INFRASTRUCTURE DEVELOPMENT AND FINANCING

A Comparative study of Infrastructure in India and China
With focus on the Power Sector

A Project Report

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On

September 5, 2000

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Abstract

This report aims to make a comparison of the Chinese and Indian power sector in terms of progress and reforms they have made to deal with their increasing demand requirements. The comparison of India was made with China because, India, when just independent, was much similar to China in terms of demographics and infrastructure availability. The power sectors of both the countries are studied and the differences are probed into. Much of these differences come in as a result of the way in which reform bodies were instituted and the reforms were carried out in both the countries. China has surged far ahead of India in its quest to satisfy the demand for power. Through this study, the authors wish to draw out the underlying methods through which China has achieved considerable success in power sector reforms. There are four ways in which China went ahead of India and which can be replicated in India. These are the way in which the power monolith was broken down in such a way that there was coordination among various bodies concerned, the way in which various projects were financed and approved through BOT, the way in which China has been emphasizing on production and conservation of power efficiently through market based incentives and the way in which it has been sensitive towards environmental issues by research and adoption of clean, less polluting technologies. The authors feel that these are the significant learnings, which one can take home and apply in India.

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1. Introduction

The East Asian region including China and India is projected to experience stronger growth in electricity consumption than any other region of the world. Total electricity consumption is projected to grow by more than 3 trillion-kilowatt hours between 1995 and 2015, a growth rate above 5 percent per year[1], with China alone accounting for more than half the growth.

The projection of electricity demand growth is driven largely by economic expansion in the region, where GDP is expected to increase by 6 percent annually. Again, China is the leading source of the growth, with an expected annual GDP growth rate of about 7.3 percent. Coal remains the dominant fuel for the region's electricity generation. The relative shares for oil and nuclear power are expected to decline, while natural gas and renewable (principally hydropower) are projected to increase in importance. Both China and India are more heavily dependent on coal for electricity generation than are the other developing Asian nations.

China has been a role model, among the developing countries, in carrying out reforms in various sectors in infrastructure. At the time of India's independence, India and China were at par with respect to overall infrastructure development. Now China's per capita consumption of steel[2] is five times that of India and that of energy if three times. The success of reforms in the power sector in China paves the way for India in understanding the formulation and implementation issues relating to the same. China is a very relevant case study for India because of various similarities viz. population, size, demographics.

2. Objective and Scope of Project

The project entails a comparative study of the power sector in two of the largest developing countries in the world. By carrying out this study the group has attempted to identify successful policies adopted by the Chinese government and analyze the

[1] Asian Energy Futures Event Report (IV): *The Here and Now of Asian energy*
[2] Per capita consumption of steel and energy are considered good measures of the level of infrastructure development in a country.

possibility of replicating any model followed by China. This includes studying the modalities of reforms as envisaged by the Chinese government, and seeing if a similar approach to power sector reforms can be implemented in the Indian scenario.

3. China and India – A Comparison

China and India have similar socioeconomic characteristics but distinct political setups. Unlike other emerging economies, these countries also constitute two huge, unexplored markets for consumer products. They are hence of immense interest to the global manufacturing and finance sectors. India is currently undergoing a phase of radical economic and political liberalization. However construction, maintenance and management of transportation infrastructure are expected to remain under the government for some time to come. Agriculture has remained a critical aspect of both the economies. It is still the traditional source of livelihood for the great majority of the population.

A major development in both these economies has been structural change and diversification. Since the 1960s the growth in industry and services, with a concomitant decline in the agricultural contribution to gross domestic product, has been conspicuous.

Table 1 compares the key socioeconomic indicators of China and India. Both these countries have populations almost four times that of the US. Per capita income and vehicle ownership levels in India are better than China but far lower than the US. The growth rates of GDP, industrial production and energy production are characteristic of the emerging economies. China is ahead of India in growth rate of GDP since it had a head start and is much deeper into the reform process.

In both these countries economic development was stimulated by colonial rule, which provided improvements in transportation and communications, administration, health care, and the exploitation of agricultural and mineral resources. Too often, however, such development produced a reliance on a limited number of commodities that were tied to the fluctuating world market prices. In addition, political systems and ideological policies, as well as internal conflicts have shaped the economic development of these two Asian giants.

4. The Power Sector

From 1995 to 2015, a near doubling of the world's total annual electricity use is expected, with about half the increase coming from the developing world. Dramatic structural changes are occurring in electric power industries around the world.

4.1. Industrialized Countries versus Developing Countries

In the industrialized world, increased demand is fueled by economic growth and growing power requirements for appliances like computers, communications, and other electronics for home and business uses. This demand growth is tempered by increases in energy efficiency brought on by regulation and technological innovation. Nonetheless, the industrialized world is expected to contribute about 3.7 trillion-kilowatt hours to the total increase of 8.6 trillion by 2015[3].

In the developing world, there are many opportunities for the expansion of electrical applications. The marginal benefit of introducing electricity into a rural village is considerable. High value-added applications such as refrigeration and communication are the reasons that providing electricity to the larger population is high on the priority lists of most of the leaders of the developing world. As countries such as China seek to electrify their rural communities, the demand for new capacity is projected to be large. About 4.3 trillion kilowatt hours of the projected total increase of 8.6 trillion kilowatt hours in world electricity generation is expected to come from the developing world where 1995 levels were about 3 trillion kilowatt hours.

In many parts of the world, financial capital may be a greater resource constraint than primary energy supplies. It has been estimated that over the period 1993 to 2010 investment to sustain the power generation infrastructure will require from 0.1 to 0.2 percent of gross domestic product (GDP) in the industrialized countries, 0.6 to 1.1 percent of GDP in China, and as much as 1.0 to 1.6 percent of GDP in India[4].

The market trends described above are developing in the midst of dramatic structural changes in the electric power industry, which have implications for every region of the world. In the industrialized world, restructuring of electricity markets is

[3] International Energy Annual, 1998

[4] www.worldbank.org

seen as a way to enhance competition, bringing market forces to bear for the benefit of consumers. In the developing world, privatization is seen as a way to attract foreign capital for investment in the energy infrastructure while preserving public capital for other important projects.

The structure of primary fuel use for electricity generation differs considerably among the various regions and countries of the world (Table 2). In the industrialized countries, with the notable exceptions of Japan and France, the projected trend is away from nuclear power and toward natural gas. Coal-powered generation is projected to decrease in fuel share percentage while increasing in absolute terms by almost 6 quadrillion Btu. Renewable power generation, principally in the form of hydropower, is projected to increase in industrialized countries (such as Canada and Japan) that still have unexploited resources. In other parts of the industrialized world, including the United States, renewable generation is expected to remain flat. The net result is that renewables are projected to increase from about 22 percent of the electricity generation market in 1995 to 25 percent in 2015 for the industrialized countries taken as a whole.

In the developing world, with its great demand for new generation capacity, the fuel picture looks quite different. Consumption increases are projected for all the fossil fuels: the use of oil for electricity generation grows from 4.9 quadrillion Btu in 1995 to 9.4 quadrillion Btu in 2015; gas use rises from 4.7 to 12.2 quadrillion Btu; and coal shows the greatest increase, 16.7 to 38.0 quadrillion Btu, with large gains in China and India. Renewable generation is also projected to grow substantially, from 9.6 quadrillion Btu in 1995 to 15.8 quadrillion Btu in 2015[5].

The increase in coal-fired generation in the developing world is offset to some extent by a decrease in the EE/FSU region, from 6.6 quadrillion Btu in 1995 to 5.4 quadrillion Btu in 2015. The other fossil fuels are projected to rise in share worldwide, and nuclear generation is projected to drop slightly, as less capital-intensive generation (i.e., natural gas) is substituted for nuclear as well as coal. Renewable generation is projected to rise by about 33 percent, from 3.1 to 4.1 quadrillion Btu.

[5] World Energy Market Analysis**,** Compiled by Craig P.B., May 26, 2000

4.2 Emerging Issues

Many changes in the power business worldwide are in the early phases, accompanied by the inevitable trials and tribulations associated with any new regulatory regime or market structure[6]. There appear to be several simultaneous occurrences that have led to the far-reaching changes in world markets for electricity.

The emergence of natural gas as a fuel for electricity generation. Worldwide, natural gas is expected to grow from 16 percent of fuel consumed for electricity generation in 1995 to 23 percent in 2015. Although coal is projected to remain the dominant fuel, projections of ample natural gas supplies and relatively low prices have made it the preferred fuel for many independent power producers around the world. The relative modularity of gas turbines as compared with coal plants, in combination with their low initial capital outlay, gives them advantages in a marketplace driven by competition rather than cost of service regulation, as competitive markets tend to favor lower risk, less capital-intensive investments.

Lower transaction costs associated with power trades. While there is little likelihood of a worldwide grid system, there are ample opportunities for regional electricity trades. Canada, the United States, and Mexico as well as the countries of Europe have been engaged in active electricity markets. Within countries, wheeling (the transmission of power across common power lines from one independent entity to another) is on the rise. Consequently, electricity prices are likely to become more homogeneous from one adjacent region to the next as consumers seek out least-cost sources of power.

Rethinking of large-scale projects such as nuclear power in electricity generation markets. As public opinion, regulatory pressures, higher construction costs, and waste storage problems changed the nuclear power scenario, many new opportunities for smaller scale technologies, such as natural gas, arose. Environmental concerns could hurt the economic attractiveness of other nonrenewable, large-scale generation technologies particularly, coal. Less centralized power technologies, such as natural gas and small-scale renewables, could benefit from tighter environmental controls, especially if new large-scale hydropower projects are found to have undesirable

environmental impacts. These developments could be of particular significance in the developing world, where small-scale renewable generation may be the most cost-effective way to bring electricity to remote villages that are not near transmission lines.

5. The Chinese Power Sector

5.1 Background

The electric power industry occupies an important position in primary energy consumption, and tends to increase its energy demand as economic growth progresses. China has the world's fastest growing electric power industry[7]. Yet, the Ministry of Electric Power estimates that about 15-20 percent of the country's electricity demand is not being satisfied. One-tenth of China's population, or roughly 100 million people, is currently without electricity. Per capita consumption in China is currently only 6% that of the United States.

5.2 The Demand – Supply Situation

Strong projected growth in electricity demand in China results from two factors.

- Increased need for rural electrification. Although nearly 90 percent of the rural households in China had access to electric power at the end of 1993, some 120 million people were still without electric power. The Chinese government plans to increase electrification to 95 percent by 2000.
- The Chinese government is working to keep electric power growth in line with economic growth. To date, China's industrialization programs have not invested adequately in the electric power industry, resulting in shortfalls. China's annual average ratio accounted for only 1.24 percent of GDP from 1980 to 1993[8]. Hence, China is heavily investing in power projects.

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[6] International Energy Annual, 1995
[7] www.eia.doe.gov
[8] According to the World Bank, the proportion of investment in the electric power industry in developing countries should be more than 2 percent of GDP.

Growth in electricity generation averaged 8% per annum during the last 15 years. Nonetheless, electricity supply did not keep pace with growth in demand. Most areas of China suffered from severe power shortage. As a result of the current financial crisis in Asia and the rest of the world, electricity growth has slacked, and most industrialized areas even seem to be experiencing a surplus.

5.3 Energy supply options

China's installed power generating capacity was 250 GW in 1997 of which 77% was thermal and 23% was hydro[9]. Nuclear capacity occupied only a fractional share of the total power generated (Table 3).

5.3.1 Thermal power

Coal-fired power plants provide more than 90% of thermal generation, with oil based generation accounting for most of the balance. The share of natural gas-based power generation is negligible and is expected to remain so even if the country succeeds in implementing its challenging gas import projects.

The power sector's use of coal amounted to 370 million tons in 1996, which is more than one-third of the total coal consumption in the country. The amount of coal used in the power sector is large not only because of the huge size of thermal power generating capacity, but also due to the relatively low thermal efficiency of the existing plants. Although government policy emphasizes the addition of larger, more efficient units of 300 MW and 600 MW, over half of the existing capacity is still in units below 200 MW. Only 15% of installed capacity are in units of larger than 300 MW, compared to 60-80% in industrialized countries. Also of serious concern is that many of the new plants being built by the local governments are in unit sizes of 50 MW or less. The main reason is that these small units are easier to finance. At the same time, these units consume 60% more coal per unit of electricity produced compared to units of 300 to 600 MW.

[9] www.eia.doe.gov

5.3.2 Hydroelectric power

Hydropower is the least-cost generation source in China. It serves, and will serve, a major role in meeting the base-load power generation needs of the country. The generation cost is about $0.03 / kWh. China has the greatest hydropower potential in the world; however, the location of this potential relative to markets and the environmental concerns associated with large projects could limit hydropower's contribution to China's electric generation needs. The country has a hydroelectric potential of 670 GW, of which 380 GW is considered suitable for exploitation. This capacity may generate up to 1900 TWh per year. By the end of 1996, 56 GW of installed hydro capacity were in operation, reflecting approximately 14.7 percent of the exploitable resource. The installed capacity is expected to increase to 100 GW by 2010.

The Three Gorges project on the Yangtze River involves construction of the world's largest dam, with its 26 hydropower generating units (700 megawatts each) slated to provide a total of 18 gigawatts generating capacity by 2009 (Table 5).

5.3.3 Nuclear power.

Nuclear power represents a relatively minor, but growing, share of China's electric generating capacity, with two plants currently in operation: Qinshan at Hangzhou Bay in Zhejiang province (288 megawatts) and a plant at Daya Bay in Guangdong province (1812 megawatts). China has plans for 9 additional units, totaling 8 gigawatts. By 2015, output from nuclear plants is projected to increase 9-fold over 1996 levels, accounting for about 4.5 percent of China's electric power generation. Under construction are two 600-megawatt units at the Qinshan plant and two 1,000-megawatt units at a new plant, Lingao, near Hong Kong.

In addition, industrial co-generators produce significant amounts of electricity for which only limited statistics are available. In energy-intensive process industries such as chemical, steel, refineries, and mining/minerals, it is typical for plants to generate their entire internal electric requirements and to export excess electricity to the local community.

5.4 Energy Consumption Projections for China

If electricity demand grows, as expected, at 8 to 9% per annum, China would need to add about 18-20 GW of capacity per year[10]. The World Bank has re-examined the demand growth in light of the Asian financial crisis and concluded that electricity consumption will continue to grow at about 8% in the foreseeable future. Even with a growth rate of 7% (low-case scenario), the growth in China's power generating capacity will be about 16 GW per year. This still accounts for more than 20% of the world's new capacity. Under the base-case scenario, the projected mix of generating capacity indicates that the share of thermal power will remain stable at about 75-78%. This translates into an addition of about 15,000 MW/year to thermal capacity or an investment of approximately $15 billion/year in thermal power. More than 90% of this investment will be directed to coal-based power generation.

Given the projected huge increase in overall energy usage by 2020 (162 percent), a massive investment in energy infrastructure for natural gas, nuclear, hydroelectric (e.g., Three Gorges Dam project), and other renewables is a must.

The biggest driver by far for China over the next generation is the more than five-fold increase predicted in electricity consumption (956 billion-kilowatt hours in 1997 to 3,450 in 2020). By 2020 China will be consuming as much electricity as the U.S., although the latter will achieve that level through a modest 33 percent increase over the 23-year time frame.

During the period 1977-1994, the share of electric power consumption in total final energy consumption doubled, and the amount of electric power consumed doubled over the period 1985-1994. It is almost certain that electric power consumption will grow at a rate greater than that of final energy consumption as the process of economic development continues. With increases in electricity demand, the amount of primary energy consumed by the power generation sector also continues to rise.

The large annual increases in energy demand in Asia will most likely be met by rapid increases in coal and oil imports. In 1992, China was a net oil exporter, but it is expected that by 2010, China will become the second largest importer of oil in Asia. Similarly, the ASEAN 6 countries (Thailand, Malaysia, Singapore, Indonesia, Philippines and Brunei)

[10] www.eande.lbl.gov

were also net oil exporters in 1992, but are expected to be importing an amount of oil equal to South Korea by the year 2010.

6. The Indian Power Sector

6.1 Background

Since independence India's power sector has grown many fold in size and capacity. Generating capacity has increased from a meager 1342 MW in 1947 to more than 91000 MW till 1998. India's per capita energy consumption is projected to grow from 6.2 million Btu in 1980 to 18.2 million Btu in 2010 -- a rise of almost 300 percent. Although, India's energy consumption per unit of output is still rising, but it is expected to level off and to decline in the future. India consumes two-thirds more energy per dollar of gross domestic product (GDP) as the world average. India consumes only about 18 percent of the energy per person as the world average.

6.2 Demand Supply Situation

The power sector has been characterized by shortage in supply vis-à-vis demand. From 1998, there has been peaking shortage of 18% and energy shortage of 12%[11]. One of the reasons for this has been that the addition of capacities below demand. The transmission and distribution losses in India are among the highest in the world. Against the normal world average of 8-10%, the figures have been about 23%, which is alarmingly high.

6.3 Energy supply options

Coal currently accounts for 78% of fuel use at India's electric power stations. As in China, India's high coal use is a reflection of its ample coal reserves. Renewable energy (almost entirely hydropower) is the next largest source of electricity supply in India. In 1995, renewables accounted for 14% of India's electricity generation. Natural gas (at about 5%), oil (at 2%), and nuclear energy (at just under 2%) provided the remaining

[11] www.indiacore.com/power.htm

fuels to India's electricity industry. In the forecast, a growing role is projected for natural gas, nuclear, and renewables at the expense of coal and oil.

6.3.1 Wind power

A wind-energy rush began in 1994 as the government opened up the power grid to independent developers and offered tax incentives for renewable energy development. Indeed, India is now second only to Germany in the number of annual wind-power installations. By early 1995, some 300 megawatts of wind power were in place, much of it resulting from joint ventures with European and U.S. manufacturers, some of whom are building assembly plants in India.

6.4 Energy Consumption Projections for India

Electricity demand in India is projected to grow dramatically over the next 20 years. With about 6 percent of total world coal reserves, India, like China, relies on coal for much of its energy supply. Although coal's share of India's electricity generation is projected to drop slightly, from 77 percent in 1995 to 64 percent in 2015, the dramatic increase in total generation implies substantial growth in coal-fired capacity. In addition, the contribution of natural gas in electricity generation is projected to rise from only 4 percent in 1995 to 12 percent by 2015[12].

7. Power Sector Reforms

Many countries are currently working to create more competitive environments for electricity markets in order to promote greater efficiency. These efforts affect regulation, industrial structure, and ownership.

7.1 Regulatory and Structural Changes

Regulatory changes can lead to the elimination of monopolies and reduction of governmental intervention in the electric power industry. Reforms include the reduction of price controls and tariff restrictions and the elimination of subsidies. Structural changes are characterized by the division of the industry into its three major functions--

[12] www.indiainfoline.com

generation, transmission and distribution--and a commitment from governments to ensure that independent producers and other power-related enterprises will have full and fair participation in each of these functions. Ownership trends include an emphasis on privatization and commercialization to attract private capital from foreign and domestic sources.

7.2 Privatization

Many non-OECD countries facing high electricity demand growth favor privatizing their electric power sectors and opening their markets to foreign firms[13]. This approach can free up large amounts of public capital, which can be used instead for social programs. In addition, private ownership allows managerial accountability, market efficiency, and better customer service while reducing government deficits and international debt.

The reasons for electric utility privatization are numerous and vary from country to country.

Some of the more evident reasons include the following:

- Raising revenues for the state through asset sales
- Acquiring investment capital
- Improving managerial performance
- Moving toward market-determined prices
- Technology transfer
- Reducing the frequency of power shortages
- Reducing the cost of electricity to consumers through efficiency gain
- Taking advantage of creating national and regional power grids, and
- Re-thinking whether electric power generation in today's economy constitutes a natural monopoly.

Privatization of formerly state-owned electric power assets in developing countries has opened up enormous investment opportunities. For foreign investors, investment in overseas electricity assets offers opportunities to achieve potentially higher returns and, in many cases, to realize greater growth opportunities than are available at home.

[13] www.oecd.org

The financing of power projects around the world has changed in recent years. Non-private sources of investment funds have grown increasingly scarce, and the critical role such publicly financed institutions, such as the World Bank, have played in financing electrical projects has diminished significantly. However, several new entrants in financing of overseas electric power investment have recently emerged--particularly in the area of equity finance. Some of these new sources of capital include the world's major petroleum companies, natural gas pipeline companies, electric utilities, and also some of the world's major construction and power equipment manufacturing companies.

There are a number of ways to privatize electric power. One involves the sale of state-owned electric power assets. Another involves allowing less restricted or unrestricted investment in new power assets--the independent power project. Arrangements whereby a foreign company builds a power unit and operates the unit for an agreed-upon number of years before transferring ownership to the host country has been another important vehicle for financing electric power. This latter investment arrangement is commonly referred to as a build, operate, transfer agreement, or BOT. In several nations, rate reform has also played a critical role in encouraging such non-utility electric power investments.

In several cases privatization has involved foreign utilities purchasing one or more utilities in other countries. Some privatization efforts have involved consortiums of foreign and domestic companies. Joint ventures with host nation companies have been another avenue of privatization. In other cases, foreign companies or investors have purchased shares in newly privatized electric utilities. In a few cases, recently privatized companies have acquired ownership interests in other recently privatized companies.

8. Power Sector Reforms in China

The Chinese Ministry of Electric Power (MoEP) began reorganization in the spring of 1996. By the following March it had been completely dismantled. Along with many other ministries, its commercial and regulatory functions have been divided and now rest in the hands of several different Chinese organizations[14]. The details and functions of these organizations as explained below:

[14] www.strategis.ic.gc.ca/SSG/ea01757e.html

8.1.1 State Power Corporation of China (SPCC): As part of the Chinese Government's efforts to "separate government functions from enterprises" the SPCC represents a wholly state-owned investment that controls approximately 80 per-cent of all power assets in China. Through a large number of exclusively owned subsidiaries, SPCC is arguably the largest utility in the world. Encouraging the localization of production is this market has been a key objective of the Chinese Government. SPCC's Main Duties in this Respect are:

- Formulating China's electric power development strategies, legislation and policies, including investment policy, technical policy and major energy production and consumption policies.
- Formulating unified energy industry planning in collaboration with the State Development Planning Commission and other governmental agencies like CEC.
- Supervising the implementation of related national policies, decrees and plans.
- Providing services to regional and provincial electric power enterprises.

SPCC has, over the past year undertaken to change the skills and the focus of the personnel in its ranks. Previously heavy with engineers and other technical personnel, SPCC is actively seeking a more commercial and business oriented employee. While SPCC theoretically no longer has any government approval or regulatory roles, it is clear that they are the implementing body for many power-related decisions by the Central Government. In a move designed to protect domestic manufacturers of power equipment SPCC announced that they would no longer allow for the importation of foreign manufactured equipment for use in conventional, coal-fired power plants of 600 MW and below.

It is intended that the regulatory functions of SPCC will be gradually taken over by the China Electricity Council and other government bodies. Eventually, SPCC will be a commercial entity that invests in and operates projects in the power industry, supervises the transmission of electricity nation-wide, and governs the country's trans-regional power network. The restructuring is intended to advance reforms and help to make the transition from central planning to a market economy. It is expected that similar restructuring measures will be adopted for the existing regional and provincial power administrations.

Under the SPCC, there are two other entities, which have administrative functions. *China Power International (holdings), LTD.*, is responsible for tapping the international markets and raisings funds for power projects. *China Power technology Import and Export Company (CPTIEC)*, is a share holding company that deals with importers of power equipment and also plays a role in exports as the largest Chinese overseas power project contractor

8.1.2 State Development Planning Commission (SDPC): A Chinese "super ministry" it sits just below the State Council and acts as the foremost strategic planning agency for infrastructure development in China. Although there has been significant shifts in responsibilities since March, 1998 National People's Congress, SDPC should still be considered the most important approval body for foreign invested power projects in China. The office within SDPC with primary purview for the financing of infrastructure projects is the Department of Foreign Capital Utilization. SDPC will normally not become involved nor its approval, be required for power projects with an investment of less than $30 million. Depending on the profile of a particular project SDPC can, however, become involved in the review of a project regardless of the level of investment.

In the past, some foreign-invested ventures have attempted to "break-up" a large project into chunks of investment of less than $30 million in order to avoid the more time consuming task of coordinating with SDPC. SDPC has taken a dim view of this tactic and in some cases this has led to further and more serious complications.

8.1.3 State Economic Trade Commission (SETC): Another "super ministry," SETC has greatly expanded responsibilities following the 1998 reorganization. Most of the defunct ministries now report to the SETC leadership as independent bureaus. Former members of the Ministry of Electric Power formed the basis for the Electric Power Bureau of the SETC. During early interviews with personnel from this bureau, they described a rather far-reaching mandate for the regulation and monitoring of the power industry in China. In a practical sense, however, most foreign firms doing business in this sector have had little or no dealing with this organization.

8.2 China Electricity Council:

China Electricity Council (CEC)[15], which was founded with the approval by the State Council in 1988, is the leading agency of all China's electric power utilities and a non-profit social and economic organization. It's aim is to represent the interests of all China's electric power utilities, reporting their opinions and requests, providing to the electric power utilities with various forms of services and bridging the government and utilities to promote the development of China's power industry. It will slowly take over, as mentioned before, the functions of SPCC.

Under the council there are 10 function departments and 8 economic entities. Also more than 20 societies and associations, such as Chinese Society for Electrical Engineering, Chinese Society for Hydroelectric Engineering and China Electric Power Enterprise Association etc., are under it's direct leadership.

8.2.1 Main Functions

- To organize and conduct technical exchanges on power production, capital construction, education and training, management and introduction of new technique.
- To organize studies and investigations in the field of electric power industry, and to solve big issues so as to push forward the technical innovations in China's power industry.
- To organize the laying out and revising of regulations and rules, technical standards, specifications, guidelines and production quota for power production, construction and management and then submit them to the SPCC for approval and help SPCC for implementation.
- To help SPCC for the equipment quality control in the electric power utilities as well as for reliability management and on-line monitoring of power production.
- To help SPCC to strengthen the management of whole electric power system in order to push forward the management structural reform; to promote the progress of science and technology and to improve the management.

[15] www.cei.gov.cn/homepage/org/dqle.htm

- To organize reviewing and evaluations in the scientific and technical studies and submit them to a higher level for award; in charge of patent work and experiences popularization.
- In charge of the higher education, adults education and on-job professional education in power system, to coordinate the work of different kinds of technical training on various levels and to organize training of leading persons in large and middle-sized enterprises and to study how to carry out the education and training.
- To provide information on diversified economy in electric power utilities to serve the production, supply and marketing of diversified economy and to provide SPCC with suggestions for conducting the work relating to diversified economy in power system.
- To organize exchange of experiences on enterprise management, to speed up modernized management of electric power enterprises, in charge of the labor protection and wealth, including medical care and convalescent hospital etc. in power system.
- To carry out the study of China's electric power development strategy, planning, policy and rules, management structure, technical and economic issues and to provide consultation services to SPCC on the above topics.
- In charge of the non-governmental foreign affairs, including the activities in science and technology, personnel exchange and economic affairs, to sponsor exhibitions on energy and electric power.

8.2 Reform policies adopted by the Chinese Government:

China has a sound energy / electricity conservation record among developing countries. Various measures to improve the efficiency of electricity use have been introduced in attempts to reduce the need for new generating capacity, and these measures have been successful, as is indicated by the low ratio of 0.86 for the elasticity of growth in electricity demand to GDP growth achieved during the last decade. However, energy / electricity conservation programs have always been based on centrally designed energy/electricity conservation policies and heavily subsidized administrative programs.

- Faced with fiscal revenue constraints, the government is now promoting a shift in the energy conservation programs to rely more on market-based incentives and introduce innovative and commercially based contractual and financing mechanisms.

- The Government is also encouraging efficient energy use through reliance upon energy price increases.
- Significant progress has been made in many ways to simplify the tariff, improve its structure and bring it into line with costs.
- Consumer prices for electricity now reasonably reflect economic costs in many provinces as time of use pricing is being done.

8.3 Tariffs in China's power sector

Both Provincial and Central authorities have purview over the formulation and approval of electric power tariff rates[16]. The current system for electricity pricing and the establishment of the tariff rate is complex and considered cumbersome. Tariff rate formula and application with regard to the grid system, is an area expected to change with the issuance of new regulations introducing competition into the grid. There are four kinds of tariffs.

- State Base Tariff: It is also known as the catalog price and generally only pertains to older, state-financed plants.
- New Plan Tariff: It has a very complex formula and it applies to post-1985-built plants).
- Additional Quota Tariff: It varies from province to province and is based on the state government's decision.

8.4 Generation Issues

A key issue for China's power industry is the distribution of generation among power plants. China's stated intention eventually is to create a unified national power grid, and to have a modern power market in which plants sell power to the grid at market-determined rates. In the short term, though, traditional arrangements still hold sway, and state-owned power plants, which have government connections, tend to have a higher priority than independent private plants. Additionally, some private plants with "take-or-pay" contracts, which provide for guaranteed minimum sales amounts, have had trouble getting the provincial authorities running the local grids to honor those terms.

[16] www.strategis.ic.gc.ca/SSG/ea01757e.html

National policy emphasizes the addition of 300 MW and 600 MW units in the system and construction of even larger units is under consideration to achieve economies of scale and thereby improve the efficiency of the generation system, reduce generation costs and minimize adverse impacts on the environment. However, new projects have lagged behind demand, largely due to difficulties in mobilizing the large investment resources necessary. A disturbing consequence is that some local governments, pressed by acute shortages of electricity, are continuing to invest in large numbers of new, small coal-fired power plants, in unit sizes of 50 MW or less. This results in inefficient generation due to lack of economies of scale. Also, the emissions too are increasing, as the plants don't have the required funds to invest in emission and pollution control measures.

To avoid a situation, in which China would be straddled with a large number of small inefficient plants as well as surplus capacities of "wrong" kind, China has recently opened its power sector to foreign investment. At present, foreign direct investment is allowed only in power generation, but loan financing has been obtained for some power transmission projects. About 20% of the funding for the electric power sector is expected to come from foreign investment. Several joint ventures have already been established for the construction of electric generating units. China is modifying its legal framework to allow the possibility of full foreign ownership of power plants. In its first project open to international bidding, China has awarded a build-operate-transfer project (the 720-megawatt Laibin coal-fired plant) to a consortium headed by France's EDF. Bidding on a second project (a 600-megawatt plant in Hunan province) is underway. Coastal constructed a 40-megawatt power plant in Wuxi City and began construction on a 76-megawatt power plant in Suzhou, and plans a 72-megawatt plant in Nanjing. Enserch reached an agreement to cooperatively develop and operate a 36-megawatt coal-fired plant near Zhejiang.

According to the reform's rules, a province should have no less than five to six independent power generators, each occupying no more than 20 percent of the electricity market, or within one- fifth of the province's total installed generating capacity, so that monopolies can be curbed. The generators will bid with each other for access to power networks. In order to avoid market fluctuations, which could result from the reform, some provincial subsidiaries will sign five-year agreements with provincial power generators

confirming that 80 percent of their generation will be purchased at last year's prices so as to ensure the profits of the generators.

8.5 Transmission and Distribution issues

In addition to building new generating capacity, China is simultaneously expanding its power networks and improving the efficiencies of existing power plants. In the past, China advanced the construction of power plants, overlooking the development of transmission systems. As a result, many transmission facilities are obsolete, there are substantial line losses in many of the systems, and they are unable to meet growing demand in many urban and rural areas. To counter this trend, the Chinese government intends to separate the transmission and generation as a part of unbundling. Energy savings are being made in transmission through elevation of grid 2 voltages and through the employment of more efficient and more easy-to-control transmission systems. Further interconnection of regional and provincial grids is being done to enhance efficiency and reliability. To supplement this, there would be replacement of low efficiency, unreliable power transformers and their adaptation of on-load tap-changers.

60% of transfer losses between generator outlets and consumers are in the distribution networks, which furthermore are generally utterly overloaded due to recent years of rapid expansion in power demand without corresponding upkeep and addition of generating resources. In distribution, hence, very urgent remedies to the grossly overloaded grids of urban grids are required and plans are already under way to be implemented. Such remedies will include the replacement of too thinly rated, aged and unreliable distribution transformers, cables and overhead lines, apparatus and meters. This is a very major undertaking, which ultimately will involve some 400 cities, stretching over at least two Five-Year Plans. Even related pilot program, to be implemented within the present 9th Five-Year Plan and include 10 large cities, under direct monitoring by the SPCC is estimated to cost 30 billion Yuan RMB.

The East China (Jiangsu) Transmission Project[17], supported by a US$250 million IBRD loan, will help China meet its rapidly growing electricity demands in a cost-effective and environmentally sustainable manner. It aims to alleviate critical bottlenecks in power transmission infrastructure in the East China region, improve efficiency of

[17] www.worldbank.org/html/extdr/extrme/1704.htm

electricity supply, and increase electricity trades on a commercial basis by helping to develop a reliable high voltage transmission network, phasing out state-mandated quota power exchanges, and implementing a commercial framework for power exchanges and trades.

8.6 Financing in Chinese Power Sector

Until mid 1997, annual investment in China's power sector from all sources was approximately $6.0 billion[18]. According to the Chinese Bureau of Statistics, there was a total investment from all sources in 1998 of almost $23 billion and approximate 18 percent increase over 1997's $19 billion in all-source investment. Prior to the 1980s the funding for all large power projects in China came from the Chinese central government. Most of this money was provided in the form of grants. All profits from future generation were remitted back to the government. Chinese banks, beginning in 1985 with the People's Construction Bank, began to provide long term loan. These loans were then governed by initial, reform-guided regulations since superseded by new regulations promulgated in 1994.

Foreign direct investment has played a critical role in financing the expansion of China's electric power infrastructure and is expected to play an even more important role in the future despite being restricted—for now—to strictly joint ventures involving less than 50 percent ownership. The question is whether such an approach can accommodate a five-fold increase in power generation requirements.

8.6.1 Criteria for approval of foreign capital

- The current power demand in the proposed region
- The financing costs with regards to the international markets
- Capability of the project to bear the tariff rate
- Projects financial structure
- Foreign exchange balancing plan

8.6.2 Scope of Chinese power plants to utilise foreign capital

- Construction of new thermal (including co-generation) power plants[19].
- Construction of new hydroelectric plants (including pumped storage units).
- Construction of new nuclear power stations.
- Power generation projects involving renewable energy or new technology.
- Expansion of or the technological renovation of an existing power plant.

8.6.3 Structure of foreign investments in Chinese power plants

- By establishing a Chinese-foreign equity joint venture (JV).
- By establishing a Chinese-foreign contractual JV (operating with Chinese cooperative JV investors).
- By establishing a wholly foreign-capital invested enterprise.

Nuclear power plants and hydroelectric plants larger than 250 MW cannot be invested in this manner. The permitted forms of investment are numerous and include: BOT (Build-Operate-Transfer), a form of limited-recourse project financing Use of export credits, preferential loans, and/or multilateral loans/guarantees Bond or share issuance abroad Foreign capital and/or Ren Min Bi (RMB) equity/debt investment. Bond Issues and Foreign Share Issues for infrastructure projects in China have, though, thus far met with limited success and continue to receive a mixed reception by both the Chinese and foreign investors.

8.6.4 Rolling exploitation mechanism

A "rolling exploitation mechanism" means that the income from the first plant does not need to be used for repayment of loans, but can be used for continued development of other power projects. It is being employed for both hydropower and nuclear power to provide financing for new projects.

9. The Indian Power Sector Reforms

A new policy of opening electricity generation to private participation was announced by the central government in October 1991. Then, in May-June 1992, a high-level team consisting of the union cabinet secretary, power secretary and finance

[18] www.strategis.ic.gc.ca/SSG/ea01757e.html

secretary visited the US, Europe, and Japan, to invite foreign private sector participation in the power sector[20]. Foreign companies returned the visit to India and found the electricity establishment offering concessions and incentives that were hitherto unheard of in the power sector business.

9.1.1 Reasons for Inviting Private Sector Participation

In 1990, the situation facing the energy sector in India was roughly as follows. The central government – the conventional source for funding power projects – was believed to have reached its limit as far as funding was concerned. The Indian electricity sector had virtually no surpluses to make available for investment. The World Bank had stated in 1989 that requests from the electricity sector of developing countries added up to $100 billion per year. In response, only about $20 billion was available from multilateral sources, leaving a gap of about $80 billion. Hence, it was suggested that the only possible source of funds was the private sector and, in view of the fact that the Indian capital market did not appear to be able to make a significant contribution, the foreign private sector should be welcomed. It was also hoped that there would be a side-benefit regarding the unacceptably low system efficiency of the state electricity boards. This efficiency would be improved through the oft-claimed better management and higher technical performance of the private sector.

9.1.2 The Post-liberalized Scenario

By August 1995, about 189 offers were received to set up private power generating projects of over 75,000 MW, at an investment of more than Rs 2,76,000 crores. These included 95 projects with an aggregate capacity of 48,137 MW, awarded through Memoranda of Understanding (MOUs) or Letters of Intent, and 32 projects (costing more than Rs 1,000 crore each) with an aggregate capacity of 20,697 MW, awarded by international competitive bidding. Of these, eight were considered for counter-guarantees by the central government. Seventeen private power projects were accorded the Techno-Economic Clearance (TEC) by the CEA, till March 1996, according

[19] Ministry of Electric Power paper: Several Measures Concerning Foreign Investment in Power Projects, March, 1997.
[20] Reddy, A.K.N., Murthy K.V.N., D'Sa, A., *India's Power Sector Liberalization: An Overview*

to a statement of the minister of state for power; these reached a total of 31 by March 1998. In December 1998, the power ministry asked all the IPPs to achieve financial closure by March 1999.

Several other projects are under way. At the end of March 1998, projects under implementation accounted for a total capacity of about 3,000 MW. Another eight projects with a total capacity of 3,654 MW had been sanctioned financial assistance by institutions, but financial closure has not yet been achieved. In contrast, several central and state government undertakings have completed or are completing their projects on time (or even earlier than scheduled). For example, Units V and VI (210 MW each) of the Raichur Thermal Power Station are being commissioned ahead of schedule by the Karnataka Power Corporation (KPCL). The completion of Unit V in a record period of only 28 months has resulted in a saving of Rs 200 crore; with a capital cost of Rs 3.22 crore per MW, it is the lowest cost thermal unit to be constructed in recent years. Further, in the case of private promoters, projects without foreign participation are being completed as scheduled. For example, the chief promoter of the 235 MW Jegurupadu project in Andhra Pradesh avoided delays by persuading Indian financial institutions to invest even before any counter-guarantee was obtained.

9.2. Problems Encountered

The stakeholders in the Indian power scenario are the generators – independent power producers (IPPs) and / or state undertakings, the distributors (at present the State Electricity Boards), the government (central and state) and the consumers (commercial, industrial, and others), as well as households (with and without electricity). Attention will now be focused on the problems noted by the private producers and the electricity establishment in the course of constructing new power plants.

9.2.1 Problems Mentioned by Private Producers

Litigation / renegotiations leading to delays: For several reasons, for example, high costs, environmental impacts, and perception of financial irregularities, there have been protests against some power plants. Litigation as also renegotiation of Power Purchase

Agreements (PPAs) has caused long delays in project completion, so that construction has not been completed as scheduled. For instance, the Mangalore Power Company's PPA for a 1,000 MW coal-based plant was originally signed in 1993, re-negotiated in November 1997, and has yet to be resolved.

Financing problems: Compared to typical commercial projects, infrastructure projects yield relatively low returns and have long payback periods. Consequently, power plants have been perceived to be commercially less profitable. Such projects were, therefore, undertaken by the public sector. Private promoters face difficulties when trying to obtain funding, as bankers are unlikely to agree to loans with a maturity longer than three years, to match the tenor of their deposit liabilities. Even financial institutions (FIs) find it difficult to extend loans commensurate with the long payback periods of power projects.

Moreover, the State Electricity Board (SEB) is invariably the sole purchaser of the power that a private sector generator generates. That being the case, the private sector "will not take the risk of not being paid" by SEBs in poor financial health. The SEBs are also unlikely to get backing from financial agencies for their commitments to purchase electricity from the private producers. Hence, counter-guarantees from the central government have been sought.

Some counter-guarantees from the central government were eventually obtained in the case of six of the eight 'fast-track' projects. Even with these counter-guarantees, promoters tend to wait for other arrangements such as fuel supply agreements to be finalised.

There are other options that could be considered for dealing with the financial problem, such as:

(a) an escrow account – into which the cash inflows of the SEB are deposited and to which an independent power producer (IPP) would have first access in case of defaults by the SEB,

(b) an agreement by which the IPP could supply electricity directly to buyers, through the existing lines, and

(c) an irrevocable letter of credit, favouring the IPP on certain conditions being met and issued by a highly rated bank/financial institution – guaranteeing payment on behalf of the SEBs.

With regard to escrow accounts, financial institutions are said to be limiting their loans to IPPs at the SEB's 'escrowable' capacity. It is recommended that the amount in the escrow account should be 25 times the monthly tariff payable by the SEBs, that the escrow account should be charged exclusively in favour of an IPP with a provision to assign the same to lenders of the IPPs, and that the escrow account should be established before financial closure.

However, problems exist even with the escrow mechanism. Several states have signed a large number of PPAs with an aggregate capacity higher than could be supported by way of escrows. For example, in Madhya Pradesh (MP), the SEB has signed PPAs aggregating to about 6,500 MW and of these, nine projects totaling about 4,600 MW have already received the CEA's techno-economic clearance. In contrast, leading financial institutions have assessed the total 'escrowable capacity' of Madhya Pradesh at only around 2,561 MW. Similar problems also exist in some other States.

In addition to the overestimation of escrow capacity, there are two problems:

(a) distribution regions that guarantee payment through escrow accounts could be 'cherry picked' by the independent power producer leaving the SEB with the unremunerative distribution regions to service its other commitments; and

(b) the existing stakeholders in the cash flows of SEBs object to such agreements. For instance, the State Bank of India (which provides overdraft facilities to the SEBs) is refusing to lift its lien on the receivables of the SEBs. Further, at a top-level meeting in January 1998, banks pointed out that state governments were not paying their dues on bonds issued, but were issuing more and more guarantees

Other sources of funds are limited. While private power projects in industrialised countries raise funds through institutional investors (insurance companies, pension funds, etc), in India these usually invest in some way (The IDBI has been financing purchase of indigenous equipment by various SEBs through its bills rediscounting scheme) in government undertakings, limiting the sources for private power projects. Hence, as compared with the investment requirements of the private power sector estimated at Rs

2,92,500 crore for the next decade, the maximum borrowing from Indian FIs/banks is pegged at 40 per cent of the outlay or Rs 1,17,000 crore.

Risk sharing: The many risks perceived by private producers are usually addressed in the PPAs.

Construction risk: This is the risk of the project not being completed on time and within the budget. To counter this risk, provisions for liquidation damages to cover the costs of delays are included in the engineering procurement construction (EPC) contract.

Market risk: The market risk includes demand risk and price risk. A demand risk is avoided by the 'take or pay' stipulation of the PPAs, according to which the SEB agrees to pay the IPP the 'availability' rate regardless of the number of KWh actually obtained. Similarly, the price risk is avoided by the tariff structure in which all costs of producing power – fixed (interest, depreciation, O and M, insurance, taxes) and variable (fuel), plus a return on equity (ROE) are assured.

Fuel-supply risk: This is the risk of not obtaining a timely supply of the appropriate fuel. To counter this risk, IPPs either sign long-term contracts with the public sector supplier (for example, gas from GAIL) or acquire a captive source (for example, a captive coalmine). For, liquid fuel transportation sometimes presents a problem, because oil suppliers do not guarantee transportation between the port/refinery and the power plant, necessitating a contract with the Railways.

Exchange fluctuation risk: The problem of losing at times when the rupee falls is avoided either by demanding payment in dollar terms or by ensuring foreign payments into an international escrow account.

Obtaining clearances: There are numerous clearances – statutory and non-statutory – to be obtained for starting a power project. The statutory clearances include cost estimate clearance, techno-economic clearance (TEC) from CEA, water-availability clearance from the CWC/State government, pollution clearance from the SPCB/CPCB, forest and environment clearance and rehabilitation and resettlement clearance from the MoEF and

the SEB/state government clearance. The non-statutory clearances include land availability from the state government, fuel linkages from the departments of coal and petroleum and natural gas, transportation of fuel from the departments of coal/petroleum and natural gas, and the ministries of railways, and shipping and surface transport, and financing from CEA/DOP/department of economic affairs/FIs. All these can result in considerable delays and thereby cost escalation.

However, from August 1996, power projects with investment of Rs 1,000 crore have been exempted from CEA and environmental clearances. The earlier limit was Rs 400 crore, but it has been suggested that this limit be raised to Rs 4,000 crore. Several 'fast-track' projects were however, above this limit.

Obtaining fuel linkage agreements: Fuel linkage agreements (including licenses for importing fuels – coal, naphtha, diesel and LNG or higher grade Indian coal) have, at times, been difficult to obtain. In addition, the rules pertaining to the use of some fuels have not been clear or have been changed. This indecision has delayed several projects. Furthermore, the charges that have to be paid by the IPPs have been regarded by them as being too high, as they include charges for commitment, import-handling, service, and so on.

Environmental problems: Some requirements of the ministry of environment have been unacceptable to the IPPs. For instance, after nine years of generation, a 100 per cent ash utilisation for coal plants was required. Power companies were also expected to develop ash products and market them.

9.3.2 Problems Faced by the SEBs

Unacceptable PPA terms: PPA terms were not viable for the SEBs. According to the terms specified in some of the PPAs, the country would have to pay an exorbitant price for foreign participation. Several harmful features are listed below.

Assured high PLF: Plants were to be assured of electricity sales at PLFs of > 68.5 per cent, these high PLFs being buttressed by power purchase agreements. This commitment

implies that during the daily off-peak hours and the monsoon season, the existing plants would have to be backed down, resulting in uneconomic plant dispatch (that is, lower cost-per-unit power would be replaced by higher cost power). Considering that several existing thermal plants that can operate at higher than 68.5 per cent are backed down in periods of good reservoir inflows in the southern region, the situation would only be worsened.

Further, if the real ailment of the power sector is a shortage of peaking power rather than energy, then the addition of base-load power stations is not likely to provide a solution.

High return on equity: A relatively high (>=11 per cent) rate of return (ROE) was promised to the investor, at a capacity utilisation of 68.5 per cent. This return would be increased if the utilisation exceeded this level. More importantly, these returns were to be guaranteed by the central government if the state electricity boards were unable to pay.

High capital costs of private plants: The capital costs of some projects (as per their PPAs) were much higher than those known to be incurred both abroad and in India (The National Working Group on Power Sector had in a detailed September/October 1994 study shown that the capital costs of both combined-cycle gas-turbine and coal-based plants are lower with indigenous technology.) where international competitive bidding did not take place.

For example, the capital cost of Phase I of the Enron (Dabhol Power Company) LNG-based plant was Rs 4.23 crore/MW (This included items such as 'pre-operative' expenses of Rs 547.26 crore or Rs 0.787 crore/MW which inflated the capital cost.) or $1,366/KW (approx. Rs 2,942.6 crore27 for 695 MW). In comparison, in the US, a basic 300 MW coal-based steam-electric plant (about 30 per cent more expensive than an LNG-based (A combined-cycle plant involving a gas-turbine driven by natural gas would cost roughly about $ 600-700/kW and a similar plant driven by LNG-handling equipment. Thus, a LNG-based combined-steam-electric plant required about $1,100/KW in 1990 prices, which works out to about Rs 3.4 crore/MW @ Rs 31/$,28 and NTPC's 645 MW gas-based Kawas project (This project was executed on a turnkey basis by Alsthom of France.) (Commissioned in September 1993) at Rs 2.4 crore per MW.

In addition, there were payments in the deal for equipment / consultancy / recurring expenses to affiliates of the owner-firms. All this led to critical comments and some re-negotiation. The Enron project (Phase I) cost was reduced, as was the Cogentrix 1,000 MW project cost (from Rs 4,387 crore to Rs 3,950 crore). However, a part of the reduction in costs is claimed by critics to be cosmetic: for instance, the Enron-LNG facility appears under operating rather than capital cost, and customs duty reductions have been reflected as capital cost reduction. In cases where the prices of equipment are falling, (This has been experienced in the international market.) adherence to the PPA prices would be uneconomical for the power purchaser (the SEB).

High tariffs: In addition to the capital component, the variable costs chargeable during the life of the projects are expected to rise, allowing the escalation of the costs of various components – fees (such as Management Fee, Testing Fee, and Commissioning Fee), insurance charges, 'tax incremental charges', etc, to be passed on to the purchaser.

Unfavorable financing: The rates of interest payable on dollar and rupee debt have been fixed as on the date of financial closure. Up to this stage (that is, financial closure and securing of counter-guarantees), the perceived lender risks and the corresponding rates of interest are relatively high. However, as the project progresses, the risk falls and the debt could be refinanced (that is, interest rates can be lowered through re-negotiation). Despite this, the utility is still bound by the fixed rates.

9.2.3 Further Problems

Technical losses and improvement of the T and D system: Increasing the generation capacity is necessary but not sufficient for supplying electricity to consumers; the transmission and distribution system has to be extended and maintained to ensure the efficient evacuation of power from the generation sites. Without improved T and D facilities, the technical inefficiencies will continue.

A separate trading enterprise for T and D (for example, GRIDCO in Orissa) that needs to collect a certain ROI would entail much higher tariff-rates which some consumers may be unable to bear.

Commercial losses on the T and D system: The losses incurred along the distribution system due to theft of electricity have not been addressed by introducing more generators into the system. In fact, the SEBs' financial position would worsen if electricity purchased at higher prices (the costs-plus-return formula) were not paid for by the users.

Privatization of the T and D system: Private participation in the transmission and distribution of the electricity system has also presented problems. The evaluation of assets in cases of transfer to new owners has to be carefully worked out. For joint-venture undertakings between an SEB and a private firm/consortia of firms, the SEB is liable to lose control. In addition, the SEBs sometimes define the requirements for transmissions contracts (For example, the minimum qualifying criteria listed in the request for qualification for the Mangalore Evacuation Project stated that the lead promoter “demonstrate successful development in the past of EHV systems (operating at not less than 380kV) of not less than 2,000 km and at least 10 EHV sub-stations (operating at not less than 380 kV)”.) such that there are very few companies capable of fulfilling the criteria as defined, so that negotiation is even more difficult.

Non-subsidised electricity: The consumers (mainly domestic and agricultural) currently provided electricity at subsidised rates would be unable to handle "user-cost recovery", that is, to pay cost-reflective tariffs. Further, if only these consumers are left to the SEBs, their financial position would be far worse than at present. Fuel imports: In spite of the availability of indigenous sources of electricity (hydropower, coal, and biomass), foreign power producers tend to opt for imported fuel. The larger the number of foreign power producers in the field, the greater will be the country's dependence on imported fuel for power generation, worsening its debt levels still further.

9.3 Restructuring and regulation

The problems experienced seem to have triggered discussions on the power system as a whole and have spurred on the restructuring and regulation process. This is being described below.

9.3.1 Regulatory Commissions

The Indian Electricity Act of 1910 and the Electricity (Supply) Act of 1948 were amended in 1996 to enable the setting up of state and central level electricity regulatory commissions. Each state and union territory was to set up an independent State Electricity Regulatory Commission (SERC) to deal with tariff fixation, that is, to determine the tariff for wholesale or retail sale of electricity and for the use of transmission facilities. Some states have established their regulatory commissions, while others are in the process of doing so.

At the center, a Central Electricity Regulatory Commission (CERC) has been formed to deal with all state-level appeals and inter-state flows. From April 1, 1999, the Central Electricity Authority (CEA) has entrusted the CERC with the task of regulating power tariffs of central government power utilities, inter-state generating companies and inter-state transmission tariffs. An important objective of the CERC is to improve operations in the power sector, by measures such as increased efficiency, big investments in the T and D systems, time-of-the-day pricing, and power flow from surplus to deficit regions. Further, the central government or the CERC can grant a transmission license to anyone to construct, maintain, and operate any inter-state transmission system under the direction, control, and supervision of the central transmission utility.

9.3.2 Restructuring of the SEBs

The power ministry has circulated detailed guidelines on power sector reforms to SEBs. The SEBs are expected to "unbundle" their activities, trifurcating them between generation, transmission and distribution (This trifurcation has already been effected in the state of Orissa, while in Haryana, the Haryana ERC has granted a license to Haryana Vidyut Prasaran Nigam for transmission and distribution.). The process of reforms should take place in a phased manner: independent divisions should be created and then

'corporatised'. The amendment to the Electricity Acts also provided for private investment in transmission and the CERC has sent guidelines to the SEBs regarding their granting licenses to private sector undertakings for the transmission of power.

9.3.3 Regional Electricity Boards (REBs)

Regional Electricity Boards (REBs) have been given (in November 1996) the authority to decide on plant dispatch, that is, to decide which plants should be operated to meet demand and those that would have to back down in case of a fall in demand, on the basis of the merit order operation clause. To strengthen grid management and enforce grid discipline, the REBs have been granted legal status. However, doubts have been expressed regarding the efficiency of co-ordination between the REBs, the SERCs, the CERC and the CEA.

9.3.4 Foreign Equity Participation

Foreign equity participation up to 100 per cent has been extended for electricity generation, transmission, and distribution (except for atomic reactors).

9.3.5 Fiscal Measures

The tax holiday, granted to the power sector, has been extended up to the year 2003.

9.3.6 Mega-Power Policy

This policy – formulated in October 1998 for large power projects at strategic locations – is applicable to the construction and operation of hydroelectric power plants of at least 500 MW and thermal plants of at least 1,000 MW.

The project promoters are insulated from the lack of credit-worthiness of the SEBs because electricity can be sold either directly to a 'cluster' of large consumers or to the Power Trading Corporation (PTC) which can withdraw funds from the state's central share (Central Plan Allocation, etc) if the SEB defaults on its payments. There will also be benefits for these Mega power projects: customs duty on the import of capital equipment has been waived, and some sales tax/octroi concessions have been provided.

However, the reaction to the mega-policy has not been very favorable. Representatives of SEBs oppose the idea of the mega projects bypassing the SEBs and attracting large customers. IPPs feel that this policy will be a hindrance to smaller projects and would prefer that the concessions extended to mega projects be extended to all IPPs.

9.3.7 New Financial Arrangements

Additional institutions: For the purpose of financing the power sector, new arrangements have been made in recent times. These include setting up of the Infrastructure Development Finance Company, broadening the scope of the public sector Power Finance Corporation (PFC), allowing an active role for the PFC in negotiating loans from international banks and foreign capital markets, constitution of a Power Development Fund by the power ministry for speedy implementation and execution of power projects as also to finance feasibility studies for setting up power plants, mooting a Power Trading Company (PTC) to purchase power from power-surplus regions and sell it to power-deficient regions, launching of 'Infrastructure Bonds' to channel household savings to the power sector, and involving provident funds as a potentially important source of funding.

Sources of finance still limited: According to the Asian Development Bank, in November 1996, Asia required $100 billion a year in capital to develop new power generation plants, of which only 5-10 per cent could be met by development banks.51 Hence, internal generation of funds is still required.

10. Learnings for India

- **Financing of power projects:** Rolling Exploitation Mechanism is used to invest and fund the projects, which are coming up. In this kind of mechanism, the revenues generated by the newly laid plants need not be ploughed back into the plan as was the rule before, but can be put into newer ventures. This would be critical as China is facing a crunch of capital for the new projects. 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.

India has looked upon opening up and privatization of Indian power sector through IPPs (Independent Power Producers). Contrary to expectations, they have not performed well. This has mostly been because of lack of clarity of the revenue and risk sharing relationship between the government and the IPP. China has concentrated upon BOT (Build Operate Transfer) kind of projects. In BOT, a government or semi-government entity grants a concession to a wholly foreign-invested company to undertake the financing, construction, and operation of a power plant. This concession is for a fixed period of time at the end of which the foreign venture transfers back the operating rights to the Chinese entity. During the period of time that the foreign company is operating the plant, the company should be able to expect a reasonable rate of return on their investment.

As the concept of BOT is similar to what is prevalent around the world, the procedures for project approval and completion are fairly standardized. Because of the standardized nature of the paperwork used to execute BOT projects, foreign investors see quicker approval of their projects in the future as compared to the traditional JV model. Not only the approval, but also, the revenue and risk sharing relationships are clearly defined so that there is no ambiguity. Hence, even India should develop such procedures which lead to clarity in the agreements and which facilitate the clearing of proposals as soon as possible.

- **Restructuring of Power Sector Decision and Policy makers:** China has broken its power monolith of MoEP in the right manner. It has begun by divesting the amount of decision making closer to the state or province level. The commercial and regulatory frameworks have been divided amongst various entities capable of doing certain things best. It has converted itself into a conglomerate comprising a regulatory body, a planning commission, and an economic trade commission. On the other hand, India has divided its power monolith into various regional authorities, which simply are scaled down versions of itself. This, apart from reducing the scale, has not done much benefit. There has been a lack of coordination among the regional entities which has led to sub-optimality and redundancies. To ensure that this isn't repeated, India can follow the way China has structured its power monolith.

Also China has started the process of carrying out reforms in the state enterprise simultaneously, which is a step in the right direction. And the effort has been in the direction of creation of electricity markets.

- **Need to improve efficiency should be stressed upon:** The challenge for sustainable future energy provision is how to achieve sustained economic growth without having energy consumption increasing at the same rate. Directing investments to the adoption of more energy-efficient measures instead of merely increasing the total energy supply will be crucial to meet this challenge. China is an interesting example in this regard. By committing around 7-8% of total energy investment to efficiency improvements in the 1980's, GDP has grown at 9.5%/year since 1980 while energy consumption has risen only half as fast, at an average rate of 4.8%/year. This has served to positively prove that you can "de-couple" economic growth and energy consumption (a relation often seen to be positive and linear) through attention to energy efficiency improvements[21].

  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. An example of the policy efforts to improve upon, say, the generation efficiency, China is setting up large scale plants and discouraging the setting up of small scale plants which won't be efficient generators as well as won't have adequate capital investment to take pollution control measures.

  While India's transmission losses are among the highest in the world, no efforts are being made in the direction of improving efficiencies in transmission as well as generation and distribution. An incentive to reduce these losses is that even if 1% of T & D losses is reduced, it would lead to saving in capacity savings of 80 MW. The growth-oriented supply-side consumption directed paradigm seems to have

[21] www.un.org/documents/ecosoc

dominated the decision-making in the energy-sector, to the exclusion of end-use efficiencies. It is not a long-term solution. Thus, India should pick up the cue from China and should boost up its efficiency efforts be it in generation, transmission or distribution.

- **Environmental considerations should be taken into account:** China is already the world's third leading source of greenhouse gases and is likely to become the biggest contributor before the middle of the next century. China's fast-growing, almost exclusively coal-fired power sector is responsible for roughly a third of these emissions. With such a polluting scenario, it is stressing upon using clean coal technologies. The power projects are given to those investing companies who are willing to put up this technology. It also has started its own R and D efforts in the development of clean coal technologies. This would make it less and less dependent on the foreign technology and would lead to a cleaner environment. Also, it is trying to take advantage of its largest hydel potential in the world by also exploiting its water resources. The Three Gorges Dam project is an example. Apart from giving a pollution free energy source, it would be very helpful in supplying energy to parts of country, which are deficient in energy. India has a similar problem as 75% of its power is derived through coal. hence, it would be worthwhile for India to follow China so that the negative externalities of pollution are minimized.

Table 1. Key Socioeconomic Indicators[22]

	India	**China**	**U.S.**
Population [million]	919.90	1,190.43	260.32
Growth Rate	2.1%	1.3%	0.9%
Area [million sq. km]	3.28	9.59	9.37
Per Capita Income [$ per year]	1,200	1,100	23,500
Pvt. Vehicle Ownership (Car Ownership)	22 per 1000 (3.3)	2 per 1000 (0.3)	560 per 1000 (537)
Real GDP [$ billion]	1,104	1,320	6,110
(Growth Rate)	(5.5%)	(11.8%)	(4.1%)
Agriculture share	32%	27%	2%
Industry share	27%	34%	29%
Services share	40%	38%	69%
Industrial Production Growth Rate	6.4%	11.1%	2.0%
Energy Production Growth Rate	7.0%	5.0%	0.7%
GD Investment Growth Rate	5.3%	-	2.3%

[22] www.worldbank.org

Table 2. World Energy Cons. for Electricity Generation by Region and Fuel (*Quadrillion Btu)*

Region/Fuel	**History**			**Projections**			
	1993	**1994**	**1995**	**2000**	**2005**	**2010**	**2015**
Industrialized Countries	**74.3**	**75.7**	**78.1**	**86.0**	**92.8**	**98.9**	**104.3**
Oil	5.3	5.6	5.2	5.4	5.6	5.5	5.6
Natural Gas	6.9	7.5	8.2	11.5	14.8	17.5	21.3
Coal	27.5	27.5	28.3	29.8	30.9	32.6	34.1
Nuclear	18.1	18.7	19.4	20.0	19.7	19.2	16.9
Renewables	16.5	16.3	17.0	19.2	21.8	24.1	26.4
EE/FSU Countries	**27.8**	**25.7**	**24.6**	**27.4**	**29.6**	**31.5**	**32.2**
Oil	3.6	2.9	2.7	3.0	3.5	4.1	4.6
Natural Gas	11.2	10.1	9.7	12.2	13.4	14.7	15.7
Coal	7.3	7.1	6.6	6.8	6.8	6.2	5.4
Nuclear	2.8	2.4	2.5	2.8	2.7	2.9	2.3
Renewables	3.0	3.1	3.1	2.7	3.1	3.6	4.1
Developing Countries	**33.0**	**35.2**	**37.3**	**46.1**	**56.6**	**67.4**	**79.0**
Oil	4.6	4.7	4.9	5.9	7.1	8.1	9.4
Natural Gas	3.9	4.4	4.7	6.6	8.3	10.2	12.3
Coal	14.6	15.7	16.7	20.7	25.7	31.6	38.0
Nuclear	1.1	1.3	1.4	1.6	2.3	3.0	3.6
Renewables	8.8	9.1	9.6	11.3	13.2	14.5	15.8
Total World	**135.2**	**136.6**	**140.1**	**159.5**	**179.0**	**197.7**	**215.4**
Oil	13.5	13.3	12.9	14.3	16.3	17.8	19.7
Natural Gas	22.0	22.1	22.6	30.3	36.5	42.5	49.3
Coal	49.4	50.3	51.6	57.3	63.4	70.4	77.4
Nuclear	22.0	22.4	23.3	24.4	24.8	25.0	22.8
Renewables	28.3	28.5	29.7	33.1	38.1	42.1	46.3

Note: EE/FSU = Eastern Europe and the former Soviet Union.

Sources:

History: Energy Information Administration (EIA), *International Energy Annual 1995*, DOE/EIA-0219 (95) (Washington, DC, December 1996).

Projections: EIA, World Energy Projection System (1997).

Table 3. Leading Electric Power Companies in Asia

RANK	COMPANY	COUNTRY	SALES ($MILLIONS)	PROFIT ($ MILLIONS)	PROFIT AS % OF		1000 RANK
					SALES	EQUITY	
1	TOKYO ELECTRIC POWER	JAPAN	38,869.5	744.2	1.9	0.7	**16**
2	KANSAI ELECTRIC POWER	JAPAN	19,838.6	401.0	2.0	0.7	**34**
3	CHUBU ELECTRIC POWER	JAPAN	16,645.2	314.3	1.9	0.7	**41**
4	TOHOKU ELECTRIC POWER	JAPAN	11,757.8	287.6	2.4	0.9	**68**
5	KYUSHU ELECTRIC POWER	JAPAN	10,924.8	197.3	1.8	0.6	**79**
6	KOREA ELECTRIC POWER	SOUTH KOREA	10,152.5	870.5	8.6	2.4	**87**
7	TAIWAN POWER	TAIWAN	8,552.1	954.7	11.2	2.9	**114**
8	CHUGOKU ELECTRIC POWER	JAPAN	7,936.8	223.9	2.8	1.0	**122**
9	EAST CHINA ELECTRIC POWER	CHINA	6,822.1	214.0	3.1	1.4	**146**
10	SHIKOKU ELECTRIC	JAPAN	4,349.6	128.8	3.0	1.1	**224**

	POWER						
11	CENTRAL CHINA POWER	CHINA	4,137.9	123.2	3.0	1.2	**249**
12	HOKKAIDO ELECTRIC POWER	JAPAN	3,989.6	120.7	3.0	1.1	**261**
13	HOKURIKU ELECTRIC POWER	JAPAN	3,676.9	62.9	1.7	0.6	**280**
14	ELEC. GENERATING AUTH.	THAILAND	3,546.7	491.1	13.8	5.7	**292**
15	NATIONAL THERMAL POWER	INDIA	3,467.2	682.4	19.7	7.9	**299**
16	ELECTRIC POWER DEVT.	JAPAN	3,449.3	121.2	3.5	0.7	**300**
17	CLP HOLDINGS	HONG KONG	3,080.5	1,043.3	33.9	14.8	**336**
18	TENAGA NASIONAL	MALAYSIA	2,914.9	-788.4	—	—	**360**
19	CHINA HUANENG GROUP	CHINA	2,672.3	111.3	4.2	0.6	**390**
20	NATIONAL POWER CORP.	PHILIPPINES	2,118.0	-88.5	—	—	**491**

Source: Asiaweek, 1999

References:

1. Asian Energy Futures Event Report (IV), *The Here and Now of Asian energy*
2. Energy Information Administration/International Energy Outlook 1996
3. Ferrier, J., *International Electric Power Encyclopedia*, PennWell Books, 1998
4. International Energy Agency, *World Energy Outlook*, Paris, 1996
5. International Energy Annual 1998, 1995
6. Matsuoka, S., *Economic Growth, Energy Consumption and Sustainable Development in Asia*
7. Reddy, A.K.N., Murthy K.V.N., D'Sa, A., *India's Power Sector Liberalization: An Overview*
8. Robert T.C., *Foreign direct investment in electric power: where does it go from here?*, Stanford University
9. US DOE, *The US-China Experts Report on Integrated Gasification Combined Cycle Technology*, IGCC, 1996
10. *World Energy Market Analysis*, Compiled by Craig P.B., May 26, 2000

Internet Sites:

1. www.cei.gov.cn/homepage/org/dqle.htm
2. www.cernet.com/undp/papers/energy.htm
3. www.eande.lbl.gov
4. www.eia.doe.gov
5. www.indiacore.com/power.htm
6. www.indiainfoline.com
7. www.oecd.org
8. www.strategis.ic.gc.ca/SSG/ea01757e.html
9. www.un.org/documents/ecosoc
10. www.worldbank.org/html/extdr/extrme/1704.htm