Chapter 1

Introduction

1.1 Background and Motivation

India's remarkable economic growth since the decade of the 1980s is fueled by increasing energy consumption. India's total commercial primary energy use has nearly quadrupled since 1980 from 102 mtoe to 404.4 mtoe (million tonnes of oil equivalent) in 2007 (Birtish Petroleum 2008). India today faces a daunting challenge of finding sustainable sources of energy to continue with the high economic growth trajectory that it has achieved since mid 1990s. Rapid economic growth is necessary to release large proportion of India's population from the shackles of poverty and hunger. India alone housed 33.12%(456 million people –42% of India's population) of the developing world's poor in 2005 Chen & Ravallion (2008). Nearly 21% of Indian population goes to sleep without sufficient food (UNFAO 2008). India has to make advances not only in quantitative terms but also in qualitative dimensions to meet its energy requirements. Currently India's energy needs are predominantly met by coal –the most carbon intensive fossil fuel. This, on the other hand, poses a serious environmental challenge. The rationalization of fuel-mix for better performance at environmental front would require an increased share of clean fuel usage e.g., gas, renewable energy sources and nuclear energy.

Economic growth is a necessary condition for elimination of various kinds of deprivations and attainment of basic needs but it is possible only by means of proper distribution of the gains from growth. Poverty, hunger and other disparities have been on the rise in the era of high economic growth since the last decade. Achieve-

ments in past show slow progress in the eradication of poverty and other deprivations. This is also reflected by the significant gap between targets as envisaged in the Plan documents and the achievements. Inadequate access to clean and modern fuels like electricity, gas and kerosene at household level another indicator od lack progress in eradication of deprivations. Nearly 576 million people were yet to have access to electricity and 782 million people lacked access to clean fuel for cooking in 2003-04 (NSSO 2007). Given the crucial role of modern energy services (MES[1]) in enhancing the quality of life and productive capacity of individuals, greater access to it would be necessary to attain human development goals. Besides, energy being universally required in the entire range of production process as an essential service input, rapid economic growth would require increased supply of commercial energy. Electricity (Supply) Act of 1948 was one of the first Acts after the Independence for achieving universal access to electricity. But achievements since the last six decades have always been below the targets set by the Planning Commission. Lack of access to MES can hinder progress in health care, education, gender justice and economic diversification of the rural economy. Therefore, one might see the lack of MES as a significant barrier to participation of individuals in the development process of the economy through employment and access to basic amenities of life.

India has embarked upon energy sector reforms since 1990s for accelerating the growth of supply for energy to sustain high rates of economic growth. Initial thrust of the reform policies were to augment the supply with the help of private and foreign capital. By mid 1990s, achieving efficiency and cost recovery of services became main issues to be addressed by reforms. Since 1991, various energy sectoral reform policies have significantly changed the incentives and ownership in many sub-sectors, leading to market development. Electricity sector has experienced the most intensive reforms. This led to increasing private ownership particularly in generation (nearly 24 percent

[1]MES is defined as electricity, liquified petroleum das (LPG) and kerosene

of the total installed capacity[2]). In addition to this two states, Orissa and Delhi, have privatized their distribution system with 49% of the asset value still remaining with the respective state governments (respectively in 1999 and 2002).

The oil & gas sector has also been significantly liberalized to augment domestic production. Most of the distribution (retail sector of oil and gas sector) is still being operated under government control though there is a presence of private distributors owned by Reliance Energy group in few states. In exploration and production (E&P) activities the state remains the dominant player but recently private players have been successful in winning bids for E&P (notably Reliance in the Bay of Bengal). Indian Oil and ONGC, which are State companies, are also very active in developing international partnerships in resource-rich regions around the world. The refinery sector has also been liberalized and there are two major private players with a significant share of the total refinery capacity. The coal sector has exprienced least changes in terms of market oriented reforms.

Under the above backdrop, we intend to develop our analysis. The scope of the thesis is limited to power sector reforms to allow us to go into details of the complex nature of incentive structure for the development of electricity supply industry. Electricity being the most modern fuel, its share in final energy consumption is rising, albeit very slowly. We focus our enquiry on electricity because of its far reaching implication for the development and thus its political sensitiveness.

The old state owned vertically integrated structure of power industry[3] has been increasingly questioned. Usually three vertical segment of the power industry i.e.,

- Generation
- Transmission

[2]This estimate includes capacity added due to in-house installations by end users, usually categorised under captive category by official documents. These installations can have access to grid in the same way as any other generating utilities for commercial purposes.

[3]US was the only country where some of the utilities were privately owned by vertically integrated monopolies. They are usually known as investor owned utilities (IOUs). IOUs, for the matter of tariff and performance standards, were regulated by the independent regulators.

- Distribution and supply

were within single ownership and operated as a monopoly in a given region. Worsening physical and financial performance of these utilities around the developing world created conditions for change. Another set of factors that facilitated change was irrelevance of scale economies after the advent of combined cycle technology for generation. This implied feasibility for competition among generators provided vertically integrated structure is unbundled. By 1990s, India also liberalized its generation sector for private/foreign capital owing to shortages during peak periods. Since then India has gradually embarked upon market oriented reforms of electricity sector. Thrust of debate in India, in this context centered around effectiveness of reform policies in bringing about competitive efficiency and quantitative and qualitative adequacy of supply.

1.2 Objectives and Chapter Scheme

Policy changes were introduced in Indian power sector initially to attract private/foreign capital in order to meet the shortages during peak loads. This was on account of inability of the central and state governments to fund new generation project due to fiscal crisis in the beginning of 90s. But the steering of the policy changes shifted towards enhancing the efficiency and financial performance of the power sector when foreign/private investment failed to meet the quantum of expected investment. Recently, Central Electricity Regulatory Commission (CERC) has started working towards the establishment of the spot market regime, a radical step towards full grown market oriented approach to the problems of electricity sector (CERC 2006). One of the major objectives of the thesis is to critically examine the impact of this policy changes on incentives and institutions of power sector.

Specifically this thesis tries to address the following objectives:

1. Analysis of past trends of energy supply and future projections of requirements for sustaining high economic growth (Chapters 2 and 3).

2. Critical examination of the policy changes on institutions and incentives for performance of power sector (Chapter 4).

3. Modeling of the spot market for power in India in short-run perspective (Chapter 5).

4. Assessing impact of the regulated retail sector tariffs on spot market prices and load rationing in the retail sector (Chapter 6).

5. Estimation of long-run marginal cost of adequate capacity additions and its implications for pricing (Chapter 7).

6. Review of international experience of spot market regime and policy lessons for India (Chapter 8).

Usual analysis of the energy sector and its linkage with the economy is limited to macro aggregates. This fails to capture the reality of the massive lack of access to MES among rural population and thus its impacts in inclusiveness of growth and environment. Our approach in chapter 2 would be to look at energy-economy link in development perspective. Therefore, we delve into issues of access and environmental sustainability. It has been demonstrated that exploring the poverty, environment and energy nexus would reveal a very different kind of approach towards policy. India, having a significant share of the globe in terms of its population, is not in a position to ignore the environmental issues. We also look at sectoral changes in Chapter 3 particulary in coal and oil & gas sector as these are the most important fuels including hydropower for power generation. Changes in these sectors will have significant impact on the availability and cost of fuel inputs for power sector.

The policy changes in electricity sector in the beginning of the 1990s were quite successful in improving the performance of generation sub-sector but at the cost of

system security (Soone et al. 2006). But these policies failed in its most important objective of adding new capacities to meet peak shortages. As a result of this, more comprehensive reforms were started in mid 1990s to revamp the sector. Major aspects of post mid 1990s reforms were to unbundle the vertical segments into separate entities and the subsequent privatisation of distribution entities, introduction of independent regulatory regime. Examination of the incentives and institutional change in the sector would reveal that there has been little improvement of the incentive structure. Introduction of independent regulatory commissions in the majority of states has resulted in greater availability of information though significant asymmetries of information regarding costs and demand still exists between the regulator and the regulated. Regulatory incentives under the cost of service regulatory regime has led to many unintended consequences (chapter 4). Even the comprehensive reform since mid 1990s has failed to attract private/foreign investment. Introduction of power exchange (hourly spot market regime) is considered to be the only option left to be tested to attract the private/foreign capital.

Spot market regime for bulk trade, as examined in this thesis, implies that electricity would be traded at market place on an hourly basis. Modeling the spot market with perfectly inelastic demand shows that generators (bulk sellers in the spot market) have enough incentive to enter the market (Chapter 5). As soon as demand response of the load serving entities (distribution companies who participate in the spot market as bulk buyers of the electricity) is introduced in the system, prices in spot market depress significantly. Because of the demand response of the distribution companies we find that existing capacity during the peak hours may not be fully utilised while demand of retail consumers remains unsatisfied. We have noted in the discussion that demand response of the distribution companies in India is an outcome of political process rather than a choice of economic agents in the economy. Political influence exercised by the state governments in matters of fixing retail tariffs limits the ability of the distribution companies to procure power from the spot market in

peak periods. As a result of this, load rationing of retail consumers are done during peak hours when spot price of electricity is high (Chapter 6). The long-term model provides us with long-run marginal cost (LRMC) of meeting loads. This is an indicative of the level of prices that would motivate investment in adequate capacities with appropriate technology which are much higher than the existing ones (Chapter 7).

There is a large body of literature on problems of the spot market regimes existing in different regions of the world and their possible solutions. Major problems that are faced in the liberalised electricity markets are the lack of incentives to bring in optimal capacity investments in transmission and generation sub-sectors. Many countries with spot market regime have been experiencing decline in their reserve margins of generating capacities. It is usually argued that spot market regimes have failed to deliver on system reliability. System reliability comprises two components – capacity adequacy (in transmission and generation) and system security. Adequacy of capacity can be successfully addressed through market based instruments but system security is claimed to be a public good and is usually under provided by the market regime. Therefore, some kind of regulatory interventions are needed but almost every suggested solution has their own limitations. These international experiences have important lessons for India as it would start a spot market regime with its existing capacity deficiency.

1.3 Data and Methodology

Our study largely depends upon exploration of the data available through secondary resources. We used data provided by central and state electricity regulatory commissions through their tariff orders, Central Electricity Authority (CEA), National Sample Survey Organisation (NSSO) through their survey on consumption expenditure for 61st round (2003-04), ministries of the Government of India relating to energy sector, International Energy Agency, United Nations Statics Division and the World

Bank.

In chapter 2 and 3, simple graphs and tabulation of the data has been used to flag the issues in the energy sector of India. In chapter 4 we use the tariff orders to analyse the impact of regulatory incentives on expected behaviour of the regulated firms with the assumption that regulated firms maximise profits. Tariff orders are the source document for information regarding rules through which costs and revenue of the regulated firms are determined. Behaviour of the regulated firms, therefore would largely be determined by the formulaes for calculation of revenues and costs given in the tariff order. Given the behaviour of individual firms, the overall outcome for electricity sector is examined.

Chapters 5 to 7 use mathematical programming technique for the analysis of the spot market regime. Chapters 5 and 6 deal with short run functioning of the spot market regime while chapter 7 addresses the long-run issues of investment in the generation capacity under spot market regime. In all the three chapters we model the problem of the system operator of the spot market (regulator of the bulk market) who tries to minimise the system cost of meeting a given load under different constraints depending on the context considered in the specific chapters.

The last core chapter (Chapter 8) of the thesis draws from the huge literature on spot market functioning of the other countries to elaborate on kinds of problems that Indian spot market regime may face in future. Lack of capacity additions in transmission and generation and achieving reliability are classical problems that are faced by spot market regimes. They have not yet been addressed sufficiently in the available literature in the Indian context. Therefore the thesis is devoted to develop an understanding of the issues of bulk market of electricity in short-run and long-run. Mathematical programming is used to anticipate results from the operation of spot market regime in India which is yet to be implemented in the country. Last chapter concludes (Chapter 9)