to 2010). The law also allows foreign loans, but not foreign investment, for setting up transmission and distribution facilities. The law will still need extensive accompanying regulation but has provided substantial comfort for private investors eager to take advantage of the world's largest market opportunity for electricity and electricity-related goods and services.

Table 3.3- Prospects for Private Power in China

### **Taiwan**

There are two major developments in the financing of power sector investments. First, Taipower is utilizing international capital markets. Second, IPPs are allowed to play a major role in the power sector. Taipower's use of international capital markets is often facilitated by the fact that Taiwan's country creditworthiness is quite high (AA-). The share of borrowing from external sources has increased from \_\_\_ percent to \_\_\_ percent during 1980 to 1995. This has been accompanied by a significant shift from bank loans to the bond market.

The discussion regarding whether Taiwan should allow IPPs into the power sector, was until 2-3 years ago an ideological matter. On the one hand, the government sought to increase the competition in the sector, and on the other hand, it was blocked by Taipower's legal monopoly status which would continue at least until 1998. There was, however, a significant turn of events in 1994-1995 when the country started to experience power shortages. The government initially granted permission to a limited participation of private sector in power generation. It then went further step-by-step to remove the limits and in effect introduce a policy of encouraging private power supply, and in particular investments in cogeneration projects. The recent policy actions include:

- a. removing the limit of 7,600 MW that the government has set for private power capacity;
- b. giving a five-year tax exemption to all private power producers and cogenerators;
- c. simplifying the procedure for approval of private power; and
- d. offering attractive rates at which cogenerators can sell power to the grid.

As a result of the new government policy, there has been a wide reception on behalf of domestic and foreign firms to invest in Taiwan's power sector. Table 3.4 contains an assessment of the capacity and the amount of investment in private power. The majority of these projects are proposed by domestic firms or by joint-ventures between domestic and foreign companies.

Table 3-4 - Prospects for Private Power in Taiwan

### **South Korea**

The method of financing power sector investments in South Korea has changed significantly over the last five years and is expected to change further in the future. The main force behind the change is the huge need for capital resources and the government's decision to limit the obligations of the government in funding new projects.

The major change of the past five years has been in the area of debt finance. While KEPCO remains a state entity it has shifted its debt financing from government-sponsored to corporate-sponsored borrowing. It has also shifted the borrowing from the foreign to domestic sources.

Until the 1980s more than 60 percent of borrowing was from external sources where official (government-sponsored) borrowing represented the main source of funding. By 1995 the share of foreign borrowing had dropped to less than 30 percent. Even with this declined share, foreign borrowing is no longer dominated by official sources. Instead almost all of foreign borrowing has shifted to commercial sources, most notably bond markets of the U.S., Japan and Europe. The internal borrowing which has now become very dominant has also shifted to a large extent to the bond market.

Table 3.5- Sources of Borrowing for Power Sector Investments in Korea

The major future change will be in the area of private participation in the power sector. Due to a recognition that KEPCO is not able to raise enough funds to build the entire capacity expansion requirements, MOTIE has announced that it will allow the private sector to build 6,250 MW of capacity for commissioning between 2001 and 2010. Foreign companies will be able to participate but will be restricted to an equity stake of less than 50 percent, requiring domestic partner(s) to hold the majority of ownership. Solicitations have been issued for bids to construct two 500 MW coal plants and two 450 MW gas-fired plants. There has been an aggressive reception on behalf of domestic private companies. MOTIE has already selected two domestic companies for the gas-based plants, and is in the process of selecting firms for the coal-based plants.

The bidding process, which was undertaken in mid-1996, has convinced the government that there is much more room to rely on private investments for meeting the power demand. Accordingly, MOTIE has proposed to the government a new "competitiveness" policy to remove current hurdles to private development of power plants. The proposal would open as much as 45,000 MW (compared with 6,250 MW in the current plan) to the private sector. According to this proposal, KEPCO's investments will be concentrated on the construction of nuclear plants while the private sector would build all other plants. The proposed policy also facilitates foreign investment in the power sector by creating a one-stop shop to handle the entire approval process. The requirement to keep the foreign share holding below 50 percent will be retained.

Table 3.6 - Prospects for Private Power in South Korea

### **North Korea**

Despite self-reliance, North Korean economy suffered seriously in the 1980's and the first half of 1990's, from a slowdown in the global economy and collapse of the Soviet Union, which represented the major source of external assistance to the country. The economic slowdown has also been due to some domestic factors, notably the poor grain harvests in the early 1990's. The economic decline has inversely affected the efficiency and reliability of energy supply. A large part of power facilities are of old and of an inefficient vintage which should have been replaced with new equipment. More generally, power systems have not been well maintained. The power-generating capacity suffers from low thermal efficiency and also low availability. The transmission and distribution facilities suffer from high losses and low reliability.

Considering the conditions of power facilities, and the state of the economy, investments in the power sector should, in the short and medium terms, concentrate on rehabilitation, retrofitting and some upgrading of existing facilities. Financing of such investments, however, would be very difficult. First, domestic financial resources are limited due to the economy's poor conditions. Secondly, external finance is not available due to the country's isolation from most of the world. Should the political situation resolve, there will be a rapid turn-around in the availability of finance as multilateral and bilateral agencies would welcome the opportunity. Nevertheless, in the absence of such resolution, KEDO will remain the only avenue for providing significant financial assistance.

However, the mandate of KEDO is limited to financing the proposed nuclear facilities. Although there is no sympathy by the development and commercial financiers to provide funds for power sector investments, there may be some sympathy on behalf of certain bilateral donors to provide assistance on a limited basis and through a "controlled channel." This is an area which is certainly worth further exploration.

## **IV THE IMPACT OF FINANCING ON THE MIX OF GENERATING CAPACITY**

The fuel mix of power generating capacity has been dictated by the governments in all the countries of North East Asia. The governments' strong will to control the fuel mix is due to several factors - economic supply of energy, security of energy supply and more recently environmental aspects of energy production, transportation and consumption. The weights of these factors in the fuel mix strategy vary significantly from country to country. However, a common feature is that the fuel mix may not remain fully under the governments' control in the future. There are two basic reasons for a freer fuel mix in the future. First, governments in the region are loosening their grips of the power sector by giving more autonomy to power companies in making investment decisions. Second, the entrance of private power producers into the sector is likely to change the incentive systems and affect the cooperative relationships which have in the past prevailed between the government and power companies. In this chapter we review the fuel mix strategy of each country and examine whether it is likely to be influenced by the emergence of new methods of financing.

### **Japan**

Almost no aspect of the Japanese energy scene involves reaction to the random events in the market. Everything is driven by the national energy strategy. Finance is no exception. Japan's fuel mix is not in essence driven by financial incentives. The mix is determined by the energy strategy. Financial support and incentives to achieve the strategy are devised subsequently.

The cornerstone of fuel-mix management is the Alternative Energy Law introduced in 1980, which was primarily concerned with security of supply, and aimed at:

- formulating targets for alternative energy;
- determining private sector role in achieving targets;
- fiscal, financial incentives for development of alternative energy; and
- establishment of the New Energy Development Corp. (NEDO).

The policy has been modified in the 1990s to pay more attention to local, regional and global environmental concerns. However, the fuel-mix targets still aim at rapid development of nuclear while emphasizing the use of clean coal technologies and renewable energy.

The supply target for fuel-mix is set by the Cabinet. The targets have consistently aimed at decreasing dependence on oil. The avenues for achieving the targets are:

- a. development of energy resources (hydro, geothermal and overseas coal resources)
- b. development of technology (nuclear, clean coal, solar, geothermal, other)
- c. promotion of specific forms of energy (diversification of fuels in power generation, financial

assistance for solar energy use in the residential sector)

d. international cooperation (both with industrial and developing countries)

In all the above avenues, there is strong cooperation between the government and private companies. Development of capacity is undertaken by private companies while some financial support is provided by JDB. The financial support and voluntary cooperation are supplemented by an effective control system. Utilities' plans for capacity expansion have to be approved by the Electric Power Development Council which ensures that these plans are in accordance with the targets approved by the Cabinet and the framework set by MITI.

Figure 4.1 - Investments in the Power Sector of Japan (1986-1995)

A major source of government support for the fuel mix promotion is the revenue collected from the "alternative energy promotion tax." This tax is imposed on electricity sales at the rate of 0.445 yen/kWh, and is intended to promote fuels other than oil. The proceeds from this tax amounted to 416 billion yen in 1995 and were spent on efficiency improvement and development of alternative energy. More than half of this budget was in effect spent on the nuclear option. In addition to 93 billion yen allocated to nuclear safety, a large part of the funds allocated to science and technology, and grants to the regions are spent on nuclear power. An important expense item is cost of securing sites for nuclear power facilities. There is a growing public opposition to nuclear power. As a result, siting of nuclear plants has become increasingly difficult. The government attempts to gain public acceptance through information campaigns as well as by payment to the surrounding communities.

Table 4.1- Allocation of Power Development Promotion Fund in Japan (1995)

Although the pattern of the fuel mix has, in the past, changed in accordance with the national energy policy, the recent market development may reduce the ability of the public-private sector cooperative system to adhere to a precise fuel mix target.

The amendment to the Electricity Law which took effect in January 1996 allows the entry of IPPs into power generation. In the first six months of 1996 about 100 bids were submitted by industrial firms to construct power plants and to sell the output to the corresponding electricity company. These bids are all for fossil fuel plants using coal, gas, and even oil. The present plan is for the government to continue to guide the fuel mix and the 10 electric companies to build the needed nuclear, hydro or other types of capacity to complement the IPP capacity and to bring the overall generation mix in line with the national energy policy. However, electric utilities will probably find it more difficult to accommodate the national energy policy because they will be operating under more stringent financial pressures imposed by competitive forces. It is important to note that IPPs are permitted to build plants of any type they wish. Therefore, they are likely to build plants which have the lowest financial cost. Over time, competition among potential IPPs would result in offering prices which fall substantially below the ceiling prices declared by the utilities. Eventually, these competitive prices would force utilities to lower the cost of their own generation. This, in turn, would shift the emphasis to minimizing financial costs rather than accommodating national energy policy.

Although the new market structure will adversely affect nuclear capacity expansion, the government is determined to continue aggressive expansion of nuclear capacity. The government support is primarily channeled through the R&D budget which amounts \$4.7 billion/year of which \$3.5 billion is spent on nuclear technology.

**Table 4.2 Government Support for Energy R&D. A Comparison between Japanese and US programs**

| <b>Sector</b>       | <b>Japan</b> | <b>United States</b> |
|---------------------|--------------|----------------------|
| Oil and Gas         | 177          | 233                  |
| Coal                | 303          | 226                  |
| Renewables          | 139          | 393                  |
| Nuclear             | 3,524        | 463                  |
| Energy Conservation | 322          | 428                  |
| Other               |              |                      |
| <b>Total</b>        | <b>4,713</b> | <b>2,914</b>         |

Table 4.2 Government Support for Energy R&D. A Comparison between Japanese and US programs

## China

The mix of generating facilities is determined within the framework of the national plan considering the viability and practicality of various options. The practicality consideration has led the power sector to a situation where 72 percent of electricity generation is based on coal, 18 percent on hydro; oil and gas contribute 8 percent and nuclear 2 percent. Coal-based power generation represents the country's cheapest option. Boilers and turbines are made in China where average cost is less than \$500 per kW compared with international prices of \$900-1000 per kW for conventional steam plants. Coal-based power generation is blamed for its local, regional and global environmental damages. However, it is generally accepted both in China and in the international community that the country has no choice but to continue to rely on coal for the foreseeable future. It is, however, hoped that there will be a serious attempt to (a) reduce the growth in electricity generation by improving the efficiency of power production, transmission and consumption; (b) expand the uses of alternative energy particularly renewables and natural gas; and (c) reduce the environmental damages of coal-based power generation by using clean-coal technologies. The shift to clean-coal technology is expected to increase the cost of coal-based power generation. Indeed, if international costs are used as the benchmark, the capital cost of coal-based plants will more than double. With such high capital costs, coal may not be the clear least-cost option, and some of the reliance may shift to other alternatives. However, the more likely event is that China will continue its heavy reliance on coal while manufacturing clean-coal technologies domestically at substantially lower than international costs. Efforts in this area have been already initiated. The use of FGD in China began in 1992 when the Luohuany power plant (2X360 MW) burning high sulfur coal in Sichuan Province was equipped with Japanese-made wet process FGD. In 1993 a domestically developed rotating and spraying dry process FGD was put into commercial operation in Baima power plant in Sichuan Province. Domestic production of clean-coal technologies is under intensive research. A joint project between the governments of China and Japan aims at developing a less expensive (compared with international costs) scrubber which is expected to be 80-85 percent effective in reducing SO<sub>2</sub> emissions, compared with 95 percent effectiveness of the wet FGD. The cost of this new scrubber is expected to be 50 to 70 percent less than the wet FGD.

Figure 4.2 - Investments in the Power Sector of China (1986-1995)

The main constraint to the expansion of coal-based power generation is likely to be the transportation bottlenecks and costs. The coal production base is concentrated in the northwest, more than 1500 km. away from load centers of central and east China. Some substantial efforts are spent on dealing with the transportation constraint. An expansion to the railway system is underway. An 800 km. coal-slurry pipeline running from Sanxi to Shandong is being built (to be finished by the end of 1997) to transport 15 million tons per year of coal crushed and made into a 50:50 percent coal/water slurry. Also, substantial reinforcement to the electricity transmission system is planned to



move power from the west to east and central regions. Nevertheless, physical transportation constraints will remain and will continue to affect the fuel mix and even fuel supply decisions. In regard to the latter China imported in 1996 some 200,000 tons of Austrian coal to fuel a power plant in Guangdong Province. Importing the coal was economically competitive with transporting coal from the north along congested rail lines.

The impact of geographical location of resources on fuel mix decisions is rather uniquely serious in China. For this reason the official fuel mix strategy calls for building coal plants in the north, hydro plants in the south and central regions, and nuclear plants along the coast.

Both in regard to the past performance and the future plans, hydro power remains the second largest option for the country. The country's hydro potentials are huge but about two-thirds of these resources are in the southwest, far from the large load centers along the coast. Long-distance transmission lines will have to cross rugged terrain before most of hydro potentials can be realized. However, government is determined to develop as much of these resources as possible. This determination is demonstrated by the fact that currently there are about 80 hydro plants under construction, and the fact that government has decided to proceed with the construction of an extremely challenging project known as Three Gorges. The Three Gorges project would involve building the world's largest dam with an estimated cost of \$28 billion and installation of 26 generating units with capacity of 700 MW each, for a total of about 18,000 MW. Target date for completion is 2009. The project has been criticized because it will displace about 1.3 million people and threaten wildlife. In May 1996, the U.S. and Japanese Eximbanks announced independently their decisions to deny financing the American and Japanese companies bidding on the project, due to concerns over the dam's environmental impact. Despite this serious setback the Chinese government is still pursuing the project. Also of some significance are small and mini-hydro projects which account for 17,000 MW of present capacity. The new mini-hydro plants would cost more than the coal option but are often suitable to supplying power in some rural areas.

Nuclear power is of quite recent origin in China. In 1983 the government approved a policy to establish nuclear capacity. The pressurized water reactor was chosen as the targeted technology. One domestically produced unit (300 MW) was commissioned in 1991 and two 900 MW generating units from France started operating in 1993. The government accelerated in 1996 its plans for the expansion of nuclear capacity. The previous target of achieving 22,000 MW of nuclear capacity which had been set for 2020 has now been brought forward to 2010. The most immediate plants are expected to consist of 1,800 MW using French technology at Lingao, 2,000 MW using Russian technology at Liaoning and 1,400 MW using Canadian technology at Qinshan.

Natural gas is not used significantly in the power sector. There is also substantial uncertainty about future gas-based plants. There are tentative plans for importing gas in the form of LNG. Although gas-based power generation would bring substantial efficiency and environmental gains, gas import schemes are quite costly and face serious financing difficulty.

Finally an important but almost untapped resource for power generation is wind power. The potential is assessed at 250,000 MW but its development has been prevented by the requirement of large up-front investments. There is some limited domestic capacity for manufacturing wind turbine equipment. This can be expanded fast but some key parts such as blades and gears have to be imported. In 1993 the government announced a plan to promote wind power. It also accepted that in the medium term the development may depend on foreign technology and capital, and provided tax incentives for importing the equipment. There is nevertheless a need for substantial financial support for expansion of domestic manufacturing capacity and importation of turbines and parts.

The new developments in the power sector, i.e., commercialization of existing enterprises and

private sector construction of some of the new plants, are likely to push the fuel mix towards coal and oil-based plants where up-front costs are smaller and payback periods shorter than other options. The government is concerned that the new business environment may jeopardize the chances of hydro and nuclear options. It has, therefore, stated that while private investors are free to investment in any fuel option, the government encourages private participation in nuclear and hydro projects. There are at least two avenues through which government will attempt to provide such encouragement. First, the government has stated a policy of generally not providing government guarantees for IPPs except in "special circumstances" where they may be needed for sharing risks to the "mutual benefit and convenience." Nuclear and hydro options could qualify for these special circumstances. Second, the government may relax its limitation on rate of return if projects achieve certain performance standards. Although the main performance standard considered thus far has been plant availability, the government has preserved flexibility in using this instrument. Again, nuclear and hydro power investments could be allowed higher rate of return.

#### Table 4.3 - The Fuel Mix of IPPs in China

The government will continue to push for a desirable fuel mix both by encouraging IPPs to undertake projects which involve longer payback periods, as well as directing provincial companies to fill the gap in the energy mix. Its task, however, will become more difficult as competitive pressures will force all the companies, private and provincial, to operate under a more stringent financial regime. The areas that are likely to fall short of targets are nuclear, hydro, clean-coal technology, and renewables.

The above areas of shortfall represent also the potential areas of significant influence by multilateral and bilateral assistance. The French, Russian, Canadian and Japanese financial assistance is likely to play an important role in the expansion of nuclear capacity. The multilateral financiers-World Bank, ADB and GEF-are likely to direct their assistance to hydro and other renewables. In the area of clean coal technology, the U.S. and Japanese firms lead the new developments. In both countries, government support has been crucial in advancing R&D and commercialization of new technologies. China offers the greatest opportunity for utilizing these technologies, and support from Japan and the United States can significantly improve the chances of widespread use of clean-coal technologies. Finally, bilateral and multilateral assistance can play an important role in implementing the government's plans to import natural gas.

#### **Taiwan**

The fuel mix of the power generation has been occasionally, but not consistently, guided by the government. In the 1960s and 1970s the government's main concern was to ensure sufficient capacity. While capacity did expand at remarkable rates (average 14.7 percent per annum), the fuel mix became heavily dependent on oil. The government's serious effort to influence the fuel mix was initiated in mid 1970s and was aimed at developing nuclear power and introducing imported coal and natural gas. As result the share of oil dropped from 67 percent in 1975 to 9 percent in 1985. Instead, the share of nuclear power increased from nil to 52 percent, and the share of coal from 8 percent to 26 percent. The fuel mix further balanced in the 1990s as natural gas took some 5 to 10 percent share in power generation.

The government's desire to keep a diversified fuel base is reflected in the power sector's long-term plan where the fuel mix in 2005 is aimed at 22 percent nuclear, 24 percent coal, 21 percent LNG, 21 percent oil and 11 percent hydro. However, the government has recently shown considerable flexibility by allowing private power producers to choose the fuel underlying their bids. Private sector, in turn, have made a large number of offers to build thermal plants but no concrete bids for building hydro projects. The government has taken a corrective action by offering a rate of up to

11/kWh for (peaking) hydro power to encourage investment in this type of plant. This compares with a rate of 3.5-4.0/kWh for thermal power generation. Another aspect of the fuel which remains highly uncertain is the share of nuclear power in the future power generation.

| <b>Table 4.4. - The Fuel Mix of IPPs in Taiwan</b> |               |                            |
|--|---------------|----------------------------|
|  | Capacity (MW) | Investments (US\$ Million) |
| In Operation:                                      |               |                            |
| Gas-Fired  | 36            | 28                         |
| Total  | 36            | 28                         |
| Project Proposals In Development                   |               |                            |
| Gas Field  | 4,233         | 3,292                      |
| Cogeneration                                       | 460           | 460                        |
| Total  | 4693          | 3752                       |
| Solicitation and Ongoing Awards                    |               |                            |
| Hydro  | NA            |                            |
| Coal-Fired   | 3,100         | 2,526                      |
| Gas-Fired  | 5,970         | 4,643                      |
| Oil-Fired  | 2,710         | 3,631                      |
| Orimulsion-Fired                                   | 3,300         | 3,300                      |
| Total  | 15,080        | 14,101                     |

Table 4.4 - The Fuel Mix of IPPs in Taiwan

Private power producers are not allowed, and perhaps not interested, to build nuclear plants. Taipower has the responsibility to expand nuclear power generating capacity but has faced serious controversy in regard to siting of the future plants. Thus, the overall trends indicate that fuel mix will be seriously affected by the new methods of funding, e.g. IPPs, and will result in an increasing share of thermal power generation.

## South Korea

The mix of generating capacity has been decided based on least-cost analysis and within the framework of the country's energy policy with usually more weight to the latter. Energy policy is very much concerned with supply security. It is aimed at reducing dependence on imported oil and diversifying sources of energy supply. Since domestic resources are limited, the fuel mix strategy has aimed at developing nuclear capacity and construction of thermal plants which use imported coal and natural gas. The emphasis among the three desirable fuels has shifted over time. In the 1970s the main emphasis was on nuclear which paid off very well in the early 1980s when international prices of fossil fuels increased drastically. However, in the second half of the 1980s, the economic wisdom of constructing nuclear plants was widely questioned and KEPCO shifted in a substantial way to power plants which would use imported coal. Also subject to question was a contract that Korea had signed with Indonesia to import LNG. There was substantial doubt about economic desirability of using LNG in the power sector.

The fuel mix strategy made a complete turnaround in the first half of the 1990s to give much more weight to nuclear and natural gas. This is based on some renewed concern over security of energy supply but more importantly on concern over local, regional and global environmental impacts of electricity generation and consumption. Plans for future capacity expansion give almost equal weight to nuclear, natural gas and imported coal.

Figure 4.3 - Investments in the Power Sector of South Korea (1986-1995)

Until very recently there was strong resistance to private sector participation in the power sector partly based on the concern that the fuel mix strategy might go out of control. Thus, the eventual decision to open up the sector to IPPs has been accompanied with a decision to reserve construction of nuclear (and large coal-based) plants to KEPCO.

Table 4.5 - The Fuel Mix of IPPs in South Korea

While the method of funding power sector investments has gone, and will continue to go, through substantial and fundamental change, the fuel mix of electricity generation is not likely to be affected by the change. The main reasons are that MOTIE has full control over fuel mix decisions, and also has under its control KEPCO as a powerful executive arm to implement these decisions.

### **North Korea**

In North Korea, the power sector's generation mix is almost equally split between coal and hydropower. The mix will shift to some 40 percent coal, 40 percent hydro and 20 percent nuclear when and if the 2000 MW nuclear reactors are commissioned. Any attempt to substantially change the fuel mix will face serious financial constraints. Even if through some international efforts the country can access external funds, investments in changing the fuel mix will not take a high priority at least in the short and medium terms. The main area of priority will be rehabilitation and retrofitting of the existing power facilities.

In the longer term, investments in changing the fuel mix could become viable but perhaps only at a marginal level. The marginal change could be based on increasing the share of hydro power. The main environmental improvement to the fuel mix is likely to materialize through introduction of clean coal technologies and improving the efficiency of power generation, transmission and distribution. The mechanisms for financial support to such improvements should be developed within the framework of the energy efficiency program which is discussed later in this report.

## **V. SUSTAINABLE FINANCE FOR SUSTAINABLE ENERGY DEVELOPMENT**

Although there is no generally accepted and practical definition for sustainable development, there is a clear framework for assessing sustainability of finance. The framework encompasses income statements and balance sheets which show whether an entity is likely to meet its operating costs and finance its investments within a financial structure which does not jeopardize its creditworthiness. These are then translated into various measures such as rate of return, debt-equity ratio, self-financing ratio, etc., which can be monitored to ensure an entity's financial health. The bottom line of all these measures is that in the long-term consumer prices should be sufficient to cover all the capital and operating costs.

The concept of financial sustainability at the sector, or even at the national level, are not far from the above concept. For example, a country's power sector will remain financially sustainable only if power tariffs would eventually pay for operating and capital costs. As such, the power utility's internal cash should constitute a significant component of investment financing. Borrowings should remain within an acceptable range and should not lead to an accumulative deterioration of debt/equity ratio.

The power utilities in the North East Asia operate under various ownership and financial regimes.

However, they have all moved towards financial sustainability by increasing power tariffs, and utilizing innovative methods of financing. Nevertheless, progress varies from one country to another. Some countries have a long way to go before reaching a sustainable state.

## 1. Projected Level of Investment and Financing Needs

Power sector investment requirement of North East Asia for the period 1996-2010 is estimated at \$1.1 trillion, representing almost 30 percent of the worldwide investments in this sector. The figure translates into an average annual requirement of about \$72 billion which by far exceeds average investments in the 1980s though not drastically higher than the average for 1991-95. This indicates that a new surge in power investment has started in the early 1990s and is expected to continue in the next 15 years.

| (US\$ million)             |              |              |               |                 |
|----------------------------|--------------|--------------|---------------|-----------------|
|                            | <b>Japan</b> | <b>China</b> | <b>Taiwan</b> | <b>S. Korea</b> |
| Generation                 | 486,900      | 189,000      | 17,674        | 68,730          |
| Transmission/distribution  | 162,300      | 81,000       | 11,492        | 62,190          |
| Total                      | 649,200      | 270,000      | 29,165        | 130,920         |
| Annual                     | 43,280       | 18,000       | 1,944         | 8,728           |
| Benchmark (1990-95 Annual) | 41,000       | 10,680       | 1,802         | 5,742           |

Table 5.1 - Power Sector Investment Requirements in Northeast Asia (1996-2010)

None of the countries in the region are able to finance the power sector investment requirements with conventional methods of financing. The need to use more innovative methods of finance has been recognized since the early 1990s and substantial shift from traditional to the new methods is under way. The new methods of finance draw upon a much wider source of funds for both equity and debt finance. On the equity side, the major additional volumes come from private sector through (a) allowing independent power producers to invest in electricity-generating facilities, (b) providing opportunity for industrial cogenerators to produce more power than their own needs, and (c) floating the shares of public utilities on the domestic or international stock markets. On the debt side, the major additional volumes come from domestic and foreign bond markets, and institutional investors.

Japan's power sector is in the hands of private monopolies. These companies enjoy easy access to relatively inexpensive funds in the domestic capital markets. Nevertheless, the government has intended to introduce more competition into the power market but has been cautious not to jeopardize the effectiveness of the national energy policy. An amendment to the Electricity Law was passed in 1995 which allows generation by IPPs. The change in the law has been received well by potential investors, who have made efforts to build almost as much as permitted by the government.

In China, the huge need for financing power investments has forced the government to commercialize power enterprises and to open the sector to private investors. Officially, the government is seeking private investment for about 20 percent of the power sector's financing needs. However, the willingness of private companies to invest in the sector has exceeded the government target. The enthusiasm has also resulted in intensive competition among the bidders. The government is likely to increase reliance on private power beyond the 20 percent target.

In South Korea and Taiwan, the corresponding national power companies (KEPCO and Taipower) were until recently viewed as efficient and competent public utilities which could also mobilize their financial needs without much burden on the government. Therefore, the need to introduce private power was not felt or justified. In the recent years, however, there has been a sharp turn of events due to the shortage of power-generating capacity to meet the rapidly growing electricity demand. In both countries, the governments turned to private sector to fill the gap. Nevertheless, the experience of allowing private sector participation has been more rewarding than initially expected. The governments of both countries are likely to make private power an important and integral component of electricity supply strategy.

|  | <b>Japan</b> | <b>China</b> | <b>Taiwan</b> | <b>S. Korea</b> |
|--|--------------|--------------|---------------|-----------------|
| Plants in operation or under construction: |              |              |               |                 |
| Capacity (MW)                              | -            | 10,087       | 36            | -               |
| Investments (\$ million)                   | -            | 9,155        | 28            | -               |
| Project proposals in development:          |              |              |               |                 |
| Capacity (MW)                              | -            | 78,083       | 4,693         | 8,705           |
| Investments (\$ million)                   | -            | 76,334       | 3,752         | 10,706          |
| Solicitations/ongoing awards:              |              |              |               |                 |
| Capacity (MW)                              | 4,292        | 68,457       | 15,080        | 2,890           |
| Investments (\$ million)                   | 3,962        | 66,615       | 14,101        | 2,942           |

Table 5.2 - Investments by Independent Private Power Producers

Aside from the contribution of IPPs and private cogenerators, the rest of investments in power generation, as well as all of investments in power transmission and distribution, will be undertaken by power utilities. The utilities will have to increasingly rely on their own internal cash for equity injection and on their own balance sheet for borrowing. The government's direct contributions which in the past represented a major source of finance in China will be minimal in the future. Instead, internal cash generation will have to improve through additional revenue and cost saving measures. Borrowing patterns indicate that Japan and Korea will continue to rely on internal sources while China will be utilizing both internal and foreign loans.

|                                  | <b>Japan</b> |             |  | <b>China</b> |             |  | <b>S. Korea</b> |             |
|----------------------------------|--------------|-------------|--|--------------|-------------|--|-----------------|-------------|
|                                  | <b>1985</b>  | <b>1995</b> |  | <b>1985</b>  | <b>1995</b> |  | <b>1985</b>     | <b>1995</b> |
| Government's direct contribution | -            | -           |  | 40           | 6           |  | -               | -           |
| Companies' internal cash         | 37           | 28          |  | 17           | 30          |  | 28              | 21          |
| Domestic borrowing:              | 63           | 68          |  | 27           | 21          |  | 23              | 55          |
| Bank loans                       | (37)         | (35)        |  | (NA)         | (NA)        |  | (9)             | (5)         |
| Bonds                            | (12)         | (14)        |  | (NA)         | (NA)        |  | (0)             | (21)        |
| Other                            | (14)         | (19)        |  | (NA)         | (NA)        |  | (14)            | (29)        |
| External borrowing:              | -            | 4           |  | 10           | 25          |  | 49              | 24          |
| Official                         | -            | (0)         |  | (8)          | (16)        |  | (48)            | (1)         |
| Commercial banks                 | -            | (0)         |  | (2)          | (3)         |  | (1)             | (0)         |

|                    |   |     |  |     |     |  |     |      |
|--------------------|---|-----|--|-----|-----|--|-----|------|
| Bond               | - | (4) |  | (0) | (4) |  | (0) | (23) |
| Other              | - | (0) |  | (0) | (0) |  | (0) | (0)  |
| Foreign Investment | - | -   |  | 6   | 18  |  | -   | -    |

Table 5.3 - - Sources of Investment Finance (%)

### Dealing with Undesirable Impacts on the Mix of Generating Capacity

The emergence of the new methods of finance will have some potential impacts on the mix of generating capacity. First, the government control over the fuel mix strategy will be reduced because of gradual deregulations. Second, IPPs will have a tendency to undertake investments which are less risky and result in quick financial payback. Third, even if state companies continue to construct a major part of generating capacity, they will be under pressure to be as cost effective as IPPs. This would adversely affect their ability to pay attention to the fuel mix targets set in the national energy strategy.

With the new financial incentives, there will be a shift from nuclear and hydro to thermal power. Within the thermal group, natural gas would be developed if available. When reaching the limit of gas availability, the emphasis would shift to coal and perhaps oil fired plants. The plant technology would be chosen to minimize the up-front investments while meeting the mandatory emission standards. Thus, the main source of power would be by default conventional coal plants while nuclear, hydro, imported gas, and clean-coal technologies would receive insufficient attention.

Table 5.4 - The Fuel Mix of Proposed IPPs in Northeast Asia

With regard to Nuclear Power, private sector would not be interested because of high capital intensity, long construction time, uncertainty regarding the time of availability and concern about public acceptance. It is particularly noted that these factors also substantially increase interest during construction. Thus, nuclear power program in each country will continue only with government support. In Japan and South Korea, governments are likely to remain in control of the nuclear program. In China, the government will continue its own support and also its attempt to mobilize support from bilateral agencies (Russia, France, Canada, etc.) In Taiwan, nuclear program is likely to experience some set back. In North Korea, there is a unique international arrangement to assist in construction of 2000 MW of nuclear capacity.

With regard to Hydro Electricity, the conventional disincentives are the high up-front investments, hydrological uncertainties and frequent cost over-runs. In addition, the recent experience in building hydro plants has proved to be much more difficult because of environmental concerns and resettlement issues. Most of the hydro candidates, particularly large ones, have continued to be postponed because of those difficulties. Any attempt to promote hydro power has to be project specific. It is generally agreed that in order to encourage private sector to undertake hydro electric projects, the government should carry out part of the preparatory work and particularly the environmental impact assessment. Among the countries in the region, China and North Korea have significant hydro potentials. Development of hydro resources in China has started to fall short of plans though still it remains impressive compared with other parts of the world.

With regard to Imported Gas, the problem arises when the existing gas supply capacity is accounted for and there is a need for importing additional gas. An IPP bidder would be eager to build gas-based power plants but would not be willing to invest in gas import facilities unless additional incentives are in place. Arranging incremental imports involves sourcing the gas supply and building import terminals. Most of the present gas import to the region is supplied by Indonesia, Malaysia, Brunei and Australia. However, most of the new imports are likely to come from the Middle East where

financing liquefaction plants are quite complex and gas buyers are expected to help in arranging the finance. Thus, investments in gas import facilities can easily go beyond the borders of importing country. The gas import option is likely to receive sufficient attention in Japan and South Korea but is likely to experience some set back in Taiwan. Also, China is now in a clear need to import gas but is facing financial constraints.

To encourage gas imports to the region, a new financial system, and correspondingly a modified bidding process, should be designed to encourage private bidders to take account of environmental benefits of natural gas and to invest in gas import and gas-based power generation.

With regard to Power Generation Clean Coal Technologies, the combustion technologies such as FBC and FGD are commercial though expensive at least in comparison to the capital cost of conventional steam plants in China. A more promising technology- integrated gasification combined cycle (IGCC) plant would provide a more economic option due to its higher thermal efficiency. However, there is not much of a track record about the performance of this technology. Two demonstration plants are operating and five new plants are under construction in the U.S. Although there is significant potential benefit in establishing demonstration projects in Asia, the Asian power utilities have resisted the idea because of the potential risks of cost over-run or operational failure. To encourage the use of clean-coal technology a financial support system either in the form of guarantees or other forms of risk mitigation arrangements, should be provided to encourage demonstration projects in the region. The target country should be China, and perhaps later North Korea.

## 1. Improving Financial Incentives for Energy Conservation

Energy conservation is the only non-controversial solution to local, regional and global environmental concerns. It is also argued that there is substantial potential for energy conservation at least in some countries of the region, notably China and North Korea. Nevertheless, energy conservation is not easily achievable. Indeed, many economist have argued that conservation should be achieved only by appropriate energy pricing. The counter-argument, however is that:

- a. energy prices are in some countries - largely subsidized and do not reflect the full cost of supply;
- b. even if prices are raised to cover the cost, they still do not reflect the full social cost (including the cost of environmental externalities);
- c. furthermore, imperfections in the capital market and deficiency in the availability of information result in under-investment in energy efficiency.

The countries in the North East Asia have taken energy conservation seriously. The extent of the seriousness and the strength of the program vary from one country to another.

In Japan, energy conservation has been by all accounts a success story and can provide very useful lessons for other countries. Energy conservation is an integrated part of the national energy policy. It covers all industrial and commercial activities as well as residential use of energy. Conservation efforts are supported by an extensive Research & Development program. Economic and financial incentives provided to promote energy conservation include low interest loans from the Japan Development Bank, preferential tax treatments, R & D subsidies, and low interest housing loans for the residential sector. These measures have been quite instrumental in improving the efficiency of production processes and developing new more efficient technologies. However, the more important factors are (a) a public conviction that energy conservation is essential for the survival of the economy and the nation; (b) genuine close cooperation between the government and private sector



in formulating and implementing the program; and (c) a well-disciplined system of checks and balances which encompasses the national objectives (economic progress and environmental safety) and monitors the progress. It is also useful to consider that Japan has now adopted a policy of assisting other countries in the design and implementation of energy conservation programs. Assistance may be provided by not only the Japanese government but also by private companies. Keidanren (Japan's Federation of Economic Organizations) is discussing, on behalf of major private companies, with the international organizations the practical means of assisting in transferring energy conservation technologies to the developing countries.

In China, energy conservation offers significant potential gains in both economic and environmental terms. It is also evident that the country has made great progress in improving energy efficiency over the past 10 or 15 years. This progress has been largely based on a strong government role and through physical quota systems, financial support, R & D, information dissemination and staff training. Also, economic reforms have encouraged energy conservation by transmitting to the users more realistic and effective price signals. Ironically, however, the same market reforms have caused a gradual dismantling of a rather solid energy conservation program. The physical monitoring system has become ineffective because the government has lost its strong control over fuel allocation. Financial incentives have been mostly eliminated in the new tax code introduced in 1994. The government has reduced its R & D support as part of reducing its role in energy supply. Training, known to be a very effective program, receives less support, again for the reason that government is leaving matters to the market. At the same time, private companies do not pay much attention to energy conservation because either energy does not represent a large proportion of their operational cost, or because investments in energy conservation do not pay back as quickly as other investments in the country's economic activities. In short, the energy conservation program in China is seriously threatened by the emerging trends. It is generally recognized that the system has to be redesigned to fit the market-based decision-making process of major energy consumers. The challenge is to redirect the program before it loses its powerful ingredients. A relatively large aspect of this challenge translates into developing financial regimes which can effectively encourage energy efficiency in the transitional state, as well as in the eventual market-based economy. A promising start for investigating the matter would be to try to combine the experiences of Japan and the U.S. in this area. While the Japanese experience allows for a close cooperation between public and private sector, the U.S. experience provides examples of institutional set-ups for financing energy efficiency in a free market environment.

In South Korea, energy conservation is addressed within the framework of the national energy policy. The conservation program covers a wide spectrum of activities including energy audits, support of demonstration projects, R & D, information dissemination and training. Although accomplishments at the micro level have been quite impressive, the overall level of energy intensity in the economy as a whole, and in the industrial sector in particular, has not responded well. Energy intensities have not declined since 1980. Nevertheless, the energy conservation program continues to receive public attention and government support.

In North Korea energy efficiency is quite low due to a host of institutional and technical factors. Opportunities for significant efficiency gains have been identified in almost all aspects of demand and supply of energy. It is in particular evident that energy efficiency can be significantly improved by rehabilitation and retrofitting of existing power equipment and industrial facilities. These improvements are expected to be very cost-effective. Nevertheless, the required investments are not undertaken because of institutional, technical and financial constraints. In all of these areas, international assistance can play a very effective role. The cooperation can be of mutual benefit because energy conservation fits into the philosophy of self-reliance to which North Korea adheres religiously, and offers significant potentials for reducing regional and global environmental damage

which appeals to many countries in the international donor community.

## 1. Prospects for International Cooperation

There are excellent prospects for cooperation in dealing with the financial matters in the energy sector of the region. These prospects are all based on synergies which can be utilized to benefit all sides. The most immediate and practical prospects are in the areas of (a) encouraging natural gas imports; (b) commercializing clean coal technologies; (c) improving financial systems for energy conservation in China; and (d) assisting power sector rehabilitation in North Korea.

**Encouraging Natural Gas Imports.** In this area Japanese assistance can provide significant improvement. Japan has now expanded its concerns for energy security, and environment beyond its borders and to the whole of the region. Accordingly, it is ready to provide financial support to projects which are beneficial in either terms. Natural gas import projects have been recognized as candidates which would serve both purposes. Thus, the Japanese government is willing to extend support to such projects. The support can be provided by the Japan Exim and Japan National Oil Company, both of which have substantial financial resources to allocate to this matter. The potential for cooperation in this area is further strengthened by the fact that Japan dominates the LNG market and has a considerable comparative advantage in materializing gas import ideas.

There is need for additional research to develop financial incentives to encourage gas imports. The research should cover (a) the possibilities that Japanese assistance can lead to sustainable effects, and (b) the changes to the IPP bidding procedures which would encourage investments in gas imports.

**Commercializing Clean-Coal Technologies.** This is an area of great interest to the U.S. and Japan. Both countries have spent substantial resources on R & D and private sector support for the development of the new technologies. However, the use of these technologies has remained limited, particularly in developing countries, due to uncertainties about construction schedules, construction costs and operating performance. The power utilities in the developing world have preferred to wait until a track record is established. At the same time these countries, particularly those in Asia offer the greatest market potential for using the clean coal technologies. It would therefore be of significant commercial interest to the U.S. and Japan to establish some type of comfort in using these technologies. The comfort can be created if some utilities start to utilize these technologies, perhaps with an initial financial encouragement.

There is a need for additional research on structuring guarantee instruments for reducing risk in adopting clean-coal technologies. The research should cover (a) an exploration of the possibilities of cooperation between the US and Japan in marketing the technologies, (b) an assessment of the amount of risk which should be mitigated, (c) development of a guarantee instrument to mitigate the risk; and (d) the possibility of building a US sponsored demonstration project in China.

**Supporting Energy Conservation in China.** Prospects for international cooperation are in two areas. First, a combination of the Japanese and U.S. experience in energy conservation can provide a very effective approach to dealing with the situation in China. Japan has established an exceptional track record in achieving energy efficiency through close public-private sector cooperation. U.S. is leading in the area of institutional innovations for encouraging energy efficiency within a free market framework. Secondly, the significant potential gains from energy conservation in China offer perhaps the most cost-effective prospects for reducing green-house gas emissions. In addition to their general appeal to many countries in the world, these prospects can be utilized within the framework of Joint Implementation to implement select activities with clear CO<sub>2</sub> reduction

advantage. Finally, another source of international assistance is the Global Environmental Facility (GEF) which already provides substantial support to certain conservation efforts in China.

There is a need for additional research on redesigning the financial incentives for energy conservation in China. The research should cover (a) an assessment of applicability of Japanese and US experience, (b) development of a revised financial system which can function in a free market environment, and (c) the interest of the donor community to finance selected activities.

**Supporting Power Sector Rehabilitation in North Korea.** Potentials for energy efficiency improvements in North Korea are widespread in the power sector, industry, and household use of energy. Although there is substantial room for international assistance in all areas, it would be more effective to concentrate at the first stage on the power sector because projects are more specific and can be monitored more effectively. These projects would involve rehabilitation and retrofitting of power plants and transmission lines which would result in immediate economic and environmental benefits. The international donor community could be receptive to providing assistance on the grounds of regional and global environmental benefits.

A program of international assistance is already in place for the specific purpose of building 2000 MW of nuclear capacity. This program is based on a 1994 framework agreement in which North Korea agreed to freeze its nuclear program in exchange for two new light-water reactors (which are considered less capable of producing weapons-grade plutonium) and 500,000 tons/year of heavy fuel oil to meet the country's energy needs until the new reactors become operational. The Korean Peninsula Energy Development Organization (KEDO) was established to implement the agreement. The founding members of KEDO were U.S., Japan and South Korea. Some other countries (including Canada, Finland, Indonesia, New Zealand, Argentina, Chile and Australia) now have joined the membership and the European Union is negotiating to join the Organization.

KEDO would be a candidate for providing further support to North Korean power sector in a bit of more general framework than its current mandate. The danger, however, would be that some of the current focus may be lost. This is particularly important from the point of view of the Organization's members who have joined to support a very specific project.

Another option would be to create a new ad hoc international organization (similar to KEDO) for the specific task of supporting power sector rehabilitation in North Korea. The advantage of an ad hoc organization over an established international institution is that the agenda will be set and members will join if they wish to support the agenda.

There is a need for additional research on preparation for the formulation of an ad hoc international financial agency to provide assistance to rehabilitation needs of the energy sector in North Korea. The research should cover (a) the interest of the donor community to support the cause, (b) the option of expanding the mandate of KEDO, and (c) the viability of creating a new ad hoc agency to serve the function.

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