PERFORMANCE OF THE PUNJAB STATE ELECTRICITY BOARD AND DISTRIBUTION OF ELECTRICITY SUBSIDY TO AGRICULTURE

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I affirm that the research for this dissertation titled ***'Performance of the Punjab State Electricity Board and Distribution of Electricity Subsidy to Agriculture'*** being submitted to the Jawaharlal Nehru University, New Delhi, for the award of the degree of Master of Philosophy in Applied Economics, was carried out entirely by me at the Centre for Development Studies, Thiruvananthapuram.

(Varinder Jain)

Certified that this dissertation is the *bona fide* work of Varinder Jain. This has not been considered for the award of any degree by any other research institute / university.

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Abstract

The concurrent nature of electricity in the Indian constitution has left the ESI, since its very inception, vulnerable to the political pressures. The practice of bestowing privileges upon the major interest groups by the ruling parties has continued to the disadvantage of the State Electricity Boards – an important segment of the Indian Electricity Supply Industry. The present study finds that the electricity utility of the agriculturally advanced state of Punjab is no exception to this rule. In spite of the efficient operation of the Punjab State Electricity Board in electricity generation, the practice of granting either partial or full price concessions on electricity sale especially to the agricultural consumers contributed towards its dysfunctionings over the years. The study traces out the political influence in overstaffing and instability in the key management posts. Besides providing an estimate of the opportunity benefits lost due to the inefficient supply of electricity, the study highlights that the distribution of this electricity subsidy is not even; rather there are large disparities between the progressive and the backward areas in terms of their access to electricity. It is the medium and large farmers who reap the benefits arising from the subsidized provision of electricity. The poor small farmers remain excluded especially in the backward area and their plight continues due to their dependence on dearer diesel pump-set based irrigation. Thus, the study questions the justification of granting across the board electricity subsidy to the agriculture sector. The study also explores the possibilities on the demand side to replace the populist practices of granting these subsidies to the agricultural sector. The positive response of a large set of farmers regarding their willingness to pay the electricity charges under the conditions of adequate and reliable electricity availability provides a ray of hope to the electricity utility in Punjab.

Chapter 1
Introduction

1.1. The Context

The purpose of this study is two-fold. The first purpose is to analyze the performance of the Punjab State Electricity Board (PSEB, hereafter) in different aspects of its operation and the second intention of the study is to delve into the existence of area-wise disparities among different classes of the farmers for getting the benefit from electricity subsidy that has been granted through partial or full price concessions on sale of electricity to the agricultural sector. This second purpose emerges from that observation of the PSEB's performance analysis, which highlights the electricity subsidy to the agricultural sector as a major factor for its dysfunctionings.

Two factors provided persuasion to this study. Firstly, though a number of studies focusing on performance of India's electricity supply industry (ESI, hereafter) at national level are available, there have been very few studies concentrating on the performance of this utility at the regional level and hitherto there have been no academic attempt to analyze the performance of electricity utility in Punjab. This study fulfills this gap. Secondly, the electricity consumption by the agricultural sector in Punjab has increased at the average annual growth rate of 10.43 percent during 1970-71 to 1999-2000, and its share in total sales has remained within the range of 35 to 50 percent during the same period. Such a large share in electricity supply and consequent huge quantum of electricity subsidy arising from the partial or full price concessions on electricity sale to the agricultural sector provides enough ground to analyze the region-wise distribution of this subsidy among different classes of the farmers.

1.2. Performance of the ESI: A Brief Review of Literature

The seminal work by Averch and Johnson (1962) has hypothesized the presence of production inefficiency among regulated private monopolies. The empirical validity of this hypothesis was tested in many industries including the ESI, where this hypothesis was tested empirically by an analysis of its performance under public and private ownership.

Meyer (1975) by estimating a quadratic cost function concludes that the publicly owned utilities have lower per unit costs than privately owned utilities. But this study does not take into account the differences in factor prices and technology. Another study (Pescatrice and Trapani, 1980) estimates a generalized translog cost function. It allows for effects of regulation by using shadow input prices rather than the market input prices. Like Meyer (1975), this study also points out that the public firms minimize cost.

On the contrary, Atkinson and Halvorsen (1986), by allowing regulation to affect both types of utilities, find that no significant differences exist in allocative efficiency between publicly owned and privately owned utilities and both types of utilities are equally cost efficient. Similarly another study by Pollitt (1995), observes no significant difference in technical efficiency between the utilities under both the types of ownership but it provides some evidence for superior cost efficiency in private utilities.

In contrast, another study by Koh, et al. (1996) points out that the question of the relative efficiency of the utility under both the types of ownership depends upon its scale of operation. It observes that the publicly owned utilities become less efficient relative to the privately owned utilities as output rises in the sense that the publicly owned utilities have lower cost than the privately owned utilities at low output levels and higher cost at high output levels.

A glance at these studies reveals that all of these studies analyzing the relative efficiency of publicly owned and privately owned electricity utilities consider the efficiency in the generation aspect of a non-integrated ESI. Also, these studies have not considered the effects of competition, but the presence of competition in the industry is an important determinant of the performance of the ESI (Kwoka, 1996; as quoted in Thillai, 2002:17).

Generally, the element of competition is absent in the case of a vertically integrated ESI solely under the state control, rather its performance remains affected by the policies of the state that acts as its owner, supplier and rule-maker. The state-owned vertically integrated ESI in India is not an exception. Its performance remained affected by various socio-economic and political factors over the period of time.

The State Electricity Boards (SEBs, hereafter) operating in the state sector have been an important constituent of the Indian ESI. These SEBs control a major part of power generation and virtually all of its distribution. They also control most of the transmission lines within states. A number of government committees have made recommendations from time to time in order to ensure the efficient functioning of the SEBs. But, these recommendations remained only in 'black and white' and were never bothered to bring into practice by the state governments, who continued to affect the SEBs' functioning in various ways. Owing to this, the SEBs' performance levels kept on worsening.

These worsening levels of the SEBs' performance have been highlighted by a number of studies. Attempts have been made both to analyze the particular aspects of the SEBs' operation as well as the overall performance in all aspects. In these studies, some of the issues addressed are capacity utilization, time and cost overruns, electricity supply efficiency, labor productivity, tariff structure etc.

A study (Jha, et al., 1992) focusing on the generation aspect of the SEBs observes technological stagnation in thermal units of all the SEBs. It also notices some evidence of technological regress in these units. The study further highlights that there have not been any economies of scale in electricity generation rather the case is quite opposite due to the presence of diseconomies of scale. The thermal units of the SEBs of small states have performed relatively better than those of larger states. However, this study does not point out any specific reasons for technological stagnation in thermal units of these states. There may be a variety of reasons but there is the possibility that the reasons for technological stagnation may be different for different states.

Alagh, et al. (1998) makes an in-depth study of generation aspect of the Gujarat State Electricity Board (GSEB, hereafter), a SEB having major share of thermal generating capacity, to point out various possible factors responsible for high level of forced outages in thermal units. This study points out the economizer tube failure and turbine-bearing vibration as the major factors out of the eight major types of faults responsible for the occurrence of high levels of forced outages in the GSEB's thermal units.

The commercial aspect of the SEBs' performance has been analyzed by Rao, et al. (1998). This study reviews the existing pricing policy and its adverse consequences on the SEBs' finances. It highlights that the prevailing inefficiencies are primarily due to lack of competition, organizational problems and political considerations in major management decisions as well as in setting prices.

Subramaniam (1996) analyzes the performance of the SEBs in India in general in technical as well as financial aspects. His study highlights that the generating units of the SEBs remained quite inefficient over the period of time and the increased levels of plant load factor (PLF, hereafter) since the 1980s have been mainly due to the introduction of 500 MW and 210 MW generation sets rather than a better operation of the existing plants. However, the study does not give any credit to the capacity improvements made by the renovation and modernization programs initiated during this period. This study also highlights the poor efficiency of the SEBs in supplying electricity. It also reveals various endogenous and exogenous factors[1] responsible for deteriorating financial performance of the SEBs.

Kannan and Pillai (2002) highlight the operational inefficiencies inherent in the system not merely by pointing them out but also by providing enough quantitative estimates of losses incurred by the system due to these inefficiencies. These operational inefficiencies in various functions range from the initial stages of project execution to the final stages of commercial operation. This study proves that there are internal rather than the external factors that are responsible for poor and deteriorating performance levels of the SEBs in India. Owing to this, the Indian power sector needs essence-specific reforms and not the structure-specific ones. This study also visualizes the existing problems of Indian power sector from political economy perspective. It highlights the role of various political economy elements like rent seeking, corruption etc. in the dysfunctioning of Indian power sector.

[1] The endogenous factors include low levels of capacity utilization, high levels of transmission and distribution losses, huge revenue arrears and high establishment costs. The exogenous factors include low tariff levels for domestic and agricultural sector consumers, improper capital structure, unfavorable pricing of coal, gas and railway freight for coal transportation.

Thus, it becomes quite clear from the above review that the performance of the Indian power sector has been analyzed at great length. The Indian power sector has been found to be inefficient in all aspects of its operation. The national level studies can provide an idea about the performance of the electricity utility in a particular state. Nevertheless, it is much difficult to trace out the actual factors responsible for latter's poor performance through an analysis of the former because of the fact that every state has its own peculiarities and it is quite impossible for a national level study to highlight their contribution to a decline in its utility's performance.

The studies like Subramaniam (1996); Rao, et al. (1998) and Kannan and Pillai, (2002) have highlighted, either directly or indirectly, that the granting of price concessions on sale of electricity to the agriculture sector has been a major factor responsible for deterioration in commercial performance of the SEBs. This finding arouses interest to focus on performance of the SEB in such a state whose agriculture is relatively well-developed and is sufficiently modernized so that more insights regarding the flow of electricity subsidy and the sustainability of electricity utility in that state can be obtained.

1.3. Choice of the PSEB

With the aim of understanding the performance of an electricity utility in an agriculturally advanced state, the choice of the PSEB has been made on account of the fact that Punjab is well known for making the 'Green Revolution' a big success. The commercial nature of agriculture in Punjab is significantly dependent on modern inputs like assured irrigation. Though Punjab has a good canal system of irrigation, the significance of tube-wells for strengthening Punjab's irrigation potential cannot be denied as tube-wells contributed to irrigate 67.5 percent of the net irrigated area in 1998-99 (CMIE, 2002a).

Most of the tube-wells are operated with electricity. The total number of electric pump-sets, as on 31st March 2000, was 7,55,141 (CMIE, 2003). Punjab has been a volunteer state to adopt flat rate tariff for electricity supply to the fields for irrigation purposes since the 1970s. Initially, this policy was adopted to boost up 'Green Revolution' but later on, it became a major populist measure to woo votes.

This practice reached extremes when one political party, in 1997, announced to provide electricity free of any charge to the agricultural sector as political agenda in its election manifesto and it did so after assuming the office. This contributed significantly to raise the magnitude of electricity subsidy to the agricultural sector. The electricity subsidy more than doubled within a short span of three years i.e. from Rs. 925.04 crore in 1996-97 to Rs. 2016.18 crore in 1999-2000 (see Table 3.27).

1.4. Objectives of the Study

The main objectives of this study are:

1. To analyze the performance of the PSEB in different aspects of its operation.
2. To assess the magnitude of inefficiency cost especially in the transmission and distribution of electricity.
3. To examine the access to electricity supply and hence the distribution of electricity subsidy among different classes of farmers in areas differing from each other on account of their levels of socio-economic development.
4. To observe whether farmers have any willingness to pay the electricity charges under the existing as well as improved conditions of electricity supply at the farm.

The following aspects would be covered under these objectives:

In the first objective, we would look into the operational, organizational and the commercial aspects of the PSEB's performance over the period of time. The operational aspect would include an analysis of the PSEB's performance in making the required capacity additions, electricity generation and its supply to the consumers' premises. The issues of labor productivity and the stability in tenure of top officials would be considered in the organizational performance whereas the commercial performance would be highlighted through the trend of average cost, average revenue, average cost and average variable cost recovery and the total subsidies / cross-subsidies to / from different categories of consumers.

The second objective would assess the magnitude of inefficiency inherent in the functioning of the PSEB in aspects like the transmission and distribution of electricity.

The third objective would analyze disparities in access to electricity supply and hence to electricity subsidy among different classes of the farmers in progressive and backward areas of Punjab. In addition to discussing the implications of granting 'across the board' electricity subsidy to agricultural sector, it would highlight the nature of policy and practices inherent in granting of new electricity connections during the later phase of free electricity supply policy.

Finally, the fourth objective would examine the farmers' willingness to pay for electricity supply in its existing and the alternative improved conditions. This objective *per se* has special significance, as it would guide towards the sustainability of electricity utility in the future.

1.5. Statistics- Its Sources and Limitations

The study makes use of both secondary and primary sources of data. The secondary data sources comprise various publications of Punjab State Electricity Board, Central Electricity Authority, Center for Monitoring Indian Economy, Census of India, Economic Surveys and Central and State government's plan documents. The primary level information has been collected from the agricultural households through a primary survey with a structured questionnaire. Some interviews with bureaucrats, academicians etc. have also been conducted and their opinions have been used to support the arguments, wherever necessary.

1.6. Methodology Adopted

The adopted methodology to analyze both the secondary as well as primary data is of the interpretative nature and centers on averages, growth rates, percentage shares in total, etc. Besides, it makes use of test statistics like the Chi-square (χ^2, hereafter) test to explore the relationship between various variables. The methodology adopted for the sample selection has been discussed in detail in section 4.3.

1.7. Significance of the Study

The Punjab State Electricity Board has remained hitherto a gray area for research. Given the fact that a major share of Punjab's plan outlay is allocated for the development of its power sector[2], it is pertinent to analyze systematically the performance of the PSEB over the years.

Besides, the study analyzes farmers' willingness to pay user charges for electricity along with highlighting the presence of disparities in access to electricity supply and hence, the electricity subsidy among different classes of farmers in the backward as well as progressive areas of Punjab – an issue of significant relevance for policy making.

1.8. Scheme of the Study

The study is organized in six chapters. Following the introductory chapter, the second chapter provides a brief overview of the composition, growth and performance of the Indian ESI over the period of time.

The structure and performance of the PSEB is highlighted in the third chapter. The structure of the PSEB is described in terms of its resources and loads. The performance of the PSEB is highlighted through an analysis of operational, organizational and commercial aspects of its functioning. The estimates of inefficiency cost implicit in the PSEB's poor performance in transmission and distribution of electricity are also given.

The fourth chapter provides the methodology adopted for sample selection. It also highlights various socio-economic characteristics of the selected areas and the surveyed agricultural households.

The fifth chapter highlights the presence of area-wise disparities in flow of electricity subsidy through a discussion on differences in availability of electrified irrigation pump-set connections, possibilities for having electricity connections, duration of electricity availability and the quality of electricity. Besides revealing the implications

[2] Table 1.1 indicating the trend of plan allocation to power sector in Punjab is in Annex 1.

of granting across the board electricity supply to the agricultural sector, it also highlights the nature of policy and practices inherent in granting new electricity connections in the later phase of free electricity supply policy. This chapter also examines different degrees of willingness of the sampled farmers to pay electricity charges in the existing and alternative improved conditions of electricity supply. It also provides a promising insight for the sustainability of electricity utility in an agriculturally advanced state like Punjab by pointing out how the new alternative scenario of reliable and quality electricity provision is beneficial to both the PSEB and to the farmers.

The summary and conclusions are highlighted in the sixth chapter.

Annex 1

Table 1.1: Allocation of Plan Outlay to the Power Sector in Punjab

Plan Period	Punjab's Power Sector Allocation (Rs. Crore)	Punjab's Total Plan Outlay (Rs. Crore)
Fourth Plan (1969-74)	119.08 (40.56)	293.56
Fifth Plan (1974-79)	403.07 (39.25)	1027
Annual Plan (1979-80)	94.17 (36.22)	260
Sixth Plan (1980-85)	732.94 (37.45)	1957
Seventh Plan (1985-90)	1638 (49.86)	3285
Annual Plan (1990-92)	700 (36.55)	1915
Eighth Plan (1992-97)	2417.5 (36.80)	6570
Ninth Plan (1997-2002)	3640 (25.45)	14300

Note: The figures in parentheses are percentages to the total plan outlay.
Source: Government of Punjab (1997a; 1997b)

Chapter 2
Electricity Supply Industry in India

2.1. Introduction

Electricity serves as a major source of energy to carry out different kinds of productive and non-productive operations. Its increasing use in a variety of functions has had a strong bearing on different aspects of human life. Its significance in daily life has risen to such an extent that the level of availability and accessibility of affordable and quality electricity has been considered as one of the main determinants of standard of living. But, this capacity of electricity to improve the levels of socio-economic development of a nation is determined by the efficient operation and growth of its Electricity Supply Industry (ESI, hereafter).

The efficient operation and growth of the ESI, because of peculiar characteristics of electricity, requires the functioning of its different segments viz. generation, transmission and distribution of electricity, in a coordinated manner. This coordination can be ensured either in a vertically integrated system or through the contract-based arrangements between independent non-integrated entities.

The coordination in the latter case involves huge transaction cost of enforcing contractual agreements whereas such coordination is implicit in a vertically integrated ESI under single ownership and control. Till recently, the arguments based on keeping the natural monopolies in the public sector for equity considerations along with the inadequacy of necessary skills to minimize the huge transaction cost embedded in enforcement of contractual agreements favored the evolution of vertically integrated ESI under state patronage throughout the world (Ruet, 2002).

In the case of a developing country like India, the similar considerations along with the socialist ideology played an important role to persuade the state for taking initiative to develop the ESI soon after independence. Besides the unattractive long gestation periods, the inability of the private sector to invest significantly required active state intervention. Owing to these factors, the ESI in India operated under the state control. The operation of the utility under single state ownership and control can be understood better through a consideration of its evolution and performance over the years.

This chapter is divided into four sections. The next section discusses the evolution of the Indian ESI on both the supply and demand side of its operation. Its evolution on supply side is studied through a discussion of its institutional framework, plan expenditure along with its composition and growth on this side whereas the evolution on the demand side is studied through an analysis of the growth of demand side parameters. The third section provides a brief analysis of its performance. The last section concludes.

2.2. Evolution of the Indian ESI

The Indian ESI has evolved over the period of time from a small industry that was confined to serve the needs of few urban areas to such mammoth size that it serves today not only almost all urban areas but also caters to the needs of a large chunk of rural population for both productive and non-productive operations. It has grown in size and scope since independence. Its evolution over the period of time can be studied under both the supply as well as demand side of its operation.

2.2.1. Supply Side

The supply side of the ESI comprises its electricity generation potential and the capacities required for efficient transmission and distribution of electricity to the consumers' premises. The Indian ESI has undergone major changes in the institutional set-up as well as composition and growth of different constituents on the supply side in response to the developments that took place on its demand side over the period of time. Therefore, the analysis of the supply side requires an understanding of changes that took place in both the institutional framework as well as composition and growth of the ESI over the period of time.

A. Institutional Set-up

The institutional set-up of Indian ESI has observed changes over the period of time. The electricity, before India's independence, was generated and supplied locally to large urban concentrations by private entrepreneurs, enterprising municipalities and provincial governments. However, it was decentralized on the ground that there was little coordination / cooperation among suppliers.

The first legislation, passed in 1877, provided for the protection of person and property from injury and risks (Rao, 2002: 3433). The 'Indian Electricity Act, 1903' replaced this legislation. Later again, it got amended through the 'Indian Electricity Act, 1910' that left the granting of all licenses in the hands of the local government.

But after independence, the 'Indian Electricity Act, 1910' was supplemented with the 'Electricity Supply Act, 1948' – an Act passed on the broad lines of the 'Electricity (Supply) Act, 1926' of the United Kingdom - to facilitate the establishment of regional coordination in the development of the ESI by transcending the geographical limits of local bodies. It paved the way for the setting up of an apex advisory organization viz. the Central Electricity Authority to advise on various power related matters.

The 'Electricity Supply Act, 1948' guided the growth of electric power in India by allowing states to create State Electricity Boards (SEBs, hereafter) responsible for generation, transmission and distribution of electricity within the state. Many states have established their own SEBs by the late 1950s but some smaller states and union territories continued to operate their power systems by Electricity Departments (EDs, hereafter). The 'Industrial Policy Resolution, 1956' reserved generation and supply of electricity almost exclusively for the states but it allowed the existing private licensees to continue their operation. This led to gradual control of the ESI by the state sector.

The need for regional integration of power systems, after establishment of the SEBs, was immensely felt due to diversity in consumption patterns and variations in the generation mix of different states. Consequently, the Regional Electricity Boards (REBs, hereafter) were established through a government resolution passed in 1964 to reap the economies that would accrue from regional integration of the power systems.

All the SEBs and EDs, for planning of power generation, have been classified into five REBs viz. Northern, Western, Southern, Eastern and North-Eastern. The ultimate objective for such an exercise was to integrate the activities of these boards to form a National Grid (Natarajan, 1989).

The REBs were given the statutory power in 1991 through an amendment in the 'Electricity (Supply) Act, 1948' to strengthen the grid management and enforce the grid discipline. These boards were authorized in 1996 to decide on the issues regarding the plant dispatch i.e. to decide upon operation of the plant to meet demand during off-peak and the peak periods on the basis of merit order operation.

In addition to the SEBs, the Central Government played a direct role in power development through Damodar Valley Corporation (1948), Neyveli Lignite Corporation (1956) and Nuclear Power Projects etc. In order to facilitate the electrification of rural areas at fast pace, it established the Rural Electrification Corporation (REC) in 1969. An amendment in the 'Electricity Supply Act, 1948', in 1976, enabled the Center for the setting up of new generating companies like the National Thermal Power Corporation (NTPC, 1976), the National Hydro-Electric Power Corporation (NHPC, 1976) and the North-Eastern Electric Power Corporation (NEEPCO, 1976) to construct power stations, to exploit economies of scale and cater to the power needs of various states.

Another major event was the establishment of the Power Finance Corporation (PFC, 1986), which aimed to provide financial assistance to the SEBs, State Electricity Departments and Central Power Corporations. Power Grid Corporation of India Ltd. (PGCIL, 1989) was set up at the national level to facilitate the inter-state transmission of electricity. In 1991, the private sector was allowed to participate in the power generation process through amendments in existing laws. These amendments enabled this sector to operate power stations but subject to certain legislative restrictions. In 1998, the private sector was allowed through the 'Electricity (Amendment) Act, 1991' to participate in transmission sector in collaboration with the PGCIL though it restricted the private sector participation to projects constructed on BOOT (Build-Own-Operate-Transfer) basis under the supervision and control of the PGCIL.

During the late 1990s, the reform process in the state sector was initiated to introduce competition in different segments of the ESI through unbundling, corporatization and privatization of the SEBs. The 'Electricity Regulatory Commission Act, 1998' provided for the creation of a Central Electricity Regulatory Commission and the State Electricity Regulatory Commissions by the states.

The states thus had an option of creating the electricity regulatory commissions either on the basis of the 'Central Act' or through a legislation of their own, as Orissa did (Dubash and Rajan, 2001: 3384). The 'Electricity Regulatory Commission Act, 1998' provided for the introduction of reforms in power sector at national level. At this juncture, the 'Electricity Bill, 2003' has been passed by the parliament. This bill intends to replace the existing Acts viz. the 'Indian Electricity Act, 1910', the 'Electricity Supply Act, 1948' and the 'Electricity Regulatory Commission Act, 1998'.

B. Plan Expenditure

The Indian planners recognized the crucial role of energy sector in general and the power sector in particular for India's socio-economic development. After Second Five-Year Plan, the share of energy sector in total plan expenditure recorded continuous rise till Seventh Five Year Plan. It registered decline during Eighth and Ninth Five-Year Plan but it remained above 20 percent of the total plan expenditure (Table 2.1).

The power sector received a priority above all other sub-sectors within the energy sector. A major share (nearly or more than 60 percent) of total energy sector expenditure has been committed for the power sector development in almost all Five-Year Plans. The share of power sector in total plan expenditure increased from Second Five-Year plan to the Fifth Five-Year plan. It declined thereafter till Ninth Five-Year plan except Seventh Five-Year plan when it improved by the margin of 0.6 percent. In the Tenth Five-Year plan, a share of around 20 percent of plan outlay has been allocated for power sector development (Table 2.1).

But, the allocation of outlay to different segments within the power sector has not been uniform over the planning era as the share of total outlay incurred for augmentation of generation potential remained higher than the corresponding share for development of adequate transmission and distribution (T and D, hereafter) network.

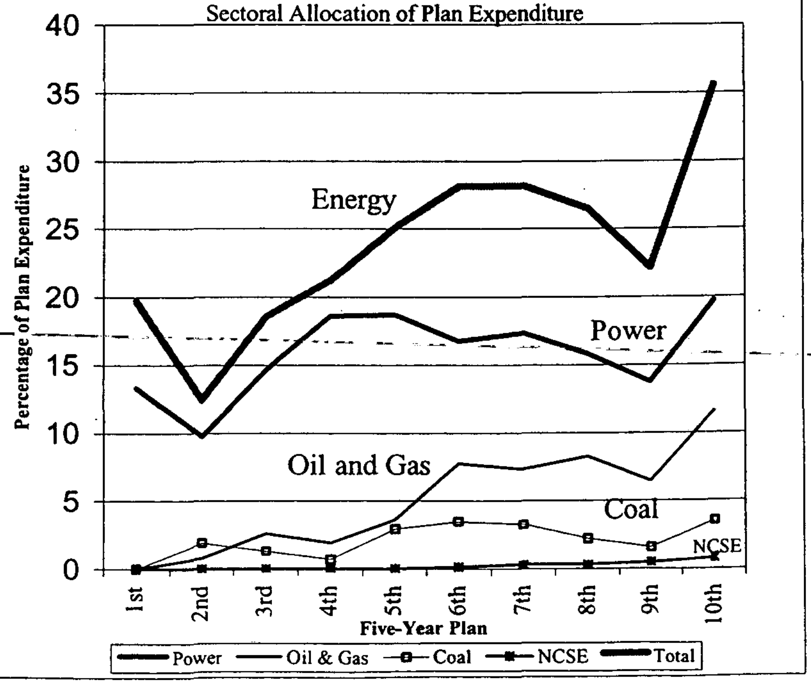
The situation has been so drastic that the *Rajyadhaksha* Committee Report (GOI, 1980: 26) mentions that the *"additions to T and D system seem to be made on 'ad-hoc' basis without any attempt to work towards a long term T and D system which has been designed to meet the projected needs at the minimum cost"*.

Table 2.1: Plan Expenditure on the Energy Sector

Plan	Period	Plan Expenditure (Rs.Cr.)	Share of Energy Sector (%)				
			Power	Oil and Gas	Coal	NCSE	Energy
First	1951-56	1,960	13.27	-	-	-	19.7
Second	1956-61	4,670	9.7	0.8	1.9	-	12.4
Third	1961-66	8,580	14.6	2.6	1.3	-	18.5
Fourth	1969-74	15,780	18.6	1.9	0.7	-	21.2
Fifth	1974-79	39,430	18.7	3.6	2.9	-	25.2
Sixth	1980-85	1,09,291.7	16.74	7.76	3.48	0.15	28.14
Seventh	1985-90	2,18,729.6	17.33	7.32	3.26	0.3	28.20
Eighth	1992-97	4,85,457.2	15.8	8.25	2.21	0.29	26.55
Ninth	1997-02	8,44,031.8	13.73	6.45	1.56	0.46	22.20
Tenth	2002-07	8,93,183	19.68	11.61	3.54	0.8	35.62

Note: '-' = Nil or Not Available; NCSE = Non-Conventional Sources of Energy
Note: Plan Expenditure is at current price of the base year of respective plan and figures for Tenth plan are the total plan outlay.
Source: GOI (1997a; 2002a; 2002b; 2003)

Figure 2.1
Sectoral Allocation of Plan Expenditure



Even after the GOI (1980) recommendations, this trend continued till the Ninth Five-Year plan when there has been some improvement in the plan allocation for the development of T and D system. In the year 2000-01, the share of allocation of power sector outlay on generation declined from that in 1992-93 and consequently, the allocation of outlay on T and D renovation and modernization and rural electrification increased in the year 2000-01 (GOI, 2002a: 14). But even then these allocations did not reach the level that has been considered to be desirable from an operational point of view i.e. 4:2:1:1 ratio for generation, transmission, distribution and rural electrification (GOI, 1980: 26). This non-optimal allocation on different segments of the ESI has led to the high levels of T and D losses along with poor quality of electricity supply to consumers in almost all states and thus adversely affecting the financial position of the SEBs.

C. Composition and Growth of the ESI

The composition as well as growth of the ESI during both pre-independence and post-independence period is discussed as under.

1. Pre-Independence Period

The history of electricity supply at a large scale begins only in 1899 with the installation of a big thermal station by the Calcutta Electric Supply Corporation (CESC) in Calcutta. The first hydroelectric station was constructed in 1902 at Sivasamudram in Mysore followed by the installation of another hydro plant by the Tata Hydro Electric at Khandala for supplying electricity to Bombay.

During this period, almost all major plants were installed to serve both the domestic and industrial needs of urban areas. The progress of the ESI till 1920 was rather slow, but afterwards, there took place a rapid expansion. The total electricity generating capacity has increased by around two times since 1939 up to the year 1949-50 i.e. about 1 million kiloWatt (kW, hereafter) in 1939 to about 1.71 million kW in 1949-50. The total electricity generated has also increased from about 2500 million kiloWatt-hour (kWh, hereafter) to 5100 million kWh over the same period (GOI, 1952: 341).

2. *Post-Independence Period*

During the post-independence period, the public utilities have been assigned a significant role for power development. But the total installed capacity for generating electricity did not remain confined to only these utilities as non–utility power stations also contributed to the total installed generating capacity and electricity generation.

a. *Non-Utilities*

The non-utilities have set up their own power stations to enable them to tide over problems due to power shortages and poor quality of electricity supply. These non-utilities comprise railways and a number of industries, viz. aluminum, cement, fertilizer, iron, paper, steel, sugar etc. who besides purchasing power from the utilities, have their own captive power plants either to supplement the electricity supply from the utilities or for generating electricity as a by-product through co-generation.

The installed generating capacity and the gross electricity generation by the non-utilities, since the 1950s, has increased 23.7 and 29.2 times respectively. The share of non-utilities in total installed generating capacity and electricity generation declined continuously till the end of 1970s (Table 2.2) because utilities continued to register relatively higher growth rates in capacity additions over this period (Table 2.3). This was mainly facilitated by the sound financial base of the utilities during this period. The irrelevance of increasing capacities in the presence of adequate supply at reasonable tariff rate may also be one of the reasons that did not prod the non-utilities to make capacity additions at a faster rate.

This trend got reversed during the post-1980 period when the non-utilities registered relatively higher growth rates in both the capacity additions and the electricity generation (Table 2.3). Owing to this, the share of non-utilities in total capacities got improved though it remained much below to that of the utilities. The non-utilities had to augment the levels of their capacity additions because utilities proved to be incapable in providing adequate and reliable electricity supply due to their poor financial performance during this period. This apart, the policies of subsidies and cross-subsidies introduced by state governments during the late 1970s may also be one of the factors that encouraged non-utilities to opt for the relatively cheaper source of electricity supply.

Table 2.2: Composition of Installed Generating Capacity and Gross Electricity Generation

Year	Installed Generating Capacity (MW)					Gross Electricity Generation (MUs)				
	Utilities			Non-Utilities (Includes Railways)	All-India	Utilities			Non-Utilities (Includes Railways)	All-India
	Hydro	Thermal	Total			Hydro	Thermal	Total		
December 1950	559.29 [32.66]	1153.23 [67.34]	1712.52 (74.45)[100.0]	587.85 (25.55)	2300.37 (100.00)	2859.7 [48.81]	2998.7 [51.19]	5858.4 (77.97)[100.0]	1655.57 (22.03)	7513.97 (100.00)
1960-61	1916.66 [41.19]	2736.39 [58.81]	4653.05 (82.29) [100.0]	1001.37 (17.71)	5654.42 (100.00)	7836.6 [46.27]	9100.4 [53.73]	16937 (84.17)[100.0]	3186.1 (15.83)	20123.1 (100.00)
1970-71	6383 [43.40]	8326 [56.60]	14709 (90.40) [100.0]	1562 (9.60)	16271 (100.00)	25248 [45.23]	30579 [54.77]	55827 (91.20)[100.0]	5384 (8.80)	61211 (100.00)
1980-81	11791 [39.03]	18422 [60.97]	30213 (90.69) [100.0]	3102 (9.31)	33315 (100.00)	46542 [41.99]	64302 [58.01]	110844 (92.94)[100.0]	8416 (7.06)	119260 (100.00)
1990-91	18753 [28.38]	47333 [71.62]	66086 (88.47) [100.0]	8612 (11.53)	74698 (100.00)	71641 [27.10]	192687 [72.90]	264328 (91.32)[100.0]	25111 (8.68)	289439 (100.00)
1998-99	22479 [24.10]	70814 [75.90]	93293 (87.01) [100.0]	13932 (12.99)	107225 (100.00)	82923 [18.49]	365622 [81.51]	448545 (90.27)[100.0]	48353 (9.73)	496898 (100.00)

Note: The figures in square brackets and parentheses are percentages of utilities' total and the All-India figures respectively.
Source: CMIE (2002b); GOI (1974-75)

Table 2.3: Growth of Installed Generating Capacity and Gross Electricity Generation

Period	Growth Rate of Installed Generating Capacity (%)					Growth Rate of Gross Electricity Generation (%)				
	Utilities			Non-Utilities (Includes Railways)	All-India	Utilities			Non-Utilities (Includes Railways)	All-India
	Hydro	Thermal	Total			Hydro	Thermal	Total		
1950-60	14.67	10.08	11.75	6.10	10.51	11.85	13.13	12.52	7.54	11.57
1960-70	14.30	13.16	13.64	5.06	12.46	13.88	14.42	14.17	6.00	13.16
1970-80	7.06	9.23	8.33	7.92	8.29	7.03	8.61	7.92	5.09	7.69
1980-90	5.29	11.05	9.09	12.01	9.39	4.91	12.97	10.14	12.91	10.35
1990-99	2.29	5.16	4.40	6.20	4.62	1.84	8.34	6.83	8.54	6.99

Source: Based on CMIE (2002b); GOI (1974-75)

b. Public Utilities

The public utilities registered an increase in installed generating capacity and electricity generation by 54.47 and 76.56 times respectively since December 1950. The public utilities have been more than two times ahead of non-utilities in recording an increase in installed capacity and electricity generation over the same period.

The installed generating capacity of the utilities comprises hydro and thermal capacities. The thermal capacity is a combination of steam, diesel, wind and nuclear potential. The share of hydro installed capacity and consequently the electricity generation remained below than that of the thermal units in total installed capacity and electricity generation by the utilities over the period of time (Table 2.2). The share of hydro installed capacity improved continuously till 1970-71 from that in December 1950 and it was well in tune with the hydro-thermal mix of 40:60[1].

The high growth rate of hydro capacity during the earlier plans has been due to the fact that it also facilitated the augmentation of irrigation potential but during the post-1970 period, the hydro share registered continuous decline. This has been mainly due to the "slackness in investment and slippages in implementation" (GOI, 1980: 18). Along with these factors, the completion of thermal units in the timely fashion due to their low gestation periods might have induced planners to alleviate the electricity supply difficulties that turned grave during the late 1970s.

The share of hydro capacity in total capacity of the utilities in 1998-99 stood at 24.10 percent (Table 2.2). The hydro-thermal mix has fallen to the ratio of 1: 3. Such non-optimal generation mix renders the inefficient operation of power system because the thermal generating capacity has to be backed down even during the off-peak hours. This situation is prevailing despite the emphasis put by the *Rajyadhaksha* Committee (GOI, 1980) on adding more hydro capacity mainly as a backup for shortfall in thermal generation to meet the peak demand.

[1] A reply to question number 3081 on 17 March 1987 in the Lok Sabha has been quoted in CMIE, 1988: 2-3. It has been mentioned, "while there is no ideal ratio of hydro-thermal mix in a power system as the same would depend on a number of system parameters, a generation mix of the order of 40 % hydel and 60 % thermal capacity is considered fairly adequate for Indian system."

The ownership of public utilities in India, at present, lies with both the public and the private sector. The growth of public utilities has varied under different controls.

i. Public Sector

The public sector has emerged as a major constituent of Indian ESI due to existing legislations and the ideological framework that prevailed during the post-independence period. Its scope spans the state and the central sector. The state sector operates through the SEBs, EDs and the Government local bodies whereas the functioning of Central Power Corporations reflects the central sector participation in India's ESI.

State Sector

A major segment of the ESI in India has grown in the state sector. It was mainly because of the fact that the 'Electricity Supply Act, 1948' and the 'Industrial Policy Resolution, 1956' vested the state sector with the prime responsibility of electricity generation and distribution. The monetary and fiscal policies of the Central Government remained favorable towards the power sector development in the state sector. This resulted in incurring of large investments by most of the states to develop their own power systems.

It was mainly the state sector where significant additions in installed generating capacity were made up to the late 1960s. Though the Center started contributing to the total installed generating capacity and electricity generation by setting up nuclear power plants, its share in the total potentials remained at relatively lower levels. The state sector owned more than four-fifths of total installed generating capacity and electricity generation in the beginning of the 1980s. Though there has been an improvement in absolute quantum of capacity additions in the later period, its share in total has registered a decline in the post-1980 period (Table 2.4).

The state sector was left behind by the central sector in this respect and the growth rate of installed capacity by the state sector continued to decline throughout the period (Table 2.5) because of the inability of the state sector to finance the required additions to the generation potential. This inability stemmed from the deteriorating commercial performance of the SEBs.

Table 2.4: Sectoral Composition of Installed Generating Capacity and Gross Electricity Generation

Period	Installed Capacity (MW)				Gross Generation (MUs)			
	Central	State	Private	All-India	Central	State	Private	All-India
1970-71	2503 (17.02)	10719 (72.86)	1488 (10.12)	14710	9402 (16.84)	40159 (71.94)	6266 (11.22)	55827
1980-81	3620 (11.98)	25213 (83.45)	1382 (4.57)	30215	12965 (11.70)	91149 (82.23)	6730 (6.07)	110844
1990-91	16772 (25.38)	46573 (70.47)	2742 (4.15)	66087	73948 (27.98)	177434 (67.13)	12947 (4.90)	264329
1998-99	28372 (30.41)	56664 (60.74)	8259 (8.85)	93295	159195 (35.49)	256546 (57.20)	32804 (7.31)	448545

Note: The figures in parentheses are the percentages of All-India figures

Source: CMIE (2002b)

Table 2.5: Sectoral Growth of Installed Generating Capacity and Gross Electricity Generation

Period	Growth Rate of Installed Capacity (%)				Growth Rate of Gross Generation (%)			
	Central	State	Private	All-India	Central	State	Private	All-India
1970-81	3.76	8.93	-0.74	7.46	3.27	8.54	0.72	7.10
1980-91	16.57	6.33	7.09	8.14	19.02	6.89	6.76	9.08
1990-99	6.79	2.48	14.78	4.40	10.06	4.72	12.32	6.83

Source: Based on CMIE (2002b)

The commercial performance continued to deteriorate because the states have pursued vigorously the populist policies of subsidizing electricity sale to their major vote banks i.e. the domestic and agriculture sector. The lack of adequate subventions from the state governments has made the SEBs financially bankrupt and this had a direct effect on the average annual growth rate of installed capacity in the state sector.

The growth of the state sector in the generation of electricity has not been much attractive. The share of this sector in total electricity generation remained below its corresponding share in installed generating capacity over the whole period of time (Table 2.4).

There have been variations in the growth rate of electricity generation over the same period. Though it has shown a declining trend, it remained above the same recorded by the state sector in installed generating capacity during the post-1980 period (Table 2.5). Subramaniam (1996) argued that it was due to the introduction of 500 MW and 210 MW generation sets. But, it may also be due to the improvement in capacity utilization by state units that might be the result of the renovation and modernization process that was started in 1984.

Table 2.6: Growth of Transmission and Distribution Lines

Lines	Sector	Length of lines (Ckt. Km.)				Average Annual Growth Rate (%)		
		1970-71	1980-81	1990-91	1998-99	1970-81	1980-91	1990-99
Transmission	Central	0	0	15999 (7.73)	29733 (13.00)	-	-	8.05
	State	79887 (100.0)	120664 (100.0)	190892 (92.27)	198941 (87.00)	4.69	5.23	0.52
	Total	79887	120664	206891	206891	4.69	6.17	1.26
Distribution	State	1034024	2401797	4326523	5481732	9.82	6.76	3.00

Note: The figures in parentheses are the percentages to the total length of transmission lines.
Source: GOI (1980-81; 1990-91; 1998-99); CMIE (2002b)

A large part of transmission and almost full distribution network is with the control of state sector. This operation of the ESI had been the monopoly of state sector before 1989 when the PGCIL was established in the central sector. The 230 / 220 Kilovolt (KV, hereafter), 132 / 110 KV and 90 KV lines along with 400 KV lines in some states[2] are the transmission lines whereas 78 / 66 KV, 33 / 22 KV, 15 / 11 KV, 6.6 / 3.3 / 2.2 KV and lines up to 500 Volts are the distribution lines in state sector.

[2] The SEBs of Uttar Pradesh and Maharashtra had introduced the extra high voltage lines of 400 KV initially during the 1970s. Later on, Bhakra Beas Management Board (BBMB) in Punjab introduced these lines.

The growth rate of transmission lines in the state sector declined significantly during 1990-99. Besides, the growth rate of distribution lines showed a continuous decline over the period of time (Table 2.6). The presence of such trend shows that the state sector gave relatively less attention to strengthen its transmission and distribution potential. This has had implications for high line losses of electricity.

Central Sector

The central sector carries out the operations of electricity generation and the bulk inter-grid transfer of electricity. The appearance of this sector in the Indian ESI is relatively new, as prior to the 1970s, this sector did not make any significant additions to the installed generating capacity. But, the center had to take initiative during the mid-1970s due to the state sector's inability to augment generation potentials to tackle the severe deficits in electricity supply. It established a number of generating units throughout the nation either alone or as joint sector projects with state governments during the post-1970 period. Thus, the share of the central sector in total capacity has increased by 1.79 times since 1970-71 (Table 2.4).

The share of central sector, due to its later appearance, in total installed capacity is bound to remain much below than that of the state sector where the ESI has assumed the mammoth size due to the developments that took place over the period of time. Under such circumstances, what becomes of interest is the rate at which the additions to installed generating capacity have been made by the two sectors.

Table 2.5 highlights that there have been huge differences with respect to the rate of capacity additions between the two sectors. The central sector registered relatively higher growth rates during the whole period except the 1970s. This may be due to the fact that there exists a time lag between the planning and execution of the plant. The plans to install plants would have been started with the establishment of NTPC, NHPC and NEEPCO after 1976 but the actual execution of most of projects especially hydro, took place only in the 1980s because of their long gestation period of 8 to 10 years.

The improvement in the share of central electricity generation in total generation was more than two times (Table 2.4). It was more than that in capacity additions by this sector. This implies that there has been an efficient capacity utilization by this sector.

ii. Private Sector

The private sector has been in operation in the Indian ESI since its inception but the operational framework of the private sector remained restricted by various legislations. Its contribution to total installed generating capacity and electricity generation remained very small till 1991 when it was allowed to come forward to contribute to the existing potentials of the Indian ESI. Many guarantees and counter-guarantees were given to lure this sector (GOI, 1997: 165).

Though capacity additions by the private sector registered high growth rate in comparison to central and the state sector during the 1990s (Table 2.5), these remained at levels much below targets (D' Sa, et al., 1999). The reasons for these inadequate capacity additions by the private sector are quite obvious, as no entrepreneur would like to make his investments on the basis of demands from a bankrupt customer.

2.2.2. Demand Side

There has been a simultaneous growth on the demand side of the ESI since 1970-71. This growth has been reflected in a rise in all the demand side parameters like the total number of consumers, total connected load and the total electricity consumption.

It is well understood that the total consumption of electricity depends on its supply. Owing to this, it may not serve as the best indicator of growth on the demand side. However, it has been considered along with other demand side parameters like the number of consumers and the connected load that register an increase over the period of time without being much influenced by the supply side of the utility.

An increasing growth rate of total connected load and total number of consumers implies that new electricity demand is arising in the system. But the trend of the growth rates of total connected load and the total number of consumers for the Indian ESI reveals that the new electricity demand has arisen at the decreasing rate. This declining trend has been uniform for the connected load and the total number of consumers over the period of time except during 1980-91 when growth rate for total number of consumers improved by a margin of 0.09 percent only (Table 2.8).

Table 2.7: Various Demand side Parameters of India's ESI

Category	Total Number of Consumers				Total Connected Load (MW)				Total Electricity Consumption (MUs)			
	1970-71	1980-81	1990-91	1998-99	1970-71	1980-81	1990-91	1998-99	1970-71	1980-81	1990-91	1998-99
Domestic	10165187 (66.25)	22337554 (68.58)	50389275 (72.36)	80272501 (75.20)	5985.91 (22.80)	13078.61 (21.30)	32051.15 (26.51)	68162.43 (33.43)	3890 (8.89)	9246 (11.23)	31982 (16.80)	64973 (21.03)
Agriculture	1528328 (9.96)	4232759 (13.00)	8631044 (12.40)	11864890 (11.12)	6224.84 (23.71)	16489.19 (26.86)	32511.46 (26.89)	48160.51 (23.62)	4470 (10.21)	14489 (17.59)	50321 (26.44)	97195 (31.45)
Commercial*	3022997 (19.70)	4582130 (14.07)	8002098 (11.49)	10719780 (10.04)	1911 (7.28)	4493.962 (7.32)	8340.783 (6.90)	14414.89 (7.07)	2573 (5.88)	4682 (5.68)	11181 (5.87)	19368 (6.27)
Industrial												
i) Low and Medium tension*	532315 (3.47)	1126465 (3.46)	2042296 (2.93)	2513741 (2.35)	4560.64 (17.37)	9933.996 (16.18)	20477.24 (16.94)	28065.61 (13.77)	3914 (8.94)	7415 (9.00)	17458 (9.17)	22706 (7.35)
ii) High tension	9995 (0.07)	23493 (0.07)	34731 (0.05)	50197 (0.05)	6403.6 (24.39)	14909.84 (24.28)	22469.48 (18.58)	35677.14 (17.50)	25665 (58.63)	40654 (49.36)	66751 (35.07)	82085 (26.56)
Total Industrial	542310 (3.53)	1149958 (3.53)	2077027 (2.98)	2563938 (2.40)	10964.24 (41.77)	24843.83 (40.46)	42946.72 (35.52)	63742.75 (31.26)	29579 (67.57)	48069 (58.36)	84209 (44.24)	104791 (33.91)
Others	85743 (0.56)	268904 (0.83)	533354 (0.77)	1320698 (1.24)	1164.11 (4.43)	2492.664 (4.06)	5051.096 (4.18)	9408.65 (4.61)	3264 (7.46)	5880 (7.14)	12664 (6.65)	22687 (7.34)
Total Consumers	15344565	32571305	69632798	106741807	26250.1	61398.26	120901.2	203889.2	43776	82366	190357	309014

Note: The figures in parentheses are the percentages of total consumers.

Note: *For commercial and low & medium tension consumers, the figures refer to 1997-98.

Note: The category of 'Others' includes consumers like Railways, Public Services etc.

Source: CMIE (2002b)

A disaggregated category-wise analysis of these demand side parameters provides some interesting insights about the changes in electricity consumption pattern across different categories of consumers. It shows that there has been an increase in electricity demand by the subsidized sectors like the domestic and the agricultural sector while the share of the good-paying consumers like industry, in new electricity demand imposed on the system i.e. total connected load, has declined over the period of time. The share of the domestic sector has improved for all the three demand side parameters and it emerged as one of the largest consumer as far as its share in the total number of consumers and total connected load is concerned (Table 2.7).

However, the domestic sector did not enjoy the same status in the case of electricity consumption. The share of domestic sector in total electricity consumption remained below than that of the agriculture and industry. Such incidence might have occurred due to the fact that most of the connected load in the domestic sector remains idle for most of the time period during the day. It is very uncommon that all the electric gadgets in the house are operated at the same time.

Though agricultural sector's share in total connected load and total number of consumers has not shown any remarkable improvement over the period of time, its share in total electricity consumption has increased by three times in 1998-99 than in 1970-71. Such swift improvement enabled agricultural sector to consume electricity, in 1998-99, at almost equal levels with industry (Table 2.7).

This reflects a major shift in the consumption pattern as in 1970-71, the share of agricultural sector in total electricity consumption was only one-sixth of the electricity consumption by the industrial sector. This along, the growth in electricity consumption by the agricultural sector has been very rapid. This sector has left behind all other sectors by attaining the highest growth rate in electricity consumption during all the periods except 1990-99 when it was left behind by the domestic sector by a small margin of 0.8 percent (Table 2.8).

On the contrary, the share of high-tension consumers in total connected load and total electricity consumption has registered continuous decline over the period of time (Table 2.7). This implies that the dependence of the industrial sector on the SEBs for electricity requirements has declined over the period of time.

Table 2.8: Growth of Various Demand Side Parameters

Category	Total Number of Consumers			Total Connected Load (MW)			Total Electricity Consumption (MUs)		
	1970-81	1980-91	1990-99	1970-81	1980-91	1990-99	1970-81	1980-91	1990-99
Domestic	9.14	9.46	6.88	9.07	10.47	11.38	10.10	14.78	10.66
Agriculture	11.98	8.24	4.65	11.43	7.83	5.77	13.96	14.84	9.86
Commercial*	4.73	6.39	4.27	9.97	7.11	8.13	6.88	10.16	8.16
Industrial									
i) Low and Medium tension*	8.69	6.83	3.01	9.04	8.37	4.61	7.36	9.98	3.83
ii) High tension	9.96	4.44	5.40	9.85	4.66	6.83	5.24	5.66	3.00
Total Industrial	8.71	6.79	3.05	9.51	6.27	5.80	5.54	6.43	3.17
Others	13.54	7.91	13.83	8.83	8.16	9.29	6.76	8.90	8.69
Total Consumers	8.72	8.81	6.29	9.90	7.82	7.75	7.28	9.76	7.17

Note: *For commercial and low & Medium tension consumers, the figures refer to 1997-98.

Note: The category of 'Others' includes consumers like Railways, Public Services etc.

Source: Based on CMIE (2002b)

The SEBs opted for planned power cuts to resolve electricity deficits. These power cuts, in most cases, has been for the industrial sector. This forced a large number of high-tension industrial consumers to invest in additional captive generation capacities Rao, et al. (1998: 54) have pointed out that by 1992-93, almost half of the electricity consumed by major power consuming industries came from captive power plants.

The share of commercial sector in total connected load has remained at almost the same level with minor variations over the period of time. The similar has been the trend of share of total connected load for the category of 'Others'. The share of commercial sector in total number of consumers has declined continuously (Table 2.7) whereas the share of 'Others' in total number of consumers has doubled over the period of time.

2.3.Performance of the Indian ESI

The performance of the Indian ESI has been analyzed, at a great length, by studies like Subramaniam (1996), Rao, et al. (1998) and Kannan and Pillai (2002).

2.3.1. Growth of the System

Before substantiating their findings, it would be better to evaluate the growth of the Indian ESI during the post-independence period through a comparison of its key performance indicators at two time-points i.e. 1950 and 1998-99. The rationale for the selection of these two time-points is that the year 1950 is marked with the eve of the planning era whereas the year 1998-99 is the latest year for which the statistics is available. The following Table summarizes the evolution of Indian ESI in terms of growth of different parameters on its supply as well as demand side.

Table 2.9: Key Indicators of Indian ESI's Performance

Key Indicators	Unit	Position in 1950	Position in 1998-99	Increased by number of times	Average Annual Growth Rate (%)
Total Installed Capacity	MW	1712.52	93293.55	54.48	8.69
Total Energy Generation	MU	5106.7	448544.06	87.83	9.77
T and D Lines	Ckt. Km	29,271	5710396	195.09	11.61
Total Energy Sales	MW	4,157	309734.05	74.51	9.40
Number of Consumers	Lakh	15	1072.35	71.49	9.30
Villages Electrified	Number	3061	504823	164.92	11.22
Electrified Irrigation Pump-sets (IPS)	Number	21,008	12216650	581.52	14.18
Per Capita Electricity Consumption	kWh	15.6	360.01	23.08	6.76

Source: GOI (1997b; 1998-99)

Indian ESI has assumed a mammoth size since 1950 due to a huge expansion in the capacities required for generation, transmission and distribution of electricity. The total installed capacity and the total electricity generation has increased by about 54 and 88 times respectively since 1950 (Table 2.9).

The electricity generation has registered higher average annual growth rate than that by the installed capacity over the same period. This increase in generation potential was supplemented by the corresponding expansion in capacities for transmission and distribution of electricity to consumer premises. The length of transmission and distribution lines has increased by about 195 times. But the expansion in the distribution lines has been higher than that in the transmission lines (see Table 2.6).

This expansion of distribution lines at relatively faster pace implies that the access to electricity facility in the far-flung rural areas has improved over the period of time. The main purpose for rural electrification was not only to provide access to electricity to rural population but also to enhance its use for productive purposes such as in irrigation. Due to this, the electrification of the IPS took place at rapid pace. The electrification of IPS and villages improved by about 581 and 165 times respectively at the average annual growth rate of 14.18 and 11.22 percent respectively (Table 2.9).

As the total number of consumers increased at an average annual growth rate of 9.3 percent, there has been a simultaneous improvement on the supply side also. The total energy sales got increased by about 75 times. Consequently, there has been an improvement in per capita electricity consumption. It increased by about 23 times at the average annual growth rate of 6.76 percent during the period of 48 years.

Such rapid growth at high average annual growth rates, at first glance, gives the impression that the Indian ESI has attained the robust growth during the planning era. But, in fact, it is not so. The whole picture turns out to be disappointing when a consideration of the achievements of Indian ESI is made in the light of the kind of priority that it has received during the planning era.

Though the expansion in electrification of rural areas took place at the average annual growth rate of 11.22 percent since 1950, the complete electrification of all the rural areas is still a distant dream as there are about 80,000 such villages where there is no sign of electricity and are yet to be electrified (GOI, 2002b: 914). This shows that there has been no remarkable sign of success in rural electrification even with the existing definition of an electrified village.

According to this definition, *"A village will be deemed to be electrified if electricity is used in the inhabited locality within the revenue boundary of the village for any purpose whatsoever"* (GOI, 2002b: 914). This definition of an electrified village *per se* does not guarantee the complete electrification of the households in that village.

Table 2.10: Status of Households Electrified in India

Households	Rural	Urban	Total
Number of Households	111,588,199	39,523,184	151,111,383
Electrified Households	34,078,077 (30.54)	29,949,824 (75.78)	64,027,901 (42.37)
Electricity Facility Available to Population (per '000)	331	781	457

Note: The figures in parentheses are the percentages of number of households.
Source: Census of India (1991: 651)

By this definition, as per 1991 census, only 42 percent of the total households in India are having electricity facility. There exist wide disparities among rural and urban households on this account. Only 30 percent of the rural households are electrified whereas this number stands at 76 percent for the urban households. This has resulted in rural-urban disparities in per capita availability of electricity facility (Table 2.10).

The picture of the growth of Indian ESI turns out to be more disappointing when its achievement levels in terms of per capita electricity consumption are considered in relative terms. India's level of per capita electricity consumption turns out to be significantly lower when it is compared with other developed countries and the economies in transition. For example, India's per capita electricity consumption in 1998-99 was 360 kWh whereas it has been much higher in the same year for a number of developed countries and the transition economies – USA (11,832 kWh), UK (5,327 kWh), Japan (7,322 kWh), South Korea (4,497 kWh), Thailand (1,345 kWh), China (746 kWh), and All-World Average (2,085 kWh) (World Bank, 2001: 302-304).

The factors responsible for non-availability of electricity facility to such high proportion of population especially in the rural areas along with low levels of per capita electricity consumption may be sought in inefficiencies on supply side of the

ESI. This side of the Indian ESI has been suffering from many weaknesses. These inefficiencies on the supply side along with other factors contributed towards increasing deficits in the electricity supply. The trend as well as magnitude of these electricity deficits is highlighted in the following sub-section.

2.3.2. Electricity Deficit

The electricity supply situation was quite favorable in the early years of the planning era as there was relatively less demand which was sufficiently backed by adequate installed generating capacity. But later on, when the scope of electricity use expanded from domestic, commercial and industrial sectors to other productive segments like agricultural sector, due to increased technical possibilities of IPS electrification, a continuous rise in different parameters like the total number of consumers, total connected load etc. (see Tables 2.7 and 2.8) took place on the ESI's demand side.

On the other side, the growth in the supply side was not at par because the ESI could not expand its potential due to a variety of factors and consequently, an imbalance between electricity availability and the electricity demand emerged. This imbalance caused the appearance of the electricity deficits in the country. These electricity deficits turned grave around the mid-1970s (Table 2.11) and got widened over the period of time i.e. starting from 8.6 billion kWh in 1975-76, these reached to the peak of 42.10 billion kWh in 1996-97 but declined thereafter to 25.10 billion kWh in 1998-99. These deficits in electricity supply appeared on account of a variety of factors. A major responsible factor has been the inadequate additions to generation potential. Though a large share of plan outlay has been allocated to the expansion of generation capacities in all the five-year plans, the achievements of the ESI on this front have not been up to the mark. In spite of the continuing practices of conducting electricity power surveys and the fixing the targets for installed capacity additions during the planning period, an insignificant attention has been paid to meet these fixed targets and the trend of slippages in additions to installed capacity (Rao, et al., 1998) continued to prevail during the whole planning era.

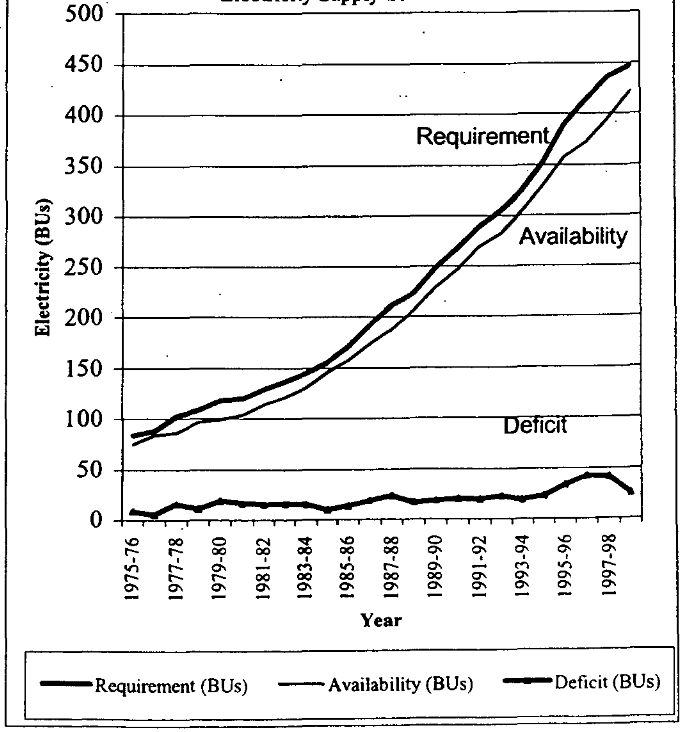
An increasing time and cost overruns in the completion of all projects in general and the hydro projects in particular has been the major factor responsible for the existence of slippages in meeting these targets of capacity additions (Kannan and Pillai, 2002).

Table 2.11: India's Electricity Supply Situation

Year	Electricity Requirement (BUs)	Electricity Availability (BUs)	Deficit (BUs)	Year	Electricity Requirement (BUs)	Electricity Availability (BUs)	Deficit (BUs)
1975-76	83.51	74.91	8.60	1987-88	210.99	187.87	23.12
1976-77	88.49	83.37	5.12	1988-89	223.19	206.33	16.87
1977-78	102.18	86.34	15.84	1989-90	247.76	228.78	18.98
1978-79	108.54	97.35	11.19	1990-91	267.63	246.94	20.69
1979-80	118.37	99.30	19.07	1991-92	288.97	269.14	19.84
1980-81	120.12	103.73	16.38	1992-93	305.27	282.38	22.88
1981-82	129.25	113.93	15.32	1993-94	323.25	303.68	19.57
1982-83	136.85	121.31	15.54	1994-95	352.26	329.26	23.01
1983-84	145.28	130.12	15.16	1995-96	389.72	356.44	33.28
1984-85	155.43	145.39	10.04	1996-97	413.49	371.40	42.10
1985-86	170.75	157.30	13.45	1997-98	436.26	394.99	41.27
1986-87	192.36	173.80	18.55	1998-99	446.58	421.49	25.10

Note: BUs: Billion Units
Source: CMIE (1988; 2002b)

Figure 2.2
Electricity Supply Situation



These deficits aggravated when existing capacity remained underutilized. A continuously deteriorating commercial performance and inefficient transmission and distribution of electricity by state sector had added further to its woes. These factors are discussed in brief in the subsequent sub-sections.

2.3.3. Poor Capacity Utilization

The level of capacity utilization is not uniform between different constituents of the utilities. The central sector's capacity utilization rate has remained above 50 percent during the 1990s whereas in case of the SEBs, the same has remained either below or little above the 50 percent for the whole period (Table 2.12). Other constituents of the state sector such as the State Government Departments and the Government Local Bodies have shown almost similar trend of capacity utilization.

Table 2.12: Capacity Utilization Rate (%) of Different Constituents of the Utilities

Year	Central Sector	DVC	State Government Departments	SEBs	Government Local bodies	Private Sector	All-India
1970-71	42.77	43.03	57.56	41.19	44.81	48.07	43.32
1980-81	44.04	36.00	49.52	40.59	54.31	55.59	41.88
1990-91	53.44	27.79	39.54	44.02	42.66	52.03	45.58
1991-92	57.77	29.94	48.10	43.70	49.86	53.70	47.44
1992-93	54.90	26.44	44.05	45.38	50.29	54.35	47.56
1993-94	54.49	35.20	47.45	45.70	47.15	52.29	48.20
1994-95	54.16	35.20	48.14	47.84	44.88	48.92	49.29
1995-96	60.47	31.80	46.93	49.59	38.73	53.46	52.06
1996-97	61.84	28.59	43.23	51.07	-	49.57	52.67
1997-98	67.33	29.04	47.56	50.58	-	47.72	54.03
1998-99	67.82	30.63	51.28	51.83	-	45.34	54.88

Note: DVC =Damodar Valley Corporation; SEBs = State Electricity Boards
Source: Based on CMIE (2002b)

The capacity utilization of the thermal units is determined by the plant load factor (PLF), by plant availability factor (that is determined by forced outages) but for the hydro plants, it is dependent on their firm power capacity constraints and is not much affected by the forced outages. The PLF is a measure of the actual electricity generated by the plant during a given period as a proportion of the maximum electricity that could have been generated by the operation of the plant at maximum capacity in that period. The PAF is a measure of the total number of hours of plant availability for electricity generation in a given period as a proportion of total number of hours in that period. It is equal to unity minus planned maintenance rate and the forced outage rate.

Further discussion on capacity utilization focuses on the performance of thermal units, as performance of hydro units cannot be substantially highlighted due to constraints posed by data availability. The average plant availability factor for the SEBs[3] during the 1990s stood at 72 percent ranging from 86 percent for Andhra Pradesh to 40 percent for Bihar (see Table 3.13). However a consideration of the PLF (Table 2.13) reveals clearly the poor performance of state sector in electricity generation.

There exists a large gap between the PLF of the central sector and the state sector units. The PLF of private sector units also remained above the state sector units but it remained below than that of central sector units for most of the years. This, however, does not imply that the private sector units are inefficient. The willingness of private sector to supply electricity only under conditions of assured return may be one of the reasons for its low PLF.

This does not seem to be the case for the central sector units who continued to meet the power requirements of the SEBs in spite of their continuous default in making payments. Owing to this, the outstanding dues of the SEBs to the central sector units kept on mounting and as on 31st March 2001, these outstanding dues were reported to be as large as Rs. 27,760 crore (Sankar, 2001).

The state sector thermal units, unlike private sector, had low PLF. These units operated at relatively lower levels of PLF. Old age, smaller average size of the plants, exclusive reliance on indigenous low-grade coal, coal supply irregularities due to non-availability of wagons, less expenditure on maintenance of existing units are the major factors causing poor operational efficiency in state sector units (Rao, et al., 1998: 38).

The inefficiency of the state sector in electricity generation has implications on its financial side in the sense that the SEBs have to depend more on purchased power when their own generation is very low. This raises their cost of electricity supply and therefore, adds to their commercial losses under the conditions of low realization from electricity sale especially to the subsidized sectors.

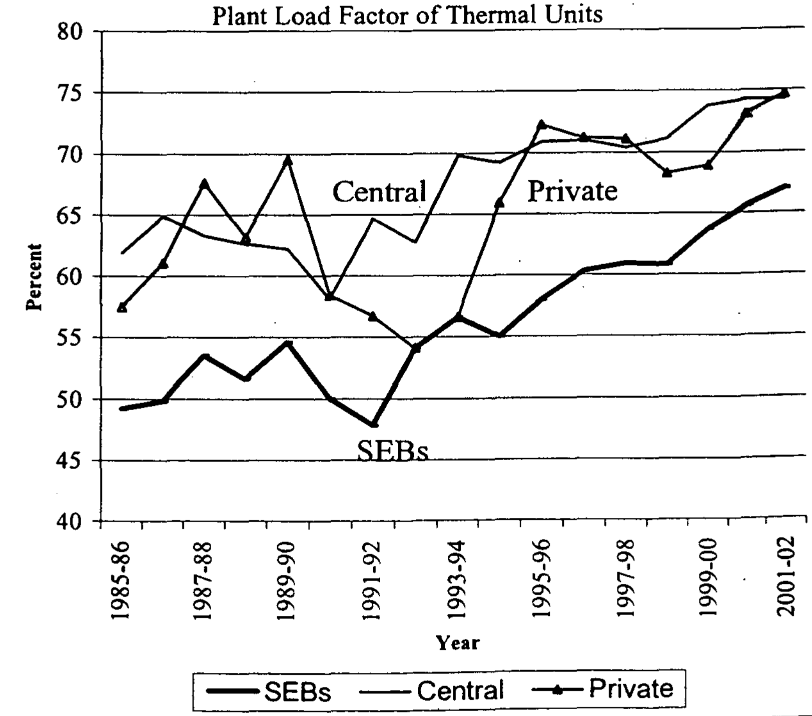
[3] Since the plant availability data for the central and private sector is not available, it is not possible to make a comparative analysis with the SEBs.

Table 2.13: Plant Load Factor of Thermal Units (%)

Year	SEBs	Central	Private
1985-86	49.2	61.9	57.5
1986-87	49.8	64.9	61.1
1987-88	53.5	63.3	67.6
1988-89	51.6	62.6	63.2
1989-90	54.6	62.2	69.5
1990-91	50	58.1	58.4
1991-92	47.8	64.7	56.7
1992-93	54.1	62.7	54.1
1993-94	56.6	69.8	56.6
1994-95	55	69.2	65.9
1995-96	58	70.9	72.3
1996-97	60.3	71	71.2
1997-98	60.9	70.4	71.1
1998-99	60.8	71.1	68.3
1999-2000	63.7	73.8	68.9
2000-01	65.6	74.3	73.1
2001-02	67	74.3	74.7

Source: CMIE (1995, 1999); GOI (2002a)

Figure 2.3
Plant Load Factor of Thermal Units



2.3.4. *Inefficient Transmission and Distribution Mechanism*

The 'Electricity (Supply) Act, 1948' assigned the responsibility for transmission and distribution (T and D, hereafter) of electricity within the state to the SEBs. But the SEBs could not perform well and they remained quite inefficient in supplying electricity from the generation end to the consumers' premises. The magnitude of their T and D losses has remained high over the period of time. For most of the SEBs, the reported T and D loss figures as the percentage of electricity available to them remained very high (Table 2.17 in Annex 2).

But, these reported T and D loss figures seem to be underestimates. For example, the electricity utility in Orissa was reporting its T and D loss as 6.15 percent in 1970-71 but the same utility after restructuring started reporting the same figure as 49.9 percent in 2000-01 (Table 2.17). In fact, this underestimation was encouraged by the un-metered electricity supply to the agricultural sector as it was considered a "convenient 'dump' for a good part of the unaccounted-for energy" (Kannan and Pillai, 2000: 25).

Also, it is quite evident from the latest reported T and D loss figures of a number of reforming states. These figures are reported by their respective utilities within the range of 30 to 50 percent.

Table 2.14: Nation-wise T and D Loss in 1998 (as percentage of electricity available)

Country	T and D Loss (%)	Country	T and D Loss (%)	Country	T and D Loss (%)	Country	T and D Loss (%)
Ethiopia	10	Sri Lanka	19	China	7	USA	7
Bangladesh	16	Pakistan	25	South Korea	7	UK	8
India	18	Japan	3	Indonesia	12	World Average	9

Source: World Bank (2001: 302-304)

These T and D loss figures ranging between 30 to 50 percent of the electricity available are quite high when compared with those of the transition economies and the developed economies like the USA and the UK etc (Table 2.14). Such high level of T and D losses is because of both the technical and non-technical factors. The most prominent technical factors are:

1. Low priority assigned to strengthen the T and D infrastructure *vis-à-vis* the development of installed generating capacity.
2. Over-abundance of the transformation stages.

3. Relatively rapid expansion of distribution lines due to urgency in the provision of electricity access to rural areas.
4. System over-loading caused by an improper load distribution.

Whereas non-technical factors like pilferage, faulty metering, un-metered electricity supply etc. also added to the total T and D loss of electricity supply. Such huge proportion of T and D loss has imposed unnecessary financial burden on the utility by leaving a relatively small proportion of the electricity with the utility on which it can claim to realize the revenue though it has incurred the supply cost even for this un-accounted proportion of electricity.

Kannan and Pillai (2000) provides an estimate of this financial burden on the utility on the basis of some plausible assumptions of comparing the T and D loss figures (including un-accounted for electricity) of the actual 30 percent against an ideal of 15 percent during the year 1997-98.

It has been found that the high incidence of T and D loss has resulted in a potential loss of electricity to the tune of 59,443 million units that could have provided the revenue of Rs. 10,996 crore at an average rate of Rs. 1.85 per unit. This loss of electricity represents the potential loss of a generating capacity of 11,310 MW at 60 percent load factor (Kannan and Pillai, 2000: 26). Such huge installed capacity and the financial resources that simply went to waste only in one year highlight the magnitude of state sector's inefficiency in performing its assigned duties.

2.3.5. Dismal Commercial Performance

Coupled with poor record in capacity additions, capacity utilization and transmission and distribution of electricity, the state sector of the Indian ESI continued to suffer on the financial aspect of its functioning that resulted basically from its dismal commercial performance. The state sector could not perform better on commercial side mainly because of the policies of subsidies and cross-subsidies that have been pursued by almost all states vigorously since the late 1970s.

The average tariff remained not only below average cost but the gap between average tariff and average cost widened (Table 2.15) over the period of time. The average tariff did not remain uniform for all categories of consumers.

3.3. Structure of the PSEB

The structure of a power system can be considered as a combination of resources and loads that has grown over the period of time. These resources and loads of the power system in Punjab are discussed below in brief.

3.3.1. Resources

The resources of the PSEB comprise its generation potential - both hydro and thermal - and the electricity transmission and distribution capacities.

i. Generation Capability

The PSEB's generation potential, at present (i.e. in 1999-2000), is a mix of both hydro and thermal capabilities with total installed generating capacity of 3974.09 MW.

a. Hydro Potential

The PSEB's hydro potential comprises its own installed capacity and its share in joint sector projects such as the Pong Power House, the Dehar Power House and the Bhakra-Nangal-Beas Complex. The major hydro plants owned by the PSEB are Upper Bari Doab Canal (UBDC) Power House – I and II, Shanan Power House and Extension, Anandpur Sahib Hydro Power House and Mukerian Hydro Power House (Table 3.1).

Besides, the PSEB has some micro hydel projects. These include Thuhi, Rohti, Nidampur and Daudhar Power Houses. The PSEB has already undertaken the construction of Mukerian Hydro Electric Project – Phase II, Anandpur Sahib Hydel Electric project. Ranjit Sagar Dam (Thein Dam), Satluj-Yamuna Link (SYL) canal and the Shahpur Kandi Barrage and Power plant are the projects under construction.

The hydro potentials constituted a major part of the total installed generating capacity in early years of the PSEB's establishment when Punjab's share in joint sector projects like the Bhakra-Nangal-Beas Complex contributed a large proportion (i.e. 69.79 percent) to its hydro potential. Besides, the PSEB was having its own hydro potential of 93.49 MW in 1974-75 (Table 3.3).

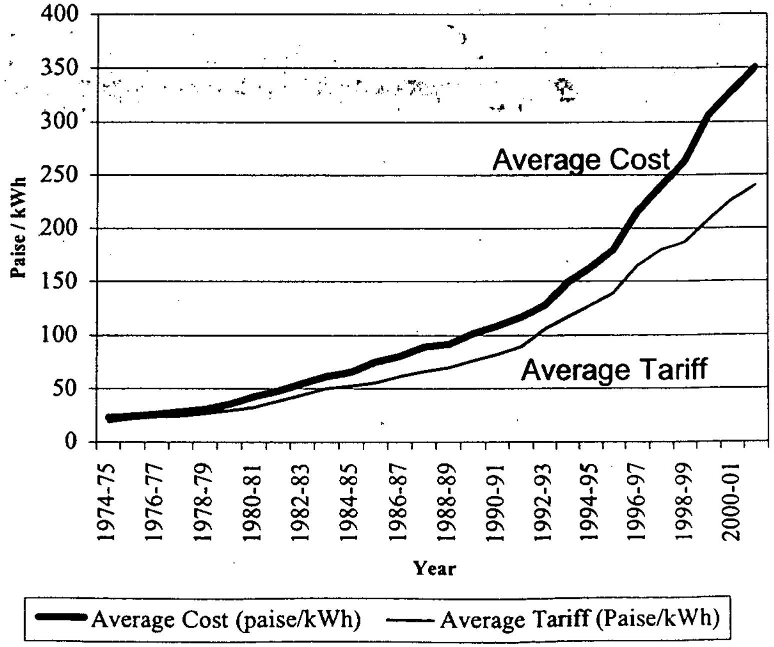
Table 2.15: Average Cost and Realization of the SEBs

Year	Average (paise/kWh)		Year	Average (paise/kWh)	
	Cost	Tariff		Cost	Tariff
1974-75	22.52	18.79	1988-89	91.2	69.43
1975-76	24.04	21.43	1989-90	101.5	75.63
1976-77	26.17	23.46	1990-91	108.59	81.8
1977-78	28.07	24.3	1991-92	116.8	89.16
1978-79	30.45	26.77	1992-93	128.2	105.4
1979-80	35.34	29.51	1993-94	149.1	116.7
1980-81	41.9	32.3	1994-95	163.4	128
1981-82	47.59	37.96	1995-96	179.6	139
1982-83	54.78	44.33	1996-97	215.6	165.3
1983-84	61.77	49.85	1997-98	239.7	180.3
1984-85	65.17	52.46	1998-99	263.1	186.8
1985-86	74.59	55.56	1999-00	305.1	207
1986-87	80.37	61.26	2000-01	327.3	226.3
1987-88	88.96	66.19	2001-02	349.9	239.9

Source: GOI (2002a); Rao et al. (1998: 89)

Figure 2.4

Average Cost and Realization of the SEBs



Some consumers like domestic and agricultural sector and to some extent industry especially in less-developed regions, have been subsidized. Though the tool of cross-subsidization has been used by states at a large scale, the magnitude of subsidization remained so high that it could not be offset through cross-subsidization. There has been a two-fold rise in the subsidy to sales revenue ratio from 1992-93 to 1999-2000 (Table 2.16).

This apart, the sales revenue that these tariffs yield has not been collected regularly. This resulted in the accumulation of huge revenue arrears. The revenue arrears increased by 3.68 times within the period of eight years (Table 2.16). The magnitude of these revenue arrears ranged from 156 crore for Meghalaya to 5699.4 crore for Uttar-Pradesh in 1999-2000. This, in a sense, reflects the seriousness of the SEBs' officials in revenue collection.

This trend of rising revenue arrears along with rising subsidy to sales revenue rations has affected adversely the trend of sales revenue as a ratio of cost. There has been a decline in the mobilization of sales revenue whereas there has been a simultaneous rise in total cost of electricity supply due to a variety of factors like the growing burden of power purchase cost, increasing dependence on thermal units due to declining hydro-thermal mix, rising fuel costs etc.

This has had implications for the commercial viability of the SEBs. There has been an increase in the commercial losses of the SEBs. 17 SEBs out of a total number of 19 were in the red in 1999-2000. Only two SEBs of Karnataka and Maharashtra showed some commercial profit with subsidy. A rising level of commercial losses affected significantly the Rate of Return[4] (RoR, hereafter) achieved by the SEBs.

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[4] The 'Electricity (Supply) Act, 1948' stipulated that the SEBs must operate and adjust their tariff in such a way that they are able to meet their operating expenditure including depreciation and interest payments, and earn such surplus as may be fixed by the respective state governments. Even then several prescriptions regarding the rate of return on capital invested by the SEBs were made. The Venkataraman Committee (GOI, 1964) recommended that the SEBs should earn a rate of return of 11 percent. The Rajyadhaksha Committee (GOI, 1980) recommended that the SEBs should generate an annual rate of return of 15 percent on an average capital base after providing for operating expemses or depreciation, or 6 percent net return after providing for interest cost on the loan capital used in completed works as well as works in progress. It was only in 1983, the 'Electricity (Supply) Act, 1948' was amended to provide for the SEBs earning a minimum of 3 percent by way of surplus after meeting the depreciation and interest payments. The SEBs have been allowed to take into account any subsidy or subvention given to them by the state governments in this computation (Khosla and Gopalaswami, 1986; Kannan and Pillai, 2002).

Table 2.16: Various Parameters of the SEBs' Commercial Performance

State	Subsidy to Sales Revenue Ratio (%) (with Cross-subsidization)		Revenue Arrears (Rs. Crore)		Sales Revenue as Ratio of Cost (%)		Net Internal Resources (Rs. Crore)		Commercial Profit (+) or Loss (-) (Rs. Crore) (with Subsidy)		Rate of Return on Capital (%) (with Subsidy)	
	1992-93	1999-2000	1992-93	1999-2000	1992-93	1999-2000	1992-93	1999-2000	1992-93	1999-2000	1992-93	1999-2000
Andhra Pradesh	6.1	79.64	345.9	677.7	94.2	55.82	103	-355.2	-4	-53	-0.2	-2.02
Assam	111	40.83	85.2	309.6	47.4	71.01	-71.8	-31.7	-205	-214	-43.3	-22.15
Bihar	56.9	56.28	613	4127.9	63.7	64.28	-201.6	-1027.8	-280	-511	-20	-39.08
Delhi (DVB)	22.4	24.38	499.2	0	81.7	58.25	-152.8	-1018.8	-207	-1103	-26.2	-79.61
Gujrat	46.1	75.48	590	1565	68.4	56.97	-216	-2041	100	-2501	3.2	-50.22
Haryana	85.3	77.48	479.2	200	54	56.38	-303.1	-412.6	-368	-835	-23.8	-36.81
Himachal Pradesh	13	40.75	34.2	122.6	88.5	71.05	-6.8	-138.2	2	-206	0.5	-26.13
Jammu and Kashmir	348.4	381.58	81.9	313	21.3	20.77	-207.4	-675.3	-225	-793	-39.1	-56.23
Karnataka	3.7	37.12	409.2	1025.8	96.5	72.99	384.8	347.2	32	76	3.3	3
Kerala	18.1	45.04	99.8	345	84.7	68.95	117.7	-141.2	-65	-181	-11.4	-9.05
Madhya Pradesh	19	33.96	394.2	2042	84	75.73	15.1	-1750.6	-113	-2718	-3.4	-69.54
Maharashtra	1.5	19.52	1125.1	4280	98.5	83.67	252.4	19.6	162	605	3.1	6.75
Meghalaya	24.2	66.94	NA	156	81.3	59.9	1.6	-14	-2	-43	-1.8	-20.44
Orissa	28	6.52	184.3	681.8	78.1	93.88	41.1	-1056.1	26	-187	2.6	-16.58
Punjab	71.7	59.92	127.4	475.3	57.6	62.53	-133.1	-909.4	-626	-1709	-19.9	-42.72
Rajasthan	31.5	50.7	211.5	521.5	76	66.6	62.2	-1376.7	22	-133	1	-3.41
Tamil Nadu	16.1	25.16	70	481	86	79.9	253.6	-735.4	92	-1192	3.2	-17.52
Uttar Pradesh	41.6	53.37	1171.6	5699.4	70.6	65.2	5	-1611.4	-808	-2596	-16.7	-24.25
West Bengal	39.9	52.04	198.6	1749.3	71.5	65.77	-105.4	-387.9	-258	-793	-35.3	-61.77
Total*	25.6	45.42	6720.3	24773.1	82.2	68.06	-161.5	-13316.3	-2725	-15088	-7.6	-24.68

Note: *It should be read as average for Subsidy to Sales Revenue Ratio, Sales Revenue as a Ratio of Cost and the Rate of Return on Capital.

Source: GOI (2001; 2002a)

The RoR with subsidy has remained negative for all the SEBs in 1999-2000 except for Karnataka and Maharashtra as they have achieved the level of 3 percent. Earlier in 1992-93, even the GSEB was performing well but in later years, its performance deteriorated (Table 2.16).

This affected the SEBs' capacity to meet their debt obligations. The SEBs' outstanding dues to major central sector undertakings such as NTPC, NHPC, DVC, PFC, REC and others, as on 31st March 2001, were reported to be as large as Rs. 27,760 crore. The receivables of certain central sector undertakings are quite substantial – NTPC (Rs. 16,063 crore), REC (Rs. 3,520 crore) and DVC (Rs. 2,788 crore) (Sankar, 2001). The central government has approved a scheme in March 2002 for one-time settlement of these outstanding dues of the SEBs.

Thus, the financial performance of the SEBs has not been much better. This poor financial performance led to deterioration in the SEBs' capacity for installing new generating capacity along with low investments for renovation and modernization of existing plants that added to the problems of low levels of electricity generation by the SEBs.

Also, the weak financial performance of the SEBs restrained not only their growth alone but it also troubled the growth prospects of many central sector units to whom these boards owe large sums of money.

2.4. Conclusion

The ESI in India has grown to a very large size over the period of time. Much of this growth has taken place in the state sector. The state sector continued to enjoy a major share in both the electricity generation and electricity transmission and distribution capacities. But, its performance has remained far from satisfactory over the period of time. It continued to suffer from many weaknesses especially in making required capacity additions, capacity utilization, efficient supply of electricity to consumers' premises and maintaining a sound financial health of its utility.

The financial position of all the SEBs in general and the Punjab State Electricity Board, in particular remained very weak over the period of time. Though the balance sheets of almost all the SEBs have been in the red during the 1990s, the PSEB's case becomes interesting in the light of the fact that the subsidized sectors like the agriculture sector, account for a major share in total electricity consumption. This apart, the Punjab government, in 1997, introduced the policy of provision of 'across the board' free electricity supply for irrigation purposes. The next part of the study analyzes the PSEB's performance in various spheres over the period of time along with the distribution of electricity subsidy to agricultural sector not only across different classes of farmers but also across different areas.

Annex 2

Table 2.17: State-wise T and D Loss (as percentage of electricity available)

Utility	1970-71	1980-81	1990-91	2000-01
Andhra Pradesh	25.42	22.6	22.4	32.9
Arunachal Pradesh	NA	24	20	34.3
Assam	17.68	19.3	24.1	38.6
Bihar	22.85	22.1	21.1	25
Delhi (DVB)	11.07	18.4	24.9	47
Goa	18.09	25.7	25	32.9
Gujrat	14.52	19.8	23.7	20
Haryana	27.94	22.6	27.5	35
Himachal Pradesh	12.23	19.3	21.5	18.3
Jammu and Kashmir	21.66	48.1	42.3	56.4
Karnataka	14.62	24.6	20.1	36.5
Kerala	12.8	14.2	21.6	17.2
Madhya Pradesh	14.69	22.3	24.9	31
Maharashtra	13.67	16.2	18.1	30
Manipur	NA	55.6	28	49.9
Meghalaya	NA	9.1	11.8	20.3
Mizoram	NA	22.2	29.6	42
Nagaland	NA	23.1	26.1	40.8
Orissa	6.15	19.2	25.3	49.9
Punjab	22.38	19.6	19	17.5
Rajasthan	13.11	26.6	25.9	29
Sikkim	NA	22.9	24.5	20.1
Tamil Nadu	17.67	19.1	18.7	16.5
Tripura	NA	31.5	29.6	38.9
Uttar Pradesh	24.49	15.6	26.9	39.8
West Bengal	10.18	13.7	21.8	30

Source: GOI (2002a); Kannan and Pillai (2000: 22-23)

Chapter 3
Structure and Performance of The Punjab State Electricity Board

3.1. Introduction

The major conclusion of the previous chapter was that almost all the SEBs in India are functioning inefficiently. However, significant differences exist between the SEBs on account of the magnitude of inefficiency in different aspects of their performance. This chapter focuses on structure and performance of the Punjab State Electricity Board (PSEB, hereafter). The chapter is divided into five sections. The next section gives an overview of the PSEB. This is followed by the discussion on structure of the PSEB that is implicit in its resources and loads. Then follows an analysis of performance of the PSEB on various spheres of its activity. This section includes an analysis of the PSEB's operational, organizational and commercial performance. The final section concludes.

3.2. An Overview

The PSEB was constituted on the first day of February 1959 under the Section 5 (1) of the 'Electricity (Supply) Act, 1948'. Subsequently, the erstwhile state of Punjab was reorganized under the 'State Re-organization Act, 1966' and the board in its present form came into existence with effect from the first day of May, 1967 with total installed capacity of 552.63 MW (PSEB, 1998) which increased to about 3974.09 MW in 1999-2000. The total generation increased simultaneously from 1135.63 MUs to 21501.62 MUs over the same period.

During this period, the total installed power generation capacity recorded the growth rate of 6.16 percent per annum whereas the growth rate of electricity generation has been much higher (i.e. 9.32 percent) over the same period. The functioning of the PSEB is guided by the 'Electricity (Supply) Act, 1948'. Like all the SEBs, as per Chapter IV of the 'Electricity (Supply) Act, 1948', the PSEB is assigned with the general duty of promoting the coordinated development of generation, supply and distribution of electricity within the state in the most efficient and economical manner.

Table 3.1: Profile of the PSEB's Hydro Plants

Joint Sector Projects		Own Power Houses					
Name	Capacity (MW)	Name	Capacity (MW)	Name	Capacity (MW)	Name	Capacity (MW)
Pong Power House	91.134	UBDC Power House – I	45	Anandpur Sahib Hydro Power House	134	Rohti Micro Hydel Power House	0.8
Dehar Power House	475.2	UBDC Power House – II	46.35	Mukerian Hydro Power House	207	Nidampur Micro Hydel Power House	1
Bhakra-Nangal-Beas Complex	731.304	Shanan Power House and Extension	110	Thuhi Micro Hydel Power House	0.8	Daudhar Micro Hydel Power House	1.5
Total	1297.638	Total					546.45

Source: PSEB (2000)

Table 3.2: Profile of the PSEB's Thermal Plants

Name	Capacity (MW)	Name	Capacity (MW)
Guru Nanak Dev Thermal Plant, Bathinda	440	Guru Gobind Singh Super Thermal Plant - Stage III, Ropar	420
Guru Gobind Singh Super Thermal Plant - Stage I, Ropar	420	Guru Hargobind Thermal Plant – Stage I, Lehra Mohabbat	420
Guru Gobind Singh Super Thermal Plant - Stage II, Ropar	420	R.S.T.P., Jalkheri	10
Total			2130

Source: PSEB (2000)

Though the hydro potential was developed further through the augmentation of generating capacity in both the common pool projects as well as the PSEB's own projects, its share in total installed capacity declined over the period of time. It was as high as 97.11 percent in 1971-72 but it declined thereafter continuously and stood at 46.40 percent (i.e. 1844.09 MW) in 1999-2000. This hydro potential comprises 29.63 percent share (i.e. 546.45 MW) of the PSEB's own hydro capacity and 70.37 percent (i.e. 1297.638 MW) share from joint projects (Table 3.3).

b. Thermal Potential

The PSEB, apart from enlarging the hydro capacities gave importance to the development of thermal potentials by starting the voyage through the construction of the Guru Nanak Dev Thermal Plant during the 1970s. It is followed by the completion of the Guru Gobind Singh Super Thermal Plant at Ropar during the late 1980s and the early 1990s. The third thermal plant known as the Guru Hargobind Thermal Plant was constructed at Lehra Mohabbat during the late 1990s. The two units of this thermal plant have started their commercial operation and the work to enlarge the generation potential of this plant is continuing. The PSEB also exploits the non-conventional sources of energy in a big way. Rice straw thermal power plant at Jalkheri is one of its types in India with the generation capacity of 10 megawatts (see Table 3.2).

In the early years of the PSEB's establishment, the share of thermal capacity was negligible (i.e. only 2.89 percent of total installed capacity in 1971-72). Thereafter, it has grown at a rapid pace of 18.11 percent per annum. This pace enabled it to stand above the hydro potential by contributing 53.60 percent (i.e. 2130 MW) of total installed capacity in 1999-2000 (Table 3.3). But this rapid pace reflected in the higher average annual growth rate of thermal capacity has affected the hydro-thermal mix of the PSEB. The hydro-thermal ratio was 97.11 : 2.89 in 1971-72 but it deteriorated continuously over the years. It stood at 46.40 : 53.60 in 1999-2000. At this juncture, this hydro-thermal mix is well in tune with the optimal hydro-thermal mix of 40 : 60 but the continuation of such trend is a cause of concern as it may have implications for the optimal operation of the plant in future.

Table 3.3: Composition of the PSEB's Total Installed Generating Capacity

Year	Hydro Installed Capacity (MW)			Thermal Installed Capacity (MW)	Total Installed Capacity (MW)	Hydro-Thermal Mix (%)
	Share in Central Projects	Own Power Houses	Total			
1971-72	-	-	676.58 (97.11)	20.14 (2.89)	696.71	97.11
1974-75	613.0 (69.79)	93.49 (10.64)	706.49 (80.43)	171.90 (19.57)	878.39	80.43
1984-85	1254.25 (53.94)	200.49 (8.62)	1454.74 (62.56)	870.56 (37.44)	2325.30	62.56
1990-91	1254.25 (40.71)	546.45 (17.74)	1800.70 (58.45)	1280.0 (41.55)	3080.70	58.45
1991-92	1254.25 (38.12)	546.45 (16.61)	1800.70 (54.72)	1490.0 (45.28)	3290.70	54.72
1992-93	1254.25 (35.83)	546.45 (15.61)	1800.70 (51.44)	1700.0 (48.56)	3500.70	51.44
1993-94	1254.25 (35.73)	546.45 (15.57)	1800.70 (51.29)	1710.0 (48.71)	3510.70	51.29
1994-95	1254.25 (35.73)	546.45 (15.57)	1800.70 (51.29)	1710.0 (48.71)	3510.70	51.29
1995-96	1254.25 (35.73)	546.45 (15.57)	1800.70 (51.29)	1710.0 (48.71)	3510.70	51.29
1996-97	1266.97 (35.96)	546.45 (15.51)	1813.42 (51.47)	1710.0 (48.53)	3523.42	51.47
1997-98	1282.93 (34.22)	546.45 (14.57)	1829.38 (48.79)	1920.0 (51.21)	3749.38	48.79
1998-99	1297.64 (32.65)	546.45 (13.75)	1844.09 (46.40)	2130.0 (53.60)	3974.09	46.40
1999-2000	1297.64 (32.65)	546.45 (13.75)	1844.09 (46.40)	2130.0 (53.60)	3974.09	46.40

Note: The figures in parentheses are the percentages of the total installed capacity.
Source: PSEB (1995; 2000)

ii. Transmission and Distribution Capacities

The PSEB has developed simultaneously, with enlargement of its generation potentials, the transmission and distribution capacities to supply electricity from the generation end to the consumers' premises. These capacities comprise the transmission and distribution lines along with transformers that can be classified as step-up transformers, step-down transformers and the distribution transformers.

Table 3.4: Transmission and Distribution Assets of the PSEB

Lines (As on 31/3/2000)				Transformers (As on 31/3/98)		
Transmission	Length (Ckt. Km.)	Distribution	Length (Ckt. Km.)	Type	Number	Capacity (MVA)
220 KV	3418	33 KV	1598	Step-up	76	5911.16
132 KV	2951	11 KV	89723	Step-down	552	2095.66
66 KV	4297	LT Lines	154461	Distribution	148316	10077.48
Total	10666	Total	245782	Total	148944	18084.30

Source: GOI (1997-98); PSEB (2000)

The expansion of transmission and distribution lines did not take place at the same pace. The distribution lines got expanded at a rapid rate than the transmission lines whose length remained only 4.15 percent of the total lines (Table 3.4). This relatively large expansion of distribution lines may be due to the fact that a greater emphasis has been laid on rural electrification to make the 'Green Revolution' a big success through the electrification of irrigation pump-sets.

But, this expansion in distribution lines was made by a relative neglect to augment the transmission capacities. This trend is bound to have a bearing on loss of electricity during its transmission and distribution. This is discussed in detail in section 3.4.1. Along with a large network of transmission and distribution lines, the PSEB has 1,48,944 different types of transformers with an aggregate capacity of 18,084.30 MVA (Table 3.4).

The main intention to develop the resource potentials especially the generation assets should be to raise the levels of net electricity availability in the state. The composition as well as utilization of the net available electricity also highlights the growth of supply side of the power system - an aspect much related with the utilization of its resources. The availability of electricity with the PSEB over the period of time is discussed in the subsequent paragraphs.

iii. Availability of Electricity

The availability of electricity is a combination of net electricity generation by own power generating units and the electricity imported from other sources of electricity supply such as the central power corporations, other SEBs etc. In Punjab's power system, there has been an increase in availability of electricity over the period of time. The PSEB's own generating units contributed a major share in this increase in electricity availability. The net generation by the PSEB's own generating units has grown simultaneously with rise in magnitude of installed generating capacity.

Though the share of net generation by the PSEB's plants remained the largest in total availability of electricity, there has been a declining trend. This trend has led the PSEB to supplement its own generation with the purchase of electricity from central power corporations and the SEBs of the neighboring states. The share of purchased power i.e. import, in total available electricity has risen to nearly or more than one-fifth of total electricity available during the 1990s (Table 3.5).

This total available electricity, during a particular year, is utilized for sale purposes. For Punjab's power system, the electricity sale within the state remained the major channel for the utilization of available electricity and it remained with in the range of 70 to 80 percent over the period of time (Table 3.5). The electricity is also sold outside the state. But, its share in total electricity available has remained almost negligible within the range of 1 to 6 percent.

Also, a part of the available electricity either gets wasted in supplying electricity to the consumers' premises or remains unaccounted due to various non-technical factors like theft, faulty metering etc. The electricity loss as a percentage of electricity available, for the PSEB, remained stagnant at levels ranging between 17 to 18 percent over the years. But, the accuracy of these reported figures on losses can be questioned in the light of the fact that the non-metering of electricity supply to agriculture might have persuaded the PSEB staff to dump a large part of this loss as electricity supply to the agricultural sector to highlight the PSEB's better performance in electricity supply. This issue is discussed in detail in section 3.4.1.

Table 3.5: Composition and Utilization of the Available Electricity

Year	Net Generation (MUs)	Import (MUs)	Net Electricity Available (MUs)	Sales in State (MUs)	Export (MUs)	Total Sales (MUs)	Electricity Loss (MUs)
1971-72	2935.84 (93.92)	190 (6.08)	3125.84	2315.18 (74.07)	54.43 (1.74)	2369.61 (75.81)	756.23 (24.19)
1980-81	5326.62 (84.99)	940.8 (15.01)	6267.42	4997.49 (79.74)	199.64 (3.19)	5197.13 (82.92)	1070.29 (17.08)
1990-91	12965.82 (83.75)	2514.98 (16.25)	15480.8	11870.7 (76.68)	668.76 (4.32)	12539.46 (81.00)	2941.34 (19.00)
1991-92	13053.31 (80.73)	3115.63 (19.27)	16168.94	12726.81 (78.71)	408.79 (2.53)	13135.6 (81.24)	3033.34 (18.76)
1992-93	14082.36 (80.13)	3491.23 (19.87)	17573.59	13846.7 (78.79)	441.16 (2.51)	14287.86 (81.30)	3285.73 (18.70)
1993-94	14625.7 (78.41)	4027.18 (21.59)	18652.88	14458.63 (77.51)	750.32 (4.02)	15208.95 (81.54)	3443.93 (18.46)
1994-95	15342.65 (78.99)	4080.3 (21.01)	19422.95	15339.83 (78.98)	524.42 (2.70)	15864.25 (81.68)	3558.7 (18.32)
1995-96	15091.25 (75.47)	4904.49 (24.53)	19995.74	15943.41 (79.73)	292.89 (1.46)	16236.3 (81.20)	3659.44 (18.30)
1996-97	16593.96 (76.68)	5045.66 (23.32)	21639.62	17320.75 (80.04)	419.19 (1.94)	17739.94 (81.98)	3895.64 (18.00)
1997-98	16090.7 (70.77)	6647 (29.23)	22737.7	17714.28 (77.91)	954 (4.20)	18668.28 (82.10)	4069.42 (17.90)
1998-99	18797.11 (74.91)	6296.03 (25.09)	25093.14	19504.03 (77.73)	1365.39 (5.44)	20869.42 (83.17)	4223.72 (16.83)
1999-2000	20305.28 (77.17)	6008.04 (22.83)	26313.32	21072.88 (80.08)	689.54 (2.62)	21762.42 (82.70)	4550.9 (17.30)

Note: The figures in parentheses are the percentages of the net electricity available.
Source: GOI (1971-72; 1980-81); PSEB (1995; 2000)

3.3.2. Loads

Every power system is designed to meet the peak and off-peak demands of electricity to the best of its capacity. These electricity demands are called as the loads on the system. These loads keep on increasing over the period of time due to rise in electricity demand by various consumers. The pressure exerted by these loads on the utility does not remain uniform; rather it varies due to difference in the duration of peak and off-peak loads.

An idea about the duration of electricity consumption by the consumers in the peak and off-peak periods can be had from the consumers' load factor. Load factor is the ratio of average electricity demand to the maximum demand in a given period, usually a year. It is expressed as a percentage.

$$Load\ Factor = \frac{Total\ Electricity\ Consumption\ in\ a\ Year}{Peak\ Load\ X\ 24\ X\ 365}\ X\ 100$$

The numerator is the total electricity consumed by the consumers in a year. It is the sum of electricity consumed during both the peak and off-peak periods. The denominator is equal to that volume of electricity, which the consumers will consume if their peak period of electricity consumption prevails throughout the year without any variations. Thus, a rise in the value of load factor implies that the consumers' duration of electricity use during the peak periods is increasing and vice versa.

The load factor of the PSEB's consumers has remained around 50 percent during the 1990s (Table 3.6). This implies that the peak load prevails, on an average, for almost half time in a given year. Such duration of peak period occurs when there is no coincidence between the loads of different consumers; rather these get adjusted on different time periods during a day.

This level of coincidence of the electricity demands of different consumers in a system is measured by the coincidence factor. The coincidence factor is a ratio of the coincident, maximum demand or two or more loads to the sum of their non-coincident maximum demands for a given period.

$$Coincidence\ Factor = \frac{Peak\ Load}{Connected\ Load}$$

It is the reciprocal of diversity factor and is always less than or equal to unity.

Table 3.6: Various Parameters of the PSEB's Demand Side

Year	Peak Load (MW)	Connected Load (MW)	Load Factor (%)	Coincidence Factor	Electricity Consumption (kWh) per kW of Connected Load				
					General	Industrial	Agricultural	Others	Total
1971-72	733.00	1244.75	21.72	0.59	571.76	1064.67	1296.69	7488.89	1120.61
1980-81	1559.91	3187.43	31.06	0.49	567.60	1408.23	1789.59	5381.45	1331.37
1990-91	3058.00	7181.98	46.81	0.43	762.18	1632.11	2490.95	4590.61	1905.77
1991-92	2971.00	7675.85	50.47	0.39	718.07	1586.95	2630.91	5419.14	1905.15
1992-93	3062.00	8339.47	53.27	0.37	710.85	1595.18	2823.12	4753.53	1917.96
1993-94	3445.00	9024.97	50.40	0.38	698.76	1570.39	2756.85	4286.21	1862.69
1994-95	3513.00	9769.24	49.49	0.36	761.99	1665.39	2467.32	4331.20	1861.26
1995-96	3757.00	10693.03	47.94	0.35	771.21	1707.45	2262.76	3817.90	1799.51
1996-97	3720.00	11368.87	52.67	0.33	805.68	1683.34	2441.44	3554.59	1850.38
1997-98	4159.00	11831.08	48.01	0.35	820.43	1700.33	2303.12	3778.91	1836.39
1998-99	4452.00	12544.71	49.40	0.35	798.02	1627.90	2810.37	4039.66	1896.96
1999-2000	4788.00	13503.27	49.90	0.35	748.58	1714.43	3021.29	3280.63	1899.66

Note: The 'Others' includes bulk and grid supply, public lighting, etc.
Source: Based on GOI (1971-72; 1980-81); PSEB (1995; 2000)

A decline in coincidence factor over the years indicates that the maximum demands for electricity by different consumers do not coincide and vice versa.

Here, the coincidence factor has declined over the period of time (Table 3.6). This implies that the peak periods of electricity consumption for different consumers has shown an increasing tendency to occur, on an average, during different times in a day. Since the consumers have little choice, it is the utility that decides about the allocation of its electricity supply to different consumers. But, an optimal capacity utilization by the utility requires the existence of both industrial and agricultural consumers so that it may adjust the electricity demands by the industrial sector to the peak periods and roster the electricity supply to the agricultural sector during the off-peak periods.

The connected load of the industrial sector has remained above than the agricultural sector over the years. This observation, at first glance, provides the notion that the electricity requirements of the former are more than those of the latter. But, the response of the utility towards these electricity requirements cannot be directly approached; rather it requires an account of the coincidence factor with the load factor (i.e. coincidence factor multiplied with load factor) to highlight the degree of the loads served by the utility. The combination of the coincidence and load factor is nothing but the electricity consumption intensity defined in terms of the electricity consumption (kWh) per kW of connected load.

The trend of this consumption intensity for different categories of consumers in Punjab indicates that it is the agricultural sector that consumes the largest quantity of electricity per kW of its connected load among the categories of industrial, agricultural and general[1] consumers (Table 3.6). The electricity consumption intensity of industrial sector has remained at relatively lower level in spite of having relatively high electricity requirements (Table 3.7). Also, this sector has registered higher growth rate for connected load during the period 1990-99 than the agricultural sector (Table 3.8). Under these conditions, the presence of low levels of consumption intensity verifies that the utility's electricity supply remained biased towards the agricultural sector and the industrial sector remained subject to high power cuts.

[1] The general category is a combination of domestic and commercial consumers. It has become difficult to interpret the electricity demand by this category in a more insightful manner due to unavailability of separate information for these sectors.

Table 3.7: Composition of the PSEB's Demand Side

Consumer Category	Number of Consumers				Total Connected Load (MW)				Total Electricity Consumption (MUs)			
	1971-72	1980-81	1990-91	1999-2000	1971-72	1980-81	1990-91	1999-2000	1971-72	1980-81	1990-91	1999-2000
General	880466 (87.48)	1713615 (83.82)	3038877 (81.04)	4146641 (82.44)	356.95 (28.68)	999.13 (31.35)	2383.30 (33.18)	6116.54 (45.30)	204.09 (14.63)	567.11 (13.36)	1816.5 (15.30)	4578.7 (21.73)
Industrial	28238 (2.81)	51760 (2.53)	100251 (2.67)	110492 (2.20)	436.12 (35.04)	1104.23 (34.64)	2595.84 (36.14)	4490.01 (33.25)	464.32 (33.29)	1555.01 (36.64)	4236.69 (35.69)	7697.82 (36.53)
Agricultural	97360 (9.67)	278184 (13.61)	609551 (16.26)	771133 (15.33)	428.95 (34.46)	1033.54 (32.43)	2045.53 (28.48)	2725.01 (20.18)	556.21 (39.88)	1849.61 (43.59)	5095.31 (42.92)	8233.06 (39.07)
Others	409 (0.041)	736 (0.036)	1086 (0.029)	1724 (0.034)	22.74 (1.83)	50.53 (1.59)	157.32 (2.19)	171.71 (1.27)	170.26 (12.21)	271.93 (6.41)	722.2 (6.08)	563.3 (2.67)
Total	1006473	2044295	3749765	5029990	1244.75	3187.43	7181.98	13503.27	1394.88	4243.66	11870.7	21072.88

Note: The figures in parentheses are percentages of the total.
Source: PSEB (1995; 2000)

Table 3.8: Growth of the PSEB's Demand Side

Consumer Category	Number of Consumers			Total Connected Load (MW)			Total Electricity Consumption (MUs)		
	1971-80	1980-90	1990-99	1971-80	1980-90	1990-99	1971-80	1980-90	1990-99
General	7.68	5.90	3.51	12.12	9.08	11.04	12.03	12.35	10.82
Industrial	-0.47	-0.34	1.09	0.99	0.57	6.28	-1.00	1.36	6.86
Agricultural	6.96	6.83	2.65	10.87	8.92	3.24	14.37	10.54	5.48
Others	-1.13	0.55	5.27	-0.13	0.42	0.98	1.07	-0.26	-2.72
Total	12.37	8.16	3.32	10.26	7.07	7.27	14.28	10.66	6.58

Source: Based on PSEB (1995; 2000)

Thus, there has been a continuous increase in the loads at an aggregate level for all the categories of consumers. These loads are of non-coinciding nature in the sense that these are distributed between peak and off-peak periods. This implies that there is not much hindrance posed by loads on the optimal utilization of resources but it becomes interesting to know how far the utility have been able to maintain a balance between the loads and its resources. This can be understood through a discussion on the performance of the PSEB in different spheres of its activity. This is discussed in the subsequent section.

3.4. Performance of the PSEB

There has been a continuous increase in the PSEB's resources and loads over the period of time. A utility is considered to be efficient in its operation if it is capable of maintaining a balance between its loads and resources or one can say, if it is able to meet the electricity demands of its customers not only by making adequate additions to installed generating capacity but also by the optimal utilization of its resources. In the light of this criterion, it would be better to see how far the PSEB has been capable of managing the loads imposed on it through the utilization of its scarce resources over the period of time. This can be understood through the PSEB's performance analysis that, for convenience, can be studied under the following broad headings:

- Operational Performance
- Organizational Performance
- Commercial Performance

3.4.1. Operational Performance

Operational performance of a utility can be analyzed through an evaluation of the pace at which it has made the required additions to the installed generating capacity along with the efficiency with which it has not only generated electricity but also supplied electricity to the consumers' premises. The operational performance of the PSEB on these three aspects is analyzed below:

i. Growth in Installed Capacity

The PSEB has made additions to its generation potential over the period of time. Consequently, it increased from 696.71 MW in 1971-72 to 3974.09 MW in 1999-2000 (see Table 3.3). It comprises both the hydro and thermal capacities.

The PSEB's hydro potentials comprise its own hydro capacity and its share in joint sector projects whereas it has developed the thermal potential itself (see section 3.3.1). During the period of 29 years, there have been significant variations in the rate at which the additions took place in both the hydro and the thermal potentials.

The hydro capacity got augmented at relatively faster pace in projects directly owned by the PSEB up to the 1990. But afterwards, the whole situation changed. The growth rates of the PSEB's own installed capacity became nil, as the PSEB could not add even a single megawatt of generation capacity to its own projects during the period 1990-99 (Table 3.9). Thus, almost a decade passed without any addition to hydro potential in projects owned by the PSEB. Probably, it may be because of a change in preferences that caused a shift in favor of thermal potential development.

The additions in thermal potential have been made at relatively higher rate. It remained about two times above the rate of hydro capacity additions till the 1990 when the gap between the rates of capacity additions to these two modes widened further. The thermal capacity additions recorded a growth 22.38 times more than that of the hydro capacity additions during the period 1990-99,. Even then, the average annual growth rate of total installed capacity has shown a declining trend over the period. It remained at an average level of 6.22 percent since 1974-75 (Table 3.9).

This average annual rate of making additions to the installed generating capacity seems to be very high. *But, was it adequate to serve the rising electricity requirements?* This query can be best answered by the demand factor that reflects a rise in installed capacity *vis-à-vis* growth in electricity demand during the peak periods. The demand factor is a measure of the system's capacity to meet electricity demand that arises during the peak period.

$$\text{Demand Factor} = \frac{\text{Peak Load}}{\text{Installed Generating Capacity}} \times 100$$

Its (percentage) value can be above or below 100 percent depending upon the inadequacy or surplus of installed capacity. The value of demand factor above 100 percent indicates that the system is not capable of meeting the peak load requirements of electricity even with the full utilization of its generation potential and vice versa.

Table 3.9: Growth of the PSEB's Installed Generating Capacity

Period	Growth in Hydro Capacity (%)			Growth in Thermal Capacity (%)	Total Installed Capacity (%)
	Central Projects' Share	Own Power Houses	Total		
1974-84	7.42	7.93	7.49	17.61	10.22
1984-90	0.00	18.19	3.62	6.64	4.80
1990-99	0.38	0.00	0.26	5.82	2.87
1974-99	3.05	7.32	3.91	10.59	6.22

Source: Based on PSEB (1995; 2000)

Table 3.10: Electricity Supply Situation in Punjab

Year	Demand Factor (%)	Electricity Requirement (MUs)	Electricity Available (MUs)	Electricity Generation (MUs)	Electricity Surplus (+) / Deficit (-) without Import (MUs)	Electricity Surplus (+) / Deficit (-) with Import (MUs)	Electricity Deficit as Percent of Requirement (%)	
							Without Import	With Import
1971-72	105.21	3665	3125.84	2935.84	-729.16	-539.16	-19.90	-14.71
1980-81	101.47	-	6267.42	5326.62	-	-	-	-
1990-91	99.26	15207	15480.8	12965.82	-2241.18	273.8	-14.74	1.80
1991-92	90.28	16318	16168.94	13053.31	-3264.69	-149.06	-20.01	-0.91
1992-93	87.47	17601	17573.59	14082.36	-3518.64	-27.41	-19.99	-0.16
1993-94	98.13	18451	18652.88	14625.7	-3825.3	201.88	-20.73	1.09
1994-95	100.07	19553	19422.95	15342.65	-4210.35	-130.05	-21.53	-0.67
1995-96	107.02	20002	19995.74	15091.25	-4910.75	-6.26	-24.55	-0.03
1996-97	105.58	21512	21639.62	16593.96	-4918.04	127.62	-22.86	0.59
1997-98	110.93	22111	22737.7	16090.7	-6020.3	626.7	-27.23	2.83
1998-99	112.03	24532	25093.14	18797.11	-5734.89	561.14	-23.38	2.29
1999-2000	120.48	26052	26313.32	20305.28	-5746.72	261.32	-22.06	1.00

Source: Based on GOI (1970; 1982; 1995; 2000); PSEB (2000)

The demand factor for the Punjab's power system has shown a fluctuating trend during the 1990s. It was below 100 percent before 1994-95 and the utility was in a position to meet the peak load requirements but since 1994-95, it crossed 100 percent and increased further till 1999-2000 (Table 3.10).

The emergence of such trend indicates that the electricity demand during the peak period has arisen at fast pace and the inadequate additions to the installed generating capacity made the PSEB quite incapable of meeting these electricity demands even if it operates its existing generation potential to the maximum levels without caring for the regular maintenance schedules.

But, no system can be operated to the maximum potential due to various technical factors that require the system to be shut down for regular maintenance etc. Besides, the presence of forced outages further restricts the utilization of available capacity. Thus, the electricity cannot be generated through full utilization of the existing potential. On account of these factors, the PSEB's generation remained quite lower than the electricity requirements.

Owing to this, a large electricity deficit took place. This deficit as percentage of electricity requirement remained with in the range of 14 to 28 percent over the period (Table 3.10). Such high deficit levels force the utility to maintain balance with the import of electricity. The PSEB also opted for the same alternative and managed these huge deficits in electricity supply through the purchase of large quantities of electricity from central power corporations and the SEBs of neighboring states.

The share of this purchased power remained nearly or more than one-fifth of electricity available during the 1990s (see Table 3.5). The electricity import improved the electricity deficit situation and there was no major deficit except for some years during the 1990s when it remained quite marginal, less than 1 percent. Though the electricity supply situation, as expected, became favorable after the sufficient import of electricity, such practice has imposed huge cost burden on the PSEB. But, such cost burden could have been avoided if the PSEB could have ensured adequate additions to the installed generating capacity along with an efficient operation of its resources.

This continuing trend of meeting electricity deficits with the import of electricity reflects the worst performance of the utility as far as the additions to the installed capacity are concerned. Such plight is not due to inadequacy of investments required for the augmentation of generation potential. In fact, large sums of money have been incurred for this purpose (see Table 3.14). In spite of this, the pace of capacity additions remained very low. The explanation for this lies in the persistence of high cost and time overruns in the completion of the projects. For example, in case of the hydro power development, the PSEB has incurred a huge expenditure on hydro projects like the Ranjit Sagar dam, the Shahpur Kandi dam, Satluj-Yamuna Link Canal, Upper Bari Doab Canal (UBDC) but these projects are not executed yet. Their completion is getting delayed due to various economic and non-economic factors[2].

Apart from the additions to the installed generating capacity, it is the efficiency in the utilization of the existing potential that has a significant bearing on the total availability of electricity. The performance of the PSEB in this respect is analyzed in the subsequent sub-section.

ii. Efficiency in Electricity Generation

Any production unit, in economic theory, is considered to be efficient if it is able to produce more output per unit of input. The same economic principle is applicable to the electricity utility. It is said to be efficient if and only if it is capable of generating more units (i.e. kilowatt-hours) of electricity through the utilization of every kilowatt of installed generating capacity. This process of generation of electricity per kilowatt of installed capacity is termed as the capacity utilization rate.

The capacity utilization rate, for the PSEB's hydro generating units, remained at the low levels. It has shown a nearly stagnant trend with very little improvement over the years (Table 3.11). Starting from about 27 percent in 1974-75, it remained within the range of 40 to 50 percent during the 1990s except in 1998-99 when it was about 55 percent – the highest hydro capacity utilization rate since 1974-75.

[2] An estimation of the time and cost overruns for these projects could reflect very clearly the inefficiency cost involved in the preliminary stage of project execution. But, this exercise was not found to be feasible because of two reasons. First, the relevant information available from the PSEB for this exercise was inadequate. Second, the accuracy of this available information became doubtful when it was cross-checked with that reported in the plan documents of the Punjab government. Under such circumstances, this exercise was dropped, on the grounds of the accuracy of the available information.

Table 3.11: PSEB's Hydro and Thermal Capacity Utilization

Year	Installed Capacity (MW)			Generation (MUs)			Capacity Utilization Rate (%)		
	Hydro	Thermal	Total	Hydro	Thermal	Total	Hydro	Thermal	Total
1974-75	706.48	171.90	878.38	1653.74	202.80	1856.54	26.72	13.47	24.13
1984-85	1454.74	870.56	2325.3	4558.80	2938.27	7497.07	35.77	38.53	36.81
1990-91	1800.70	1280	3080.70	7545.61	5938.79	13484.40	47.84	52.96	49.97
1991-92	1800.70	1490	3290.70	7651.69	5934.36	13586.05	48.51	45.47	47.13
1992-93	1800.70	1700	3500.70	7595.39	7105.03	14700.42	48.15	47.71	47.94
1993-94	1800.70	1710	3510.70	6528.87	8854.11	15382.98	41.39	59.11	50.02
1994-95	1800.70	1710	3510.70	7624.22	8439.14	16063.36	48.33	56.34	52.23
1995-96	1800.70	1710	3510.70	7563.34	8232.05	15795.39	47.95	54.96	51.36
1996-97	1813.42	1710	3523.42	7620.54	9778.25	17398.79	47.97	65.28	56.37
1997-98	1829.38	1920	3749.38	6672.63	10274.01	16946.64	41.64	61.09	51.60
1998-99	1844.09	2130	3974.09	8813.98	10913.79	19727.77	54.56	58.49	56.67
1999-2000	1844.09	2130	3974.09	7670.48	13831.14	21501.62	47.48	74.13	61.76

Source: Based on PSEB (1995; 2000)

On the contrary, the capacity utilization rate of the thermal capacity jumped sharply from about 13 percent in 1974-75 to about 53 percent in 1990-91 and it improved further by about 1.5 times by touching the levels of 74 percent in 1999-2000. Though it has shown variations over the period of time, it remained within the range of 45 to 75 percent for most of the years in the 1990s (Table 3.11).

But, for the system as a whole, the capacity utilization rate did not remain much high. It remained at low level even under conditions of better capacity utilization by the thermal units because the other constituents of the total installed capacity (i.e. the hydro potential) could not achieve better utilization rates due to varied reasons like less water in reservoirs, inadequate maintenance of hydro units etc.

The generation efficiency of the hydro units cannot be analyzed further due to inadequate availability of detailed technical data. But it is not difficult in case of thermal units. The thermal potential has shown a continuously rising trend and constitutes more than half of the PSEB's total installed generation capacity in 1999-2000 (see Table 3.3). Under these circumstances, it becomes appropriate to analyze further the generation efficiency of the PSEB's thermal units.

The generation efficiency of a thermal unit can be analyzed through the consideration of major performance indicators like the Plant Load Factor (PLF, hereafter), Plant Availability Factor (PAF, hereafter), Forced Outage Rates (FOR, hereafter), Auxiliary Consumption and the Fuel consumption per kWh of electricity generation. The considerations of PAF and FOR are usually associated with the analysis of technical efficiency of only thermal power plants as the hydro plants are generally expected to be much less prone to forced outages than the thermal ones and their availability is expected to be always open and, at maximum, subject to their firm power capacity constraints.

The PLF is a measure of actual electricity produced by a plant during a given period as a percentage of the maximum electricity that could have been generated with operation of the plant at its full capacity during the same period. The PLF of the PSEB's thermal units remained at an average level of 62.80 percent during the period 1991-2000. It recorded average annual growth rate of 4.43 percent over the same period (Table 3.12).

The *Rajyadhaksha* Committee (GOI, 1980: 147) recommended a PLF of 58 percent for the Indian thermal units. Though the average PLF of the PSEB's thermal units during the period 1991-2000 remained not only above this recommendation but was also higher than all SEBs' PLF except Andhra Pradesh (72.95 %), Gujrat (62.07 %), Karnataka (69.36 %), Maharashtra (64.65 %), Rajasthan (73.23 %) and Tamil Nadu (67.10 %) (see Table 3.13). However, it remained lower than the average PLF achieved by the thermal units in the private sector (65.88 %) and the central sector (69.27 %) during the same period.

Table 3.12: Generation Efficiency Parameters of the PSEB's Thermal Plants

Year	Plant Load Factor (%)	Plant Availability Factor (%)	Forced Outage Rate (%)	Auxiliary Consumption (% of Total Generation)	Coal Consumption (kg / kWh of Generation)	Oil Consumption (ml / kWh of Generation)
1991-92	52.8	77.8	7.1	3.92	0.69	3.71
1992-93	58.3	80.8	11.8	4.2	0.7	5.22
1993-94	63.5	82.1	13.1	4.92	0.74	5.11
1994-95	56.7	81.6	10.2	4.49	0.74	5.83
1995-96	55	78.7	13.6	4.46	0.71	4.27
1996-97	65.7	80.8	12.8	4.63	0.7	3.51
1997-98	69.1	88.1	4.7	5.05	0.69	1.73
1998-99	69.4	79.2	12.2	4.72	1.03	3.49
1999-2000	74.7	82.7	9.5	5.56	0.69	2.57
Average (1991-2000)	62.80	81.31	10.56	4.66	0.74	3.94
Growth Rate (1991-2000)	4.43	0.77	3.71	4.47	0.00	-4.49

Source: PSEB (1995; 2000)

However, the PLF is not the best indicator to highlight the level of electricity generation efficiency of a utility because it is a measure of actual generation at the generation end. Also, it tends to vary between power stations and between two time periods for the same power station possibly because of system demand and forced outages (Alagh, et al., 1998: 28).

The PAF, on the other hand, provides better measure of a plant's generation efficiency as it indicates the plant's capacity along with its readiness to generate. It is defined as the total number of hours in a year, for which the plant is available for electricity generation as a proportion of the total number of hours (i.e. 365 X 24 hours) in a year. The PAF is equal to unity minus FOR and the planned maintenance rate.

The *Rajyadhaksha* Committee Report (GOI, 1980: 51) states that *"an 80 percent plant availability is considered a reasonable norm to work to i.e. for 20 percent of the time, the plant will be shut down due to planned maintenance and forced outages".*

The PSEB is among the six SEBs who could qualify this norm during the period 1991-2000 (Table 3.13). This shows that the thermal units of the PSEB were available for generation for a large period of time in a year. This can be understood in the light of the fact that most of thermal units of the PSEB are relatively new.

Along with PAF, the FOR is another indicator to evaluate the technical health of a generating unit. The FOR occurs when the unit goes out of operation due to factors such as equipment malfunction, poor quality of fuel, wet coal being supplied, and the lack of timely and proper maintenance practices etc. The FOR is defined as the total number of hours for which the plant is shut down due to breakdown or equipment malfunction etc. during the year as a proportion of the total number of hours in a year.

In case of the PSEB's thermal units, the average FOR remained low at 10.56 percent over the period 1991-2000 whereas the thermal units of the other SEBs except Andhra Pradesh (7.10 %), Gujrat (8.61 %), Karnataka (7.72 %), Maharashtra (10.36), Rajasthan (8.83), recorded relatively higher levels of average forced outages over the same period (Table 3.13).

Table 3.13: Technical Efficiency Parameters of Thermal Units of Different SEBs

State	Average					
	Plant Load Factor (%)	Plant Availability Factor (%)	Forced Outage Rate (%)	Coal Consumption (kg / kWh of generation)	Oil Consumption (ml / kWh of generation)	Auxiliary Consumption (% of total generation)
	(1991-2000)	(1991-2000)	(1991-2000)	(1992-99)	(1992-99)	(1992-99)
Andhra Pradesh	72.95	85.90	7.10	0.83	3.12	6.16
Assam	23.71	51.11	38.64	0.67	46.62	8.72
Bihar	20.59	39.60	37.40	0.94	25.08	12.64
Gujrat	62.07	80.28	8.61	0.59	9.07	9.53
Haryana	45.73	66.10	26.52	0.80	15.07	5.27
Himachal Pradesh	0.00	NA	NA	0.00	0.00	0.27
Jammu & Kashmir	0.00	NA	NA	0.00	0.00	0.88
Karnataka	69.36	82.64	7.72	0.00	0.00	5.83
Kerala	0.00	NA	NA	0.00	0.00	0.50
Madhya Pradesh	59.19	75.73	12.60	0.81	8.39	8.88
Maharashtra	64.65	83.71	10.36	0.80	4.34	7.37
Meghalaya	0.00	NA	NA	0.00	0.00	0.36
Orissa	52.65	74.06	15.73	0.41	12.19	11.60
Punjab	62.80	81.31	10.56	0.71	3.92	4.59
Rajasthan	73.23	82.78	8.83	0.69	3.43	7.35
Tamil Nadu	67.10	78.13	11.09	0.74	6.36	6.72
Uttar Pradesh	48.58	63.47	27.56	0.80	6.10	7.95
West Bengal*	36.49	63.79	25.32	1.11	9.84	21.05
All SEBs Average	54.15	72.04	17.72	0.76	11.81	6.98
Central Sector	69.27	-	-	-	-	-
Private Sector	65.88	-	-	-	-	-

Note: '-' = Not Available; * = It includes West Bengal Power Development Corporation figures also.
Source: Based on CMIE (1999; 2002b) and TERI (1999-2000)

The average level of auxiliary consumption remained at the lower levels. Not only this, the PSEB possesses a distinction for having relatively low levels of average coal and oil consumption per kWh of the electricity generated. It is quite possible that the PSEB's thermal units, in actual, may be more efficient than these levels in terms of fuel consumption as these units achieved the higher efficiency levels in fuel consumption even in the conditions of availability of high ash content coal for electricity generation.

Thus, it has been found that the generation efficiency of the PSEB's thermal units is quite robust. But the efficiency at the generation end *per se* is not enough. The other complementary factor that is required to make the system efficient on the operational side is its efficiency in supplying electricity to the consumers' premises. This is discussed in the subsequent sub-section.

iii. Efficiency in Electricity Supply

The presence of efficiency in electricity supply is another aspect that is of c significance because only that part of the supplied electricity that gets reported consumers' metering devices, ensures revenue returns to the utility. Thu financial health of the utility and therefore, each and every aspect of its perforn is closely linked with utility's efficiency in transmission and distribution of elect

The adequate and optimal spread of the high-tension (HT, hereafter) and the tension (LT, hereafter) lines is necessary for efficient transmission and distribut electricity. The spread of these transmission and distribution lines requires ade expenditure on the development of T and D infrastructure.

But, the existing trend of expenditure (Table 3.14) indicates that the generation cornered a large share of the total expenditure incurred for the development of sector in Punjab. The actual spending, except 1980-81, has hitherto fa generation as the expenditure on generation remained above 50 percent ov period. This increase in share of expenditure on generation took place in spite recommendation of the *Rajyadhaksha* Committee (GOI, 1980) that the investn generation should not exceed 50 percent of the total investment in the power se

Table 3.14: Cumulative Expenditure on Major Segments of the PSEB (Rs. Cr

Year	Generation	Transmission	Distribution	Rural Electrification	Totı
1980-81	50.05 (48.55)	25.92 (25.14)	9.44 (9.16)	17.46 (16.93)	103.
1984-85	660.48 (68.16)	138.17 (14.26)	76.11 (7.85)	11.07 (1.14)	968.'
1990-91	2465.11 (70.21)	462.02 (13.16)	372.12 (10.60)	33.72 (0.96)	3510
1994-95	3775.59 (67.31)	754.03 (13.44)	759.2 (13.53)	18.69 (0.33)	5609
1999-2000	6582.57 (65.35)	1550.61 (15.39)	1441.23 (14.31)	-	1007:

Note: The figures in parentheses are the percentages of the total expenditure.
Source: PSEB (2000)

The *Rajyadhaksha* committee (GOI, 1980: 26) also provided a rule of thu investment in generation, transmission, distribution and rural electrification ratio of 4:2:1:1. The incurring a large proportion of total expenditure on gen and the relative neglect of the transmission and distribution sector reveals clea degree of attention paid by the PSEB to the *Rajyadhaksha* Comn recommendations during the post-1980 period.

The trend of incurring major share of expenditure on generation has had the implications for other aspects of the utility's performance. The corresponding expenditure on the development of transmission and distribution network remained at relatively lower levels. Owing to this, there has been an inadequate growth in the length of transmission and distribution lines. The length of both transmission and distribution lines except the 220 KV lines, per 1000 consumers recorded negative average annual growth rate since 1984 (Table 3.15).

Table 3.15: Growth of Transmission and Distribution Lines (per '000 consumers)

	Length of T and D lines (Ckt. Kms)			Average Annual Growth Rate (%)		
Year	1984-85	1990-91	1999-2000	(1984-91)	(1990-2000)	(1984-2000)
220KV	0.45	0.49	0.69	1.34	3.83	2.83
132KV	1.00	0.78	0.60	-4.10	-2.87	-3.36
66KV	0.88	0.90	0.82	0.38	-1.00	-0.45
33KV	1.33	0.43	0.32	-17.15	-3.31	-9.11
11KV	18.34	17.79	17.39	-0.50	-0.25	-0.35
L.T. Lines	38.75	36.17	30.82	-1.14	-1.76	-1.51

Source: Based on PSEB (1995; 2000)

This decline in the length of transmission and distribution lines is bound to have an impact on the efficiency in transmission and distribution of electricity. The supply of electricity through per circuit kilometer of all the lines except 220 KV lines has increased over the period of time. The quantum of electricity transmitted per circuit kilometer of 220 KV transmission line has shown a fluctuating trend. But, the transmission of electricity per circuit kilometer of 132 KV transmission lines recorded continuous increase during the 1990s. This growth has been higher during the period 1995-2000 (Table 3.16). This trend clearly shows the PSEB's negligence in the development of required transmission network.

The situation with the development of the electricity distribution network is quite similar. The supply of electricity per circuit kilometer of the distribution lines (66 KV, 33 KV, 11 KV, LT lines) recorded continuous increase during the 1990s. The growth rate of electricity supply through each circuit kilometer of the 11 KV and LT lines during the period 1995-2000 was nearly twice than that during the period 1990-95.

Table 3.16: Electricity Supply through per Circuit Kilometer of Lines (MUs)

Year	220KV	132KV	66KV	33KV	11KV	L.T. Lines	T and D Losses (%)
1990-91	9.00	5.66	4.89	10.26	0.25	0.12	19.00
1991-92	8.35	5.88	4.97	10.89	0.25	0.12	18.76
1992-93	8.14	6.35	5.37	12.12	0.26	0.13	18.70
1993-94	8.13	6.76	5.59	12.87	0.27	0.14	18.46
1994-95	8.29	6.96	5.70	13.12	0.27	0.14	18.32
1995-96	8.08	7.09	5.74	13.86	0.27	0.14	18.30
1996-97	8.76	7.69	6.22	15.02	0.29	0.16	18.00
1997-98	9.11	8.08	6.40	15.54	0.29	0.16	17.90
1998-99	9.58	8.89	6.76	16.68	0.31	0.17	16.83
1999-2000	8.15	9.33	6.80	17.63	0.32	0.18	17.30
Growth Rate (%)							
1990-95	-2.03	5.33	3.90	6.35	2.08	3.71	-0.91
1995-2000	0.23	7.10	4.35	6.21	4.89	6.14	-1.40
1990-2000	-1.09	5.72	3.73	6.21	2.94	4.53	-1.04

Source: Based on PSEB (1995; 2000)

This implies that the flow of electricity through each circuit kilometer of these distribution lines increased further in the period 1995-2000. But, these are the 33 KV distribution lines that remained the most heavily loaded lines over the period of time (Table 3.16). This clearly shows that within distribution lines, less attention was paid to augment the potential of the 33 KV lines.

Thus, it becomes clear that almost all the HT and LT lines are loaded fully with no standby capacity. Owing to this, the line loss in each circuit kilometer of the transmission and distribution line is bound to increase. This implies that in order to supply a given quantum of electricity to the consumers' premises, the amount of line losses will increase over the period of time. Consequently, there will be a rise in line losses as proportion of the total electricity available.

But, the reported T and D loss figures by the PSEB are stagnating at almost the same level over the period of time (Table 3.16). In the light of above discussion, however, it cannot be so. A higher level of the T and D loss is bound to occur due to inadequate availability of sub-transmission and the distribution network. Therefore, it cannot be denied that these reported T and D loss figures are the underestimates.

The electricity supply to the agricultural sector in Punjab is not metered. This makes it convenient to dump a significant proportion of the T and D losses as the electricity consumption by the agricultural sector. The un-metered electricity supply to the agricultural sector provides an opportunity to the PSEB's officials to hide their inefficiencies and thus, in a way, to highlight the utility's efficiency in electricity supply by reporting such low levels of its T and D losses. But, an attempt has been made on the basis of some plausible assumptions of the average duration of electricity availability at the farm to highlight the magnitude of T and D losses dumped as the electricity consumption by the agriculture sector.

a. Dumping of T and D losses into Agriculture

The persuasion of the populist policies by the state governments encouraged the electricity sale to the agricultural sector at subsidized flat rates or even free in some states like Tamil Nadu and Punjab. The SEBs too showed their reluctance for metering the electricity supply to the agricultural sector by arguing that such practice would impose an unnecessary monitoring burden on them. Consequently, the electricity consumption by the agricultural sector is un-metered in many states. Owing to this, there are no reliable estimates of electricity consumption by the agricultural sector.

It has been alleged that the SEBs are unwilling to meter the electricity consumption by the agricultural sector, as they can dump a significant part of their T and D losses in this electricity consumption to show low levels of the T and D losses (Sant and Dixit, 1996). This allegation gets strengthened further in the light of the statement made by the APSEB audit, in 1998, that the board made the technical calculations first instead of trying to use the commercial information to estimate the utilization of its available electricity. It further elaborated, *"as has been the practice in all the SEBs in the country, the APSEB was showing the difference between its generation and sales as the agricultural consumption plus technical losses. Technical losses have been computed to be in the range of 18 % to 19 %, and hence the remaining electricity losses were attributed to agriculture"* (as mentioned in Ruet, 2001: 17).

This methodology adopted by the SEBs for the estimation of agricultural electricity consumption leaves little room to doubt that these reported T and D loss figures are the underestimates. A significant proportion of the loss of energy not only on account of technical factors but also due to non-technical factors like pilferage etc. is reported in the un-metered agricultural electricity consumption.

However, a sketchy guess of the magnitude of the T and D losses can be made. There are studies (Kannan and Pillai, 2002) that used different approaches to highlight the SEBs' practices of underestimating the T and D losses. In a study by Kannan and Pillai (2002), the electricity consumption by agriculture in Tamil Nadu serves as a base to the estimates of actual electricity consumption by the agricultural sector. Though being a good attempt, this approach ignores the differences in capacity, efficiency and duration of the use of irrigation pump-sets on the farm across the country.

Keeping in view these limitations, the same approach cannot be adopted to reach even at the rough estimate of the dumped and thus, the actual T and D losses of the PSEB. This apart, a difference exists between Tamil Nadu and Punjab on account of not only the cropping pattern but also for climatic conditions that significantly affect the irrigation pattern and thus the electricity consumption by the agricultural sector.

We have attempted to highlight the magnitude of inefficiencies in electricity supply disguised by the PSEB on the basis of some plausible assumptions and data adjustments.

Assumptions:

1. The average duration for the electricity availability at farm before the introduction of free electricity supply policy (i.e. before 1997-98) is 6 hours.
2. The average duration for electricity availability at farm after the introduction of free electricity supply policy (i.e. after 1997-98) is 7 hours.

In Punjab's case, these two assumptions seem to be quite realistic. Though there exist disparities across different regions in Punjab on the account of duration of electricity availability at farm, the average figure can be assumed at 7 hours during the post 1997-98 period as during the primary survey, it was found that the average duration of electricity availability on majority of the fields is about 8 hours in the progressive area and about 6 hours in the backward area (see Table 5.9).

It was also found through discussions, during field survey, with farmers of the backward area that the duration of electricity supply before announcement of free electricity supply to agricultural sector was worse than that of present situation. On the other hand, there has not been much variation over the two periods for the same in the progressive area. Thus, under these circumstances, the assumption of the average duration of electricity availability for 6 hours during the pre 1997-98 period seems to be quite valid.

Apart from these assumptions, some data adjustments also have been made. The data available from the PSEB's sources provides information on the number of electric motors within some range of their capacity. The capacity of these reported number of electric motors has been adjusted by assuming its level equal to its maximum limit in that specified range. For example, in 1994-95, 2,93,500 is the number of motors that have the capacity within the range of 3 to 5 horse-power (HP, thereafter) (Table 3.17). Each of these motors has been assumed to be of the 5 HP capacity. This data adjustment is made to take into account the inefficiency in use of electricity by these electric motors. The upper limit instead of the average of these two bounds of the motor's capacity has been considered in the light of the fact that many farmers, in collusion with the board's staff, hide the actual capacity of their electric motors and report relatively less capacity to minimize their HP- based electricity bills.

b. Estimation of Agricultural Electricity Consumption

On the basis of above assumptions and data adjustments, the electricity consumption by the agricultural sector can be estimated through some elementary calculations.

b.i. Agricultural Electricity Consumption in the pre-1997-98 Period

<u>Methodology:</u>

It has been assumed that during the pre 1997-98 period, the average duration of the electricity availability at farm is 6 hours. If an electric motor of 1 HP capacity operates daily for 6 hours then it will consume 4.41 kWh (i.e. 6 X 735.499 Watts)[3] of electricity in a day and 1610.74 kWh (i.e. 365 X 4412.994 Watts) of electricity in one year.

[3] There is no consensus on any standard definition for horsepower. Each nation has its own standard. For example, in the United Kingdom, one horsepower is 745.7 Watts while in the United States, one horsepower for machinery is 745.6999 Watts and one metric horsepower is 735.499 Watts (Patrick, 2000-01). However, in this estimation exercise, horsepower is considered as metric horsepower of 735.499 Watts.

Table 3.17: Estimated Electricity Consumption by Agriculture during 1994-95

Capacity of Electric Motor (HP)	Electricity Consumption, Assuming Operation of 6 Hours Daily in A Year (kWh)	Number Of Electric Motors (1994-95)	Electricity Consumption by Agriculture During 1994-95 (MUs)
Up to 3	4,832.23	3,08,229	1,489.43
3-5	8,053.71	2,93,500	2,363.77
5-7.5	12,080.57	76,375	922.65
7.5-10	16,107.43	19,610	315.87
10-15	24,161.14	4,126	99.69
15-20	32,214.86	1,214	39.11
20-25	40,268.57	308	12.40
25-30	48,322.28	9	0.43
30-45	72,483.43	3	0.22
Total	2,58,524.22	703,374	5,243.57

Source: Based on PSEB (1995)

This electricity consumption by the electric motor of 1 HP capacity is multiplied first with the assumed capacity of electric motor and then to the reported number of electric motors having that capacity so as to reach at an estimate of electricity consumption by electric motors of different capacities in 1994-95 – a year falling in the pre 1997-98 period.

By the use of this approach, it has been estimated that the total electricity consumption by all the electric motors of different capacities during the year 1994-95 is 5,243.57 MUs (Table 3.17).

b.ii. Agricultural Electricity Consumption in the post 1997-98 Period

The same approach has been used to estimate the quantum of electricity consumption by the agricultural sector in the post 1997-98 period. The post 1997-98 period represents the period when electricity has been provided without any monetary charge to the agricultural sector.

The 1999-2000 is the year that has been considered to have an estimate of electricity supply during this period, as the information about the capacities of electric motors is accessible for this year in this period. In this case, the average daily duration of electricity availability at the farm for 7 hours has been assumed. Thus, the electricity consumption has been estimated by taking into account the daily operation of the electric motors for 7 hours.

Table 3.18: Estimated Electricity Consumption by Agriculture during 1999-2000

Capacity of Electric Motor (HP)	Electricity Consumption, Assuming 7 hours daily Operation in a Year (kWh)	Number of Electric Motors (1999-2000)	Electricity Consumption by Agriculture in 1999-2000 (MUs)
Up to 3	5,637.600	314,530	1,773.19
3-5	9,396.000	346,791	3,258.45
5-7.5	14,094.000	75,293	1,061.18
7.5-10	18,791.999	17,178	322.81
10-15	28,187.999	5,769	162.62
15-20	37,583.999	1,353	50.85
20-25	46,979.999	177	8.32
25-30	56,375.998	10	0.56
30-45	84,563.998	18	1.52
Above 45 (proxied at 55)	1,03,355.997	14	1.45
Total	4,04,967.588	761,133	6,640.95

Source: Based on PSEB (2000)

Thus, it has been estimated that the total estimated electricity consumption by all the electric motors of different capacities during 1999-2000 is 6,640.95 MUs (Table 3.18).

c. Estimation of Dumped and Actual T and D Losses

On the basis of this estimated level of electricity consumption by the agricultural sector, it is possible to reach at an estimate of the dumped and the actual T and D losses. It is clear from the above exercise that the estimated electricity consumption by the agricultural sector is not as high as reported by the PSEB. A comparison of this estimated electricity consumption with the reported electricity consumption by the agricultural sector indicates that the latter is higher than the former in both the periods (Table 3.19).

Table 3.19: Reported and Estimated Agricultural Electricity Consumption

Year	Reported Agricultural Electricity Consumption (MUs)	Assumed Electricity Supply (Hours)	Estimated Electricity Consumption (MUs)	Dumped T and D Losses (MUs)
1994-95	5979.76	6	5,243.57	736.19
1999-2000	8233.06	7	6,640.95	1592.11

Source: Based on PSEB (1995; 2000)

One more interesting result that is obtained in this exercise is that the announcement of free electricity supply to agricultural sector made the PSEB's officials very enthusiastic to use agricultural sector as the convenient dump for their inefficiencies as the dumping of the T and D losses increased by 9.09 percent during the post-1997 period. It has been estimated that 20.75 percent of the actual T and D loss has been dumped into the electricity consumption by the agricultural sector in 1994-95 whereas the same figure stands at 29.84 percent in 1999-2000 (Table 3.20).

This provides, in a sense, an impression that the reported T and D loss figures by the PSEB are the underestimates and a significant part of this loss is being dumped into the un-metered electricity consumption by the agricultural sector.

Thus, it is possible to estimate the actual level of T and D losses by taking into account the dumped T and D losses. The reported technical losses in 1994-95 were 18.32 percent of the electricity available that is equal to 2810.25 million units. This magnitude of the T and D losses when combined with the dumped T and D loss figures of 736.19 million units shows that the reported T and D loss figures underestimate the actually estimated T and D loss figures by 4.8 percent of the total electricity available in 1994-95 (Table 3.20)

Table 3.20: Reported and Estimated T and D Losses

Year	Electricity Available (MUs) (1)	Reported T and D Loss		Assumed Electricity Supply (Hours) (4)	Dumped T and D Loss (MUs) (5)	Estimated T and D Loss	
		(% of 1) (2)	Magnitude (MUs) (3)			Magnitude (MUs) (6)	(% of 1) (7)
1994-95	15339.83	18.32	2810.25	6	736.19	3546.44	23.12
1999-2000	21072.88	17.76	3742.54	7	1592.11	5334.65	25.31

Source: Based on PSEB (1995; 2000)

Similarly for the year 1999-2000, the reported figures underestimate the actually estimated T and D loss by 7.55 percent of the total electricity available in this year. The estimated T and D loss in 1999-2000 is higher than that in 1994-95 (Table 3.20). This trend of the T and D loss is quite opposite to that revealed by the PSEB's reported figures. The PSEB data reported a decline in the level of electricity losses (see Table 3.16). But, it seems to be doubtful in the light of the above discussion of increasing electricity supply burden on the transmission and distribution lines as this rising burden on these lines is bound to cause a rise in the level of T and D losses.

d. An Estimate of Electricity Supply Inefficiency

By considering the fact that the actual level of T and D losses is very high, the magnitude of the PSEB's inefficiency in supplying electricity to the consumers' premises can be estimated. For this estimation exercise, an attempt has been made through a comparison of the estimated T and D loss figures with an ideal, say 15 percent, level.

A comparison of the estimated T and D loss figures with an ideal 15 percent level shows that there has been an excess of 8.12 percent and 10.31 percent T and D losses for the years 1994-95 and 1999-2000 respectively. These levels of T and D losses, if avoided, had the potential to raise the levels of electricity availability by huge amounts in both the years under consideration.

This available electricity, if sold at the average price of the respective years, could have raised the PSEB's revenue earnings by about Rs. 134 crore and about Rs. 348 crore in 1994-95 and 1999-2000 respectively. The electricity thus saved represents a potential saving of 250.78 MW and 332.02 MW of the installed generating capacity in both the years (Table 3.21).

Table 3.21: Potential Savings with 15 percent T and D Loss Levels

Year	Excess T and D Loss (%)	Electricity Available (MUs)	Quantity of Electricity Lost (MUs)	Average Revenue (Rs.)	Plant Load Factor (%)	Revenue Realizable (Rs. Cr.)	Savings in Installed Capacity (MW)
1994-95	8.12	15339.83	1245.59	1.08	56.70	134.52	250.78
1999-2000	10.31	21072.88	2172.61	1.60	74.70	347.62	332.02

Source: Based on PSEB (1995; 2000)

Thus, the PSEB could have made these savings by reducing its level of T and D losses to this ideal level of 15 percent. But, this did not happen and the PSEB's inefficiency in electricity supply has resulted in an opportunity loss of both revenue as well as the generation potential. Owing to this, the PSEB's performance in supplying electricity to consumers' premises has remained far from satisfactory.

3.4.2. Organizational Performance

The organizational performance of the utility is inherent in the performance of its workforce and the tenure of top officials in the utility. The PSEB's performance in these two aspects of organizational performance is discussed as under:

i. Labor Performance

The PSEB during 1997-98 had as many as 80,329 employees. Such staff strength may be due to the utility's requirements. A glance at such strength of employees cannot provide an idea about their productivity. But, an idea about the relative efficiency of the PSEB's staff can be had through a comparison of its various labor productivity ratios *vis-à-vis* those of the other SEBs.

Table 3.22: Selected Indicators of Labor Productivity (per '000 employees)

SEBs	Consumers (Number)		Sales (MUs)		Connected Load (MW)	
	1992-93	1997-98	1992-93	1997-98	1992-93	1997-98
Punjab	58085.68	59490.41	188.87	220.52	119.77	147.28
Andhra Pradesh	111009.45	140448.68	260.95	311.60	165.89	242.08
Gujrat	137492.42	163806.20	367.92	502.36	277.50	346.77
Kerala	165806.74	202621.38	235.30	292.46	275.57	249.15
Maharashtra	103863.95	132562.03	233.52	354.97	203.90	275.53
Tamil Nadu	95684.27	122971.19	193.44	274.84	160.48	215.36
All-India Average	72742.35	116421.65	205.96	298.86	139.81	227.36

Source: Based on GOI (1992-93; 1997-98); CMIE (1999; 2002b)

The productivity of the PSEB's employees has been found to be quite low for these selected parameters in comparison to some of the best performing SEBs and the all-India average levels. The number of consumers served per thousand employees remained less than all the SEBs during the years 1992-93 and 1997-98 (Table 3.22). This number of consumers served is too low when compared with China that has a similar structure of ESI. In China, the number of consumers served per employee in 1991 is 242 (Guttierez, 1993) whereas in Punjab, it has been 58 and 59.4 per employee in 1992-93 and 1997-98 respectively. For other parameters of electricity sales and connected load too, the PSEB's labor performance has been quite similar.

This shows that many of the employees contribute little. The payment of huge salaries to them adds to financial burden that has caused a rise in the share of establishment and administration cost in the total cost of electricity supply (see Table 3.23). But, such unproductive financial burden on the PSEB should be avoided.

ii. Tenure of Top Officials

The *Rajyadhaksha* Committee (GOI, 1980: 155-156) recommended that the procedure adopted by Public Enterprises Selection Board should be used for filling up the posts of chairman and the members of the SEBs. It also recommended that the tenure of chairman and members of the board should be at least 3 or preferably 5 years.

But, these recommendations were never put into practice and the state governments continued to influence the utilities. The PSEB too has been a victim of vacillation and indecisiveness of the state government that has been always biased on making appointments to its top posts. The PSEB has received a startlingly shocking and shabby treatment from the successive popular governments in matters of the appointment of its chairman at various times.

The tenure of the chairman remained quite unstable. Since 1st April 1990, the PSEB had as many as thirteen chairmen. Among these only one chairman completed a full tenure of a little over three years and at least two chairmen had the tenure of less than six months.

Most of the time during the 1990s, these were either the bureaucrats or the persons with political influence who assumed the office of the PSEB's chairman and the talented engineers were sidelined. As one senior bureaucrat said, *"The PSEB has many talented engineers who are known for their honesty and efficiency. They know very well how to operate the board in an efficient manner but they simply retired and no attempt was made to utilize their services. Any of them suitable to the government could have been chosen for appointment to the key post of chairman so as to improve the PSEB's fate"*[4].

Similar is the case with the appointments of board members. Some of the members continue to work on a purely temporary basis depending upon the willingness of their political superiors. This clearly reflects that the chairman and the members of the board are often appointed with the tenure till further orders, and are often shown the door at the whims of their political bosses for reasons unstated. Such prevalence of uncertainty in tenure of top officials has an impact on their commitment towards meeting the targets and the seriousness in policy-making.

[4] Interview on 23/12/2002.

3.4.3. Commercial Performance

The overall performance of the utility is dependent on its commercial performance because only a commercially efficient utility can ensure the availability of sufficient resources to finance the development of its capacities that are required for efficient generation and supply of electricity to the consumers' premises. A utility is said to be efficient in commercial aspects if it is able to not only cover its operating expenditure but also to earn sufficient rate of return on its capital. This rate of return has been stipulated at 3 percent through an amendment made in 1983 to the 'Electricity (Supply) Act, 1948'.

But, the commercial performance of most of the SEBs did not remain attractive over the period of time because of their inability to achieve a positive rate of return (see Table 2.16). Such a situation existed mainly due to the fact that electric utility in India, like many developing countries, continued to be typically owned and operated or else strongly influenced by the government. For the PSEB too, the continuing political interference in its operations has had a significant impact on its commercial performance.

Here, the commercial performance of the PSEB has been highlighted through a consideration of its average operating expenditure, average realization of revenue from the sale of electricity, cross-subsidies and subsidies from / to different consumers etc. These different parameters of the PSEB's commercial performance are explained as under:

a. Average Operating Expenditure

Operating expenditure is an expenditure incurred to keep system in working conditions. It comprises different cost elements like the fuel cost, establishment and administration cost, operation and maintenance cost, power purchase cost, interest cost and depreciation.

There has been an increase in the average cost of electricity supply over the period of time. The average cost increased by 2.61 times at the average annual growth rate of 12.72 percent since 1991-92 (Table 3.23). This increase in average cost took place due to rapid increase in its constituents like fuel cost, power purchase cost, depreciation, and establishment and administration cost.

Average fuel cost remained the major constituent of the average cost of electricity supply over the period of time. It recorded the highest average annual growth rate among different components of cost. Its magnitude increased by 3.30 times in absolute terms. Owing to this, its share in average cost increased further by 7.50 percent in 1999-2000.

Table 3.23: PSEB's Average Operating Expenditure (Ps. per unit sold)

Year	Fuel Cost	Power Purchase Cost	Interest Cost	Depreciation	O and M Cost	E and A Cost	Average Cost
1991-92	26.21 (27.89)	15.07 (16.04)	18.10 (19.26)	7.40 (7.88)	4.96 (5.28)	22.21 (23.64)	93.96
1992-93	36.57 (31.58)	18.43 (15.91)	20.48 (17.68)	11.60 (10.02)	5.51 (4.75)	23.24 (20.06)	115.82
1993-94	52.88 (37.52)	23.15 (16.42)	20.89 (14.82)	11.99 (8.51)	6.49 (4.60)	25.55 (18.13)	140.95
1994-95	52.57 (33.93)	29.82 (19.25)	20.59 (13.29)	19.30 (12.46)	6.03 (3.89)	26.61 (17.17)	154.93
1995-96	53.83 (32.54)	31.46 (19.02)	20.57 (12.44)	21.11 (12.76)	6.83 (4.13)	31.63 (19.12)	165.44
1996-97	62.74 (35.99)	34.68 (19.90)	17.64 (10.12)	17.02 (9.76)	8.04 (4.61)	34.20 (19.62)	174.32
1997-98	72.95 (30.02)	53.60 (22.06)	20.11 (8.28)	16.99 (6.99)	42.28 (17.40)	37.10 (15.26)	243.03
1998-99	70.41 (31.37)	47.19 (21.03)	25.40 (11.32)	16.47 (7.34)	7.83 (3.49)	57.14 (25.46)	224.45
1999-2000	86.66 (35.39)	44.54 (18.19)	30.78 (12.57)	19.97 (8.15)	8.84 (3.61)	54.10 (22.09)	244.89
Growth Rate (%)							
1991-2000	16.13	14.50	6.86	13.20	7.49	11.77	12.72

Note: O and M = Operation and Maintenance; E and A = Establishment and Administration
Note: The figures in parentheses are the percentages of the average cost
Source: Based on PSEB (1995; 2000)

Average establishment and administration cost is another major cost component. Though its share recorded a marginal decline over the period, it still continued to have a larger share in the average cost of electricity supply. The PSEB's expenditure on salaries and allowances of its employees is a major part of this establishment and administration cost because of a huge strength of its employees.

Average power purchase cost is another component of average cost whose magnitude increased continuously up to 1997-98 but thereafter it recorded decline till 1999-2000. This cost component has registered the growth rate next to fuel cost since 1991 because of the increased dependence on purchased power (see Table 3.5) and the rise in per unit price of the purchased power by 2.58 times i.e. from Rs. 0.60 in 1991-92 to Rs. 1.55 in 1999-2000 (PSEB, 2000).

The magnitude of interest cost recorded continuous increase after 1996-97. Relatively less dependence on other sources due to availability of sufficient loans from the state and the strong position of the internal resources was the main reason for a stable level of interest cost during the pre-1996-97 period (Table 3.28 in Annex 3). But, afterwards with the emerging fiscal deficit situations in the state, there was no adequate availability of loans from the state. There was also a steep fall in internal resources. This resulted in increased reliance on sources other than government and consequently, an increase in interest cost burden.

The share of operation and maintenance cost has declined since 1991-92. This is a cause of concern. It indicates that the PSEB has given less importance to the maintenance of its existing units. This apart, the depreciation reserve remained below 10 percent for most of the years during the 1990s.

b. Average Revenue

The SEBs in India follow the procedure similar to the 'fair rate of return regulation' method adopted by the regulatory commissions in USA till the early 1980s for determination of tariffs. Nevertheless the SEBs' practice differs from the latter in the sense that their tariff determination process is affected by many socio-economic and political considerations (Rao et al., 1998: 88). The state governments continued to affect the determination of retail tariffs. These governments have adopted the policies of subsidizing some categories of consumers through cross-subsidization of other categories. The state of Punjab is one among them.

Table 3.24: Category-wise Trend of Average Revenue (Ps. per unit sold)

Year	Domestic	Commercial	Industrial	Agricultural	Others	All-Consumers
1991-92	87.38	161.31	103.63	9.81	99.40	60.90
1992-93	92.45	169.76	129.33	10.87	106.39	71.22
1993-94	103.60	189.54	156.06	19.47	134.13	88.38
1994-95	121.14	210.31	166.90	34.49	148.62	108.23
1995-96	137.38	237.20	193.76	39.43	182.09	128.68
1996-97	135.55	258.87	228.02	28.48	229.21	137.98
1997-98	149.90	293.58	252.26	0.00	258.43	146.19
1998-99	180.94	338.20	281.08	0.00	299.59	154.11
1999-2000	194.46	366.53	289.29	0.00	313.89	160.52

Source: Based on PSEB (1995; 2000)

The PSEB has pursued the policy of granting subsidies through cross-subsidization. This policy provided electricity to some categories of consumers at relatively lower rates. The agricultural sector received electricity at the lowest average tariff rate during the 1990s (Table 3.24). This is because of the fact that the electricity is supplied to the agricultural sector at the flat rate – a tariff rate based on the capacity of electric motor rather than actual electricity consumption. Since 1991-92, the average realization from electricity sale to the agricultural sector improved by a small margin of 29.62 paise up to 1995-96 but afterwards, it declined and became zero in 1997 due to the state policy of free electricity provision to the whole agricultural sector.

Domestic sector is another sector that yielded lower average revenue from sale of electricity. On the contrary, there have been the categories of consumers like industrial, commercial and others (to some extent), which yielded relatively higher levels of average revenue. The average realization from the commercial sector remained the highest. The industrial sector consumers and others have been the next to the commercial sector consumers to provide the PSEB with relatively higher average revenue from the sale of electricity (Table 3.24).

c. *Cost Recovery*

A comparison of the average cost and the average realization (see Table 3.23 and Table 3.24) reveals that the latter remained lower than the former during the 1990s. This gap between the two forced the PSEB to incur loss from the sale of every unit of electricity. Under these conditions, it becomes crucial to examine how far the PSEB could recover its average cost of supplying electricity.

The average cost of supplying electricity has two components viz. average variable cost and average fixed cost. The fuel cost, operation and maintenance cost, power purchase cost, and the establishment and administration cost constitute the average variable cost and the average fixed cost comprises interest payments, depreciation and returns on equity (Rao et al., 1998: 87). In economic theory, in the short run, any loss-making firm can continue its production if it is recovering at least its average variable cost (Koutsoyiannis, 1979: 158). The same logic applies to the electricity utility like the PSEB. There is scope for the board to continue its operations of electricity generation and supply only if it is able to recover at least its average variable cost.

But, it has been found that the PSEB could not recover the average cost that it has incurred for supplying electricity to different consumers. The average cost recovery remained within the range of 60 to 80 percent during the 1990s (Table 3.25).

Table 3.25: Average Variable Cost and the Average Cost Recovery

Year	Average Cost (Ps.)	Average Variable Cost (Ps.)	Average Revenue (Ps.)	Average Cost Recovery (%)	Average Variable Cost Recovery (%)
1991-92	93.96	68.45	60.90	64.82	88.97
1992-93	115.82	83.75	71.22	61.49	85.04
1993-94	140.95	108.07	88.38	62.70	81.78
1994-95	154.93	115.03	108.23	69.86	94.09
1995-96	165.44	123.75	128.68	77.78	103.98
1996-97	174.32	139.67	137.98	79.15	98.79
1997-98	243.03	205.93	146.19	60.15	70.99
1998-99	224.45	182.58	154.11	68.66	84.40
1999-2000	244.89	194.14	160.52	65.55	82.69

Source: Based on PSEB (1995; 2000)

The position of revenue realization from the sale of electricity has remained so poor that the PSEB could not recover fully even its average variable cost for almost all the years during the 1990s except 1995-96, a year when the agricultural sector yielded the highest average revenue (i.e. 39.43 Ps; see Table 3.24).

This inability of the PSEB to recover even its average variable cost clearly reflects its poor commercial performance. This cautions the PSEB to undertake remedial measures to not only increase the average revenue but also to cut short the unnecessary expenditure, for example, the high burden of salaries due to overstaffing.

This pattern of average cost recovery is not homogenous across different sectors. The average cost recoveries from different categories of consumers vary because of the differential pricing policy that has been pursued by the PSEB on account of various socio-economic and political factors. By this policy, it has been supplying electricity to some of the consumers like the domestic and the agricultural sector at rates much below than the average cost incurred for supplying electricity to them[5] whereas the PSEB has been charging a relatively higher price to some consumers like the categories of commercial, industrial and others.

[5] Since the available PSEB data does not provide the average cost of supply to each consumer, the average cost of electricity supply has been assumed to be the same for all the consumers. In fact, it is not so. But, even then, an attempt has been made just to have an idea about the subsidized and the cross-subsidized consumers.

The sale of electricity to the commercial sector yielded highest average realization since 1991 (see Table 3.24). This resulted in the largest proportion of average cost recovery from this sector (Table 3.26). The average cost recovery from the industrial sector remained relatively lower than that of the commercial sector but, in fact, it is not so. Such results are obtained because of the data limitations.

The actual cost of electricity supply to the industrial sector is even less because most of the electricity supply to the industrial sector is made through the high tension lines and there does not arise the need for the development of the low tension distribution network for this sector. But, it is not so in case of supplying electricity to the commercial sector. Owing to this, it can be expected that the average cost recovery is the highest from the industrial sector among all categories of consumers.

Table 3.26: Sector-wise Cost Recovery

Year	Domestic	Agriculture		Commercial	Industrial	Others
	ACR (%)	ACR (%)	AFCR (%)	ACR (%)	ACR (%)	ACR (%)
1991-92	92.99	10.44	37.44	171.69	110.29	105.80
1992-93	79.82	9.39	29.72	146.56	111.66	91.86
1993-94	73.50	13.81	36.81	134.47	110.72	95.16
1994-95	78.19	22.27	65.61	135.75	107.73	95.93
1995-96	83.04	23.83	73.25	143.38	117.12	110.07
1996-97	77.76	16.34	45.40	148.50	130.80	131.49
1997-98	61.68	0.00	0.00	120.80	103.80	106.34
1998-99	80.62	0.00	0.00	150.68	125.23	133.48
1999-2000	79.41	0.00	0.00	149.67	118.13	128.18

Note: ACR = Average Cost Recovery; AFCR = Average Fuel Cost Recovery
Source: Based on PSEB (1995; 2000)

On the other hand, the average cost is not recovered fully from the domestic and the agricultural sector consumers. Even the category of 'others' was in this group for some yeas during the early 1990s. The average cost recovery from the domestic sector has shown the fluctuating trend. It has remained below or around 80 percent for most of the years during the 1990s (Table 3.26). But, it continued to be much above the agricultural sector during the same period.

The average cost recovery from the agricultural sector has been at the lowest level among all the consumers. A great deal of electricity is supplied to the agricultural sector where even the fuel costs are not recovered. The average fuel cost recovery from the agricultural sector remained below 50 percent except the two years of 1994-95 and 1995-96. The levels of both the average fuel cost recovery and the average cost recovery had been reduced to zero from 1997-98 onwards (Table 3.26) with the introduction of the state policy of providing free electricity to the agricultural sector. But, this policy has been replaced by a flat-rate based tariff pattern by the state in 2002. However, the trend of providing partially or fully subsidized electricity clearly reflects the nature of political patronage enjoyed by Punjab's agricultural sector.

d. Subsidy / Cross-subsidy:

The above discussion of cost recovery provides an idea about the subsidized and cross- subsidized consumers. Along with this, it is important to examine the total magnitude of subsidies and cross-subsidies enjoyed / borne by different categories of consumers in order to understand better the financial burden that has been borne by the PSEB over the years due to various socio-economic and political considerations.

It is quite evident from the earlier discussion on cost recovery that the agriculture sector has been getting a large part of subsidy on electricity consumption. The same has been the trend for total quantum of subsidy as a mammoth share went to this sector during the 1990s. The total magnitude of electricity subsidy given to the agricultural sector for a period of 9 years during the 1990s, stood at Rs. 9,426.49 crore (Table 3.27).

It has been proposed in the Chief Ministers' conference held in 1996 that a minimum tariff of Rs 0.50 per kilowatt-hour ($ 0.015/kWh) will be charged to the agricultural sector and it will be brought within three years to the 50 per cent of the average cost of electricity supply (Dubash and Rajan, 2001: 3371). If one assumes that the agricultural sector is charged the Ps. 50 per unit, then the PSEB would have been relieved from incurring the financial burden of Rs. 2037.37 crore during the period of 9 years since 1991-92 (Table 3.27).

The domestic sector has been the second major beneficiary of the subsidy, which is granted through price concessions on sale of electricity. The total electricity subsidy that went to domestic sector during the period 1991-2000 stood at Rs. 1057.99 crore. The domestic sector got, on an average, the subsidy worth Rs. 117.55 crore every year during the 1990s. This apart, the category of 'others' also got a small amount of electricity subsidy for some years in the early 1990s (Table 3.27).

Table 3.27: Trend of Total Subsidy / Cross-Subsidy for / from Different Consumers

Year	Subsidy (Rs. Crore)				Cross – Subsidy (Rs. Crore)				Cross - Subsidy / Subsidy Ratio (%)	Net Subsidy (Rs. Crore)	
	Domestic (1)	Agriculture At PSEB's tariff (2)	Agriculture At Ps. 50 per unit (3)	Total (1+2)	Commercial (4)	Industrial (5)	Others (6)	Total (4+5+6)		At PSEB's Tariff	If Agriculture is charged Ps.50 per unit
1991-92	10.37 (2.18)	466.42 (97.82)	243.65	476.79	-21.65 [32.25]	-42.36 [63.11]	-3.12 [4.65]	-67.13	14.08	409.66	186.89
1992-93	41.64 (6.01)	644.84 (93.15)	404.43	692.29	-19.76 [23.60]	-63.96 [76.40]	5.81 (0.84)	-83.72	12.09	608.57	368.16
1993-94	73.13 (8.62)	770.65 (90.86)	576.95	848.21	-19.13 [20.24]	-75.39 [79.76]	4.44 (0.52)	-94.52	11.14	753.69	559.99
1994-95	80.53 (10.00)	720.16 (89.45)	627.44	805.10	-25.48 [27.15]	-68.36 [72.85]	4.41 (0.55)	-93.83	11.65	711.27	618.55
1995-96	76.98 (9.63)	722.62 (90.37)	662.00	799.61	-39.81 [17.80]	-178.07 [79.62]	-5.78 [2.58]	-223.66	27.97	575.94	515.33
1996-97	119.52 (11.44)	925.04 (88.56)	788.57	1044.56	-53.57 [12.55]	-354.79 [83.14]	-18.35 [4.30]	-426.71	40.85	617.85	481.38
1997-98	310.75 (17.45)	1470.19 (82.55)	1167.73	1780.94	-34.15 [33.05]	-63.73 [61.69]	-5.44 [5.26]	-103.32	5.80	1677.62	1375.16
1998-99	154.46 (8.37)	1690.39 (91.63)	1313.83	1844.86	-84.46 [16.80]	-388.69 [77.32]	-29.53 [5.87]	-502.68	27.25	1342.17	965.62
1999-2000	190.60 (8.64)	2016.18 (91.36)	1604.53	2206.78	-97.22 [21.19]	-332.48 [72.48]	-29.03 [6.33]	-458.73	20.79	1748.05	1336.40
Total (1991-2000)	1057.99	9426.49	7389.12	10499.14	-395.22	-1567.84	-76.59	-2054.31	-	8444.83	6407.46
Average (1991-2000)	117.55	1047.39	821.01	1166.57	-43.91	-174.20	-8.51	-228.26	-	938.31	711.93

Note: The figures in parentheses and square brackets are the percentages of the total subsidy and cross-subsidy respectively.
Source: Based on PSEB (1995; 2000)

The agricultural and domestic sector consumers remained the major beneficiaries of electricity subsidy. This has been due to the fact that all the ruling parties in Punjab at different times, through the use of electric utility, have attempted to serve the interests of their major vote banks.

The PSEB, like other SEBs, pursued the policy of cross-subsidization to offset the emerging losses from the subsidized sale of electricity. The average recovery has been higher than 100 percent for consumers in the categories of commercial, industrial and the others. This average cost recovery has been the highest for the commercial sector (see Table 3.26). But, it is the industrial sector that contributes more than the commercial sector to the total cross-subsidy (Table 3.27).

Though the PSEB has used the policy of cross-subsidization rigorously, it could offset only a part of its losses emerging from the subsidization of electricity. It was mainly because of the fact that the losses from the subsidization process have been too high to be offset merely by cross-subsidization[6]. The cross-subsidy to subsidy ratio remained at very low levels. It was at the highest level (i.e. 40.85 percent) in 1996-97 (Table 3.27).

Owing to the low levels of revenue realizations through cross-subsidization, the levels of net subsidy remained very high. The magnitude of net subsidy increased significantly after 1997-98 mainly on account of the fact that the total subsidy to domestic and agricultural sectors increased significantly during this period. But, out of the two, it is the electricity subsidy to the agricultural sector, because of its huge quantum, that has emerged as a major factor responsible for poor commercial performance of the PSEB.

3.5.Conclusion

Though having a relatively sound position in electricity generation, the PSEB could not maintain a balance between the loads and its resources. It had opted a much dearer option of power purchase instead of augmenting as well as improving the utilization of its generation potential especially the hydro, over the period of time.

[6] One senior bureaucrat told that the government subventions remained almost negligible. The PSEB adjusted its subsidy burden with interest payable on government loans.

Besides, the PSEB has remained quite inefficient in supplying electricity to the consumers' premises but it continued to report stagnating level of T and D losses over the period of time. Such figures have been found fake in the presence of heavily loaded T and D lines. A quantitative estimate of the inefficiency in this respect shows that there has been a potential loss of hundreds of crores of rupees just because of inadequate attention given to the development of the required T and D network.

In organizational aspect too, the PSEB's performance is not attractive. Its employees have been found to be quite inefficient than the other better performing SEBs. This apart, the tenure of the officials at the key management posts had been quite unstable due to the influence of politics in board's functioning. This instability has had the implications for effective planning and this may be one of the factors due to which the PSEB could not meet its load requirements on its own.

The worst affected performance aspect was the commercial one where the populist policies pursued by the state had played a significant role. There has not been a parallel rise in the realization of average revenue *vis-à-vis* the average cost over the period of time. Consequently, the PSEB could not recover even its average variable cost for most of the years.

The domestic and agricultural sector remained the major subsidized sectors. But the agricultural sector emerged as the most pampered one to get a mammoth share in total electricity subsidy. It has been found that though the charging of Ps. 50 per unit to the agricultural sector can relieve the PSEB a bit, the financial burden of providing subsidies to the agricultural sector will remain huge.

Having observed the mounting burden of granting subsidies in general and to the agricultural sector in particular, it will be of more interest if one can explore further the real beneficiaries of this electricity subsidy. The subsequent chapters focus on this aspect.

Annex 3

Table 3.28: PSEB's Pattern of financing

Year	Internal Resources (Rs. Cr.)	Other Loans (Rs. Cr.)	Government Loans (Rs. Cr.)
1991-92	110.16	73.98	454.71
1992-93	110.41	63.68	466.62
1993-94	241.56	84.73	423.16
1994-95	305.88	54.64	549.31
1995-96	247.92	281.87	392.89
1996-97	-676	320.16	197.11
1997-98	248.19	836.51	132.18
1998-99	76.54	909.87	497.14
1999-2000	-71.64	1193.06	176.18

Source: PSEB (1995, 2000)

Chapter 4
Characteristics of Primary Survey Areas and Households

4.1. Introduction

In this chapter, along with an explanation of the methodology adopted for selecting the required sample size, an attempt has been made to highlight various distinguishing features of areas and the households that have been selected for the primary survey. This chapter comprises six sections. The next section provides the rationale for the primary survey. The methodology for selection of the required sample size has been discussed in the third section. The fourth section provides a brief introduction to selected districts and the villages. The fifth section has two parts: the first part highlights various socio-economic characteristics of the selected districts and the second part describes socio-economic characteristics of respondents. The final section sums up.

4.2. Rationale for the Primary Survey

One of the major findings of the previous chapter was that apart from other variables, the state's continuing practice of granting partial / full price concessions on electricity sale for irrigation purposes to agricultural sector has been the major factor, because of its magnitude, responsible for the poor commercial performance of the PSEB.

The granting of price concessions on agricultural inputs *per se* is desirable due to their effect on lowering the cost of production. But, there is the possibility that the distribution of benefits resulting from the granting of these price concessions may be skewed among different classes of the farmers. There may be the similar case for price concessions that are granted on electricity sale to the agricultural sector. In order to search the presence of such phenomena, it becomes necessary to analyze farmers' access to quality and reliable electricity not only across different farmer classes but also across different regions.

The need for primary survey has arisen because the secondary information is not of much use in tracing out the actual beneficiaries of electricity subsidy that arises from partial / full price concessions on electricity sale to agricultural sector. It is only the primary level information that has an advantage in this respect.

4.3. Methodology of the Sample Survey

The total sample of a size of 300 farm households has been collected in two parts. The first part is a general survey of 200 farm households. This part aims to make a comparative analysis of the status of electricity supply to the fields of different classes of farmers in selected progressive and backward districts of Punjab. The second part, on the other hand, comprises 100 farm households. This part focuses only on those farm households who took electricity connections under the 'Own Your Tube-well' (OYT, hereafter) scheme[1].

This scheme was introduced by the PSEB, under the existing policy of free electricity supply to the agricultural sector, on the pretext of resource crunch on June 2000. This scheme provided open access to electricity connections, through the provision of self-financing, to only those farmers who incur the whole cost for installation of new electricity connection.

Along with analyzing disparities regarding the status of electricity supply to the fields of different classes of farmers in both the selected progressive and backward districts of Punjab, the main purpose for bifurcation of total sample size is twofold. The first is to trace out the impact of the state policy of providing the new 'Irrigation Pump-Set' (IPS, hereafter) connections. The second is to highlight practices that are hidden in granting these connections.

For the selection of a sample size of 200 farmer households, 'Multi-Stage Sampling' technique has been adopted. This sample size has been selected in three stages.

The first stage involves the identification of one district each from the progressive and backward districts of Punjab. These districts have been classified as progressive and backward according to their achievements in various socio-economic aspects of development. This follows the selection of some villages from the selected districts on the basis of following conditions:

I. A representative village should be a large one.
II. The under-ground water should be of a relatively better, if not superior, quality.

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[1] A detailed description of PSEB's directions regarding the OYT scheme is given in Annex 4.

Apart from the possibilities of getting a truly representative sample from a large village, the consideration of the quality of under-ground water in village selection is to take into account the basic fact that the need for electricity connection on the farm is justified only if the quality of the under-ground water is suitable for the cultivation of crops.

Table 4.1: Distribution of Operational Holdings in Backward and Progressive Districts

District	<1 Acre	1-2 Acres	2-4 Acres	4-10 Acres	>10 Acres	Total Acres
Bathinda[2]	14882 (14.55)	13871 (13.56)	25783 (25.21)	37396 (36.56)	10343 (10.12)	102275 (100)
Ludhiana	24031 (28.92)	15164 (18.25)	17674 (21.26)	20681 (24.88)	5560 (6.69)	83110 (100)

Note: The figures in parentheses are the percentages of total acres.
Source: Agriculture Census (Punjab) 1990-91, printed in Government of Punjab (2002)

In the second stage, a sample size of 200 households - 100 households from each district, has been selected randomly using the 'Proportionate Sampling' method. 'Operational Land Holding'[3] data served as the basis for the proportionate sampling (Table 4.1). The proportions of farmers having operational holdings up to 4 hectares have been clubbed together, for convenience, as one farmer class.

The farmers who have operational land holdings up to 4 hectares are termed as small farmers, whereas the farmers having operational land holdings between 4 and 10 hectares and above 10 hectares have been termed as medium and large farmers respectively. These ratios to classify farmers have been assumed same for the selected villages in each district.

In the third stage, the information about the farmers' name etc. has been collected from the village 'Patwari'[4]. On the basis of this information, the farmer households are

[2] Before 13th April 1992, Mansa district was part of the Bathinda district. As the available 'operational land holding' data is for the year 1990-91 so this data of Bathinda district is assumed to be the same for the Mansa district.

[3] It is reasonably believable that the ownership of land holding can be taken as a proxy for the varying level of the interest group strength that may affect state's policies of granting electricity subsidy to the agricultural sector, but, as the land-ownership data is highly defective in case of all states in general and for Punjab in particular, it has been substituted by 'operational land holding' data to serve as the basis for proportionate sampling.

[4] An official assigned with the duty to keep as well as update all land records of a village.

selected randomly. This is followed by an enquiry from the farmer about number of acres of land that he / she, at present, is cultivating. This procedure continued till the required sample size within each farmer class from each selected village has been collected.

While following this approach of sample selection, a very negligible number of farmers have been found to be having connections under the OYT scheme. This set of farmers has been rejected because of their insignificant number in the total sample size. In such case, it has been considered better to rely on the sample size of OYT households collected in the other part to avoid any sort of confusion that may arise while interpreting the results.

The other part of the total sample size comprises the households who have taken electricity connections under the OYT scheme. The information, about the particulars of such households has been collected from two electricity sub-stations in each district.

On the basis of this information, some villages with relatively high number of OYT connection holders have been selected. This has been followed by a random selection of households from each village to complete the sample size of 50 households from each district. For every household, the household head has been interviewed. Sometimes, when the head of a selected household has been found to be out of the house during the survey, an appointment to see the household head on next day has been fixed to get the accurate required information about the OYT connection.

4.4. A Brief Profile of the Study Area

The study area comprises two districts of Punjab viz. Mansa and Ludhiana. The main reason for selection of these two districts lies in the fact that the Mansa district is one among the backward districts that have achieved relatively lower levels of development and the Ludhiana district, on the other hand, has proved itself as the progressive one by attaining rapid growth in various socio-economic aspects of development.

4.4.1. An Introduction to the Selected Districts

An introduction to the general indicators like the location, area, population etc. is crucial to understand various characteristics of the selected districts and villages.

i. Mansa District

Known as the *'Area of White Gold'*, the Mansa district is situated in the cotton belt of Punjab. It was formed on 13th April 1992 from the erstwhile district of Bathinda. Mansa is a small district both in terms of area and population. This district is spread over 2,077 square kilometers and is having a total population of 6,88,630 as per 2001 census that amounts to 2.83 percent of the total population of Punjab.

The canal network for irrigation is not much developed in this district. Owing to this, most of the farmers depend on tube-wells for irrigation purposes. The soil quality is sandy and it absorbs lot of water. This district has relatively less amount of rainfall even during the normal years. The under-ground water is very deep in some of its villages. Also, the under-ground water, in most part of this district, is not of 'the best' quality.

ii. Ludhiana District

Known as the *'Manchester of India'*, Ludhiana is the principal city. It is situated in the central part of Punjab on the banks of river *'Satluj'*. Ludhiana, as district, is big both in terms of population and area. With a total spread of over 3,426 square kilometers, this district is having a total population of 30,30,352 as per 2001 census that is equal to 12.47 percent of the total population of Punjab.

The canal network for irrigation is relatively much developed. The sand of the Ludhiana district is of alluvial kind that has been transported to its present location by the water flow. Such sand absorbs relatively less water than that of the Mansa district. This apart, it is very fertile. The under-ground water is not much deep. The presence of good amount of rainfall in all normal years is one of the major reasons for it. Also, the under-ground water is of 'the best' quality. It was only due to these factors that this district became the first district in Punjab to conduct experiments with the *'Green Revolution'* in the 1960s.

4.4.2. An Introduction to the Selected Villages

The total sample size of 300 households has been collected from a different set of villages in each district. As the number of villages is large, it is possible only to mention limited details like the location etc. of these villages.

For the sample survey of 200 households, a set of villages has been chosen from each district. In Mansa district, four villages have been selected for sample survey. The names of these villages are 'Sangha', 'Ahlupur', 'Kahnewala' and 'Jhanda Kalan'. These villages fall within the jurisdiction of the 'Sardulgarh' sub-division. The distance and direction wise location of these villages is given in Table 4.2 along with the road on which these villages are either situated or connected via a link road.

Table 4.2: Location of Villages Selected from Sardulgarh Sub-division

Village Name	Distance from Sardulgarh (Kilometers)	Direction from Sardulgarh	Connecting Road to Selected Village
Sangha	17	South	Sardulgarh-Fatehabad
Ahlupur	7	East-South	Sardulgarh-Ratia
Kahnewala	5	North-West	Sardulgarh-Bathinda
Jhanda Kalan	6	South-West	Link road to Sardulgarh-Sirsa

Source: Personal Observation

In the Ludhiana district, two large towns viz. 'Sudhar' and 'Mullanpur', instead of villages, having a good strength of agricultural workers, have been selected. The basic rationale for the selection of these towns was that these towns, apart from satisfying the two basic conditions required for the selection of a study area, are among the most progressive areas, on agricultural fronts, of the Ludhiana city. These towns are situated in the neighborhood of the Ludhiana district. Sudhar is situated on the 'Ludhiana-Barnala' road at a distance of 26 Km from Ludhiana and the Mullanpur is situated at a distance of about 18 Km from Ludhiana on the 'Ludhiana-Feozepur' road.

The information about sample size of electricity connection holders under the OYT scheme has been collected from two sub-stations in each district. In Mansa district, the information about the farmers having electricity connections under the OYT scheme has been collected from electricity sub-stations of 'Jhunir' and 'Sardulgarh'. 'Bhunder', 'Jhanduka', 'Sangha' and 'Sardulewala' are the villages selected for primary survey in this district.

In Mansa district, it became possible to collect the required sample size of electricity connection holders under the OYT scheme from relatively less number of villages because the electricity connections under this scheme have been taken by the farmers of only those villages where the ground water is of relatively better, if not of the superior, quality.

The farmers of this district considered this scheme as an opportunity to get easy electricity connection because under earlier policies that contained the provision of granting electricity connections on the priority basis, there existed an information gap between the utility and the farmers regarding the procedure for granting of electricity connections. Owing to this information gap, the farmers of this district had to wait much time, sometimes several years, to get the electricity connection for their farm.

In Ludhiana district, the information about the OYT connection holders has been collected from the electricity sub-stations of 'Hambdhan' and 'Mullanpur'. On the basis of this information, the required sample size has been collected from a number of villages because farmers in each village took very few connections under the OYT scheme.

An earlier existence of at least one electricity connection on the farms of most of the farmers may be one of the main reasons that explains the very low probability of finding an OYT connection holder in each village of this district.

Still some of the villages having relatively large number of farmers holding electricity connections under the OYT scheme have been selected. The names of the selected villages are 'Bharowal Kalan', 'Bhundri', 'Birmi', 'Dakha', 'Fadla', 'Gorahoor', 'Majri', 'Mandeaani', 'Nurpur Veit', 'Pdain', 'Ranke', 'Sidhvan Veit', 'Svadi Kalan' and 'Talwandi Khurd'. These villages are concentrated around these two sub-stations.

4.5. Characteristics of the Selected Districts and the Respondents

Any district may be classified as progressive or the backward on the basis of its performance in economic and the social spheres. The same approach has been used to classify the districts of Mansa and Ludhiana as backward and progressive ones respectively. A brief discussion on these socio-economic characteristics of the two districts is given below along with some important information, collected through the primary survey, about the socio-economic characteristics of the respondents.

4.5.1. Socio-economic Characteristics of the Selected Districts

Different districts of a state may have attained different achievement levels in both the economic and social sphere over the period of time. This disparity among districts in both spheres can be highlighted through a discussion on performance of these districts in fields of agriculture, industry, infrastructure, banking, population density and urbanization, literacy, and health.

a. Agriculture

A center for animal husbandry, poultry and horticulture, Ludhiana district – *the land of green, white and blue revolutions,* is more advanced on agricultural fronts than the Bathinda / Mansa district. This is reflected in terms of cropping intensity. The cropping intensity in the Ludhiana district is much higher than that in the Mansa district. For example, the Mansa district occupied 15th rank for cropping intensity in 1999, whereas the Ludhiana district stood at the 4th rank out of the 17 districts of Punjab in the same year (Table 4.3).

The two districts differ even in terms of net irrigated area and fertilizer consumption, for which the Ludhiana district achieved the top position. Interestingly, the number of agricultural workers as the percentage of total workers in the district, by 2001 census, is the highest in Mansa district whereas it is the lowest in Ludhiana district among the 17 districts of Punjab. This indicator reflects the extent by which the population of this district is dependent on agriculture to secure its means of livelihood. It also reflects, though indirectly, the level of industrial development of the two districts.

b. Industry

Not only on agricultural fronts but also on industrial fronts, the Ludhiana district is much ahead of all the other districts. It is famous for its small-scale industries especially the bicycle and bicycle components industries, sewing machine industries along with a myriad of other small-scale industries. Its industries are catering not only to the domestic needs but also have made their place in the export market. It exports especially the hosiery goods – both cotton and woolen- to Russia, Croatia, USA, European countries etc.

This achievement on the industrial fronts is reflected through the number of factories that is the highest in this district when taken as the percentage of total factories in the state. Not only this, the industrial workers as the percentage of total workers is also the highest in Ludhiana district (Table 4.3).

This high level of industrial development in Ludhiana district may be due to high development levels of the banking sector in this district as this district is the only one in Punjab that receives the highest amount of per capita credit for its industries from the institutional sources like banks.

The position of the Bathinda district is not satisfactory on this front as the industrial development in this district is relatively at a low level. It is not only the number of factories as percentage of total factories in the state but also the number of industrial workers as percentage of total industrial workers in Punjab that is much lower in this district. Still, it has some factories but most of them are agro-based. These agro-based factories are situated mainly in the urban areas. This reflects, in a sense, the level of industrial backwardness of the Bathinda district.

c. Infrastructure

There seems to be a positive correlation between industrial and infrastructural development of a region from the data given in table 4.3 in the sense that the Ludhiana district, in 1995, along with recording a top rank for industrial development achieved 2nd rank in infrastructural development index whereas the Bathinda district got the 7th rank – almost same rank that it has achieved on the industrial fronts. There exist wide differences between the two districts on account of road length per 100 square kilometer and the number of post offices per lakh population.

Table 4.3: Selected Socio-Economic Indicators of the Selected Districts

Variable	Unit	Bathinda		Ludhiana		Punjab
		1995	Rank	1995	Rank	1995
Agriculture						
Cropping Intensity	-	[176]	15	[195]	4	[187]
Net Irrigated Area	Percentage of Net Cropped Area	[88.0]	14	[100.0]	1	[94.5]
Number of Tractors	Per '000 hectares	[43]	14	[90]	4	[63]
Fertilizer Consumption	Kilogram per hectare	116.8	11	199.0	1	161.1
Agricultural Workers	Percentage of Total Workers	(59.1)	1	(19.8)	17	(39.4)
Industry						
Factories	Percentage of Total factories	5.22	8	30.95	1	100
Industrial Workers	Percentage of Total workers	4.90	7	32.15	1	100
Infrastructure						
Infrastructure Development Index	Percent	162.5	7	185.82	2	171.9
Road Length	Per 100 square kilometer	61.7	12	156.96	2	113.2
Post Office	Per lakh population	[17.26]	14	[24.84]	5	[22.1]
Banking						
Commercial Banks	Per lakh population	8.36	9	10.59	5	10.4
Deposit	Rupees per capita	3543	11	11392	3	8176
Credit	Rupees per capita	2307	7	10281	1	3543
Credit to Agriculture	Rupees per capita	1091	3	527	6	732
Credit to Industry	Rupees per capita	315	10	4400	1	1361
Population Density and Urbanization						
Population Density	Per square kilometer	(317)	16	(804)	1	(482)
Urban Population	Percentage of total population	(20.68)	14	(55.8)	1	(33.9)
Urban Population	Percentage of total urban population	(1.73)	16	(20.51)	1	(100)
Literacy						
Literacy Ratio	Percent	(52.5)	17	(76.54)	5	(69.9)
Primary Schools	Per lakh population	24	12	35.29	11	57.18
Middle / Higher Schools	Per lakh population	4.06	12	4.51	11	6.93
Health						
Primary Health Centre	Per lakh population	1.37	11	1.22	12	2.04
Hospital Beds	Per lakh population	78.1	11	138.9	4	138.8

Note: Figures in square brackets and parentheses refer to year 1999 and year 2001 respectively. These figures for 1999 and 2001 belong to the Mansa District.

Note: Ranks for all variables are for the year 1995 except for 1999 and 2001 figures where the ranks are for the corresponding years; Literacy Ratio is percentage of literates to population aged 7 years and above

Source: CMIE (2000), Census of India: Punjab (2001), Government of Punjab (2002) *d. Banking*

The Ludhiana district is again much ahead of the Bathinda district in terms of the development of its banking sector. The number of commercial banks per lakh population along with the level of deposit and credit per capita is much higher in the Ludhiana district than that in the Bathinda district. This may be the result of the high levels of industrial and agricultural development achieved by this district.

The per capita availability of credit to industry is the highest in Ludhiana district. On the contrary, the banking sector of Ludhiana district is left behind by the backward district of Bathinda to provide per capita credit to the agricultural sector. This may be not only due to the higher probability of getting assured returns from industry than agriculture but also because of the fact that the credit needs of agriculture are more limited than that of the industry.

e. Population Density and Urbanization

The achievement of an area on economic fronts i.e. agriculture, industry, infrastructure, banking etc. is bound to have an impact on the socio-economic indicators of development. The density of population and urbanization are the foremost socio-economic variables that are influenced by the economic development of an area chiefly because of migration from other regions and the levels of per capita income of that area.

The same trend can be observed in the advanced district of Ludhiana. This district, by census 2001, ranks 1st in terms of the density of population whereas the Mansa district comes at the 16th rank out of the 17 districts. The level of urbanization is the highest in Ludhiana district. It holds the 1st rank in this respect. This apart, the urban population as the percentage of total urban population of the state is the highest in the Ludhiana district that again enables it to hold the 1st rank in this respect (Table 4.3).

f. Literacy

The high levels of per capita income along with high degree of urbanization in a region have a strong bearing on the achievement of that region on literacy fronts. Though Ludhiana district being at the 5th level could not perform as per its ability, it is still much ahead of the Mansa district (17th rank) that holds the distinction for recording the lowest literacy ratio out of the 17 districts of Punjab. The lowest literacy ratio within the Mansa district, by 2001 census, has been recorded by the sub-division of Sardulgarh- the villages from the jurisdiction of this sub-division have been selected for the sample survey of electricity supply situation in the backward area.

Merely by looking at the number of primary, middle and higher schools per lakh population of both the districts that is below the all-Punjab average number, it cannot be interpreted that there does not exist much difference between the two districts on this aspect as these two districts may differ on the school's potential to enroll the different strength of students.

Keeping in view the indicators like the per capita income, urbanization etc., the Ludhiana district may be expected to take the lead even in this respect. Besides, the equality of numbers does not imply that there does not exist any difference between the quality of education that is imparted to the students as many advanced educational institutions are situated in the Ludhiana district.

g. Health

Like the number of primary, middle and the secondary schools, the number of primary health centers per lakh population too indicates that there does not exist much difference between the two districts on this aspect. However, one should not rely on these numbers alone to assess the level of development of the health sector in these districts, as there is the possibility that the differences may exist between these two districts on account of the capacity of the primary health centers to provide health care facilities. The Ludhiana district again may be expected to be much ahead of the Bathinda district due to its possession of relatively higher number of hospital beds per lakh population.

4.5.2. Socio-Economic Characteristics of the Respondents

After having a glance at the socio-economic levels of development in the two districts that have been selected for sample survey, it becomes easy to understand the socio-economic characteristics of the respondents. Various socio-economic characteristics of the respondents, classified under various sub-heads, are discussed in the subsequent paragraphs.

a. Family Status[5]

The family status, among other factors, is determined by the nature of source of livelihood of the family. The previous discussion on socio-economic characteristics of selected districts has highlighted the agriculture-oriented nature of the backward district's economy. This along with relatively low levels of mechanization has determined family status in this district.

Table 4.4: Farmers' Family Status in the Two Areas

Area	Family Status		
	Nuclear Family	Joint Family	Total Farmer Households
Progressive	59 (39.3)	91 (60.7)	150 (100.0)
Backward	32 (21.3)	118 (78.7)	150 (100.0)
Total	91 (30.3)	209 (69.7)	300 (100.0)

$\chi^2 = 11.499$, $\chi^2_{0.05} = 3.841$, d f = 1

Note: The figures in parentheses are percentages of total farmer households within that area.
Source: Primary Survey

There is the prevalence of some old rituals that contribute towards large family size. For example, the farmers of one of the villages viz. Kahnewala, generally marry their children at an earlier age. In such cases, the boy and his family stay with his parents either for the whole life or till the boy becomes able to support his family.

In progressive area, on the other hand, a relatively high proportion of the farmers live in nuclear family as the need to have joint family becomes less acute due to relatively high degree of agricultural mechanization (see Table 4.3).

[5] Family status has been defined in terms of nuclear and the joint family. Nuclear family is defined as the one that includes the parents and their unmarried children. Joint family is defined as a family that comprise of the parents, their married children and other kith and kin.

Owing to this, one may expect that various socio-economic characteristics of the areas have played a significant role in the determination of the family status of the respondents. This relation between area differences and the family status can be analyzed with the help of Chi-square (χ^2, hereafter) test[6].

In this case, the estimated χ^2 value is larger than its theoretical value at 5 percent level of significance for 1 degree of freedom (Table 4.4). This means that the area and the family status are not independent and the area differences have some role to play in the determination of the family status of the selected farmer households.

b. Education

The education attained by the respondents also differs in line with the area differences. A significant χ^2 value strongly indicates the presence of differences between farmers of the two areas in attaining the different levels of education. It has been highlighted in section 4.5.1 that this particular area of the backward district from which the sample has been taken, has the lowest literacy ratio in Punjab. But still the literacy levels of farmers of the surveyed households are relatively better as only a very small proportion (i.e. 5.3 percent) of the farmers are illiterate (Table 4.5).

The farmers of this area are much behind their counterparts in the progressive area in this respect as a very negligible proportion of farmers of the backward area have attained education above the matric level. The non - availability of adequate number of the educational institutions in the villages is one of the main reasons for this low educational level of the respondents. These relatively lower levels of educational attainment may be one of the reasons for the existence of the large family size in the backward areas.

[6] The x^2 test analyzes the independence between the two characteristics. Its decision rule is: if the estimated x^2value is greater than its theoretical value at a certain level of significance then it implies that the two characteristics are not independent rather there is an association between the two.

Table 4.5: Education Attainment Levels of Farmers in the Two Areas

Area	Education Attainment[7]				
	Illiterate	Up to Primary level	Below / up to Matric level	Above Matric level	Total Farmers
Progressive	-	12 (8.0)	115 (76.7)	23 (15.3)	150
Backward	8 (5.3)	74 (49.4)	66 (44.0)	2 (1.3)	150
Total	8 (2.67)	86 (28.67)	181 (60.33)	25 (8.33)	300

$X^2 = 83.603, X^2_{0.05} = 7.815$, d f = 3

Note: The figures in parentheses are the percentage of total farmers within that area.
Source: Primary Survey

Interestingly, no farmer has been found to be illiterate in the progressive area and most of the farmers have attained education below or up to the matric level. Also, a relatively large proportion of the farmers in the progressive area have attained education above the matric level (Table 4.5). These differences in the levels of educational attainment may have a strong bearing on the farmers' choice to adopt some additional source of income.

c. *Sources of Income*

Though agriculture is the main source of income of all the farmers in both the areas, the two areas differ on account of the adoption of different sources of income by the farmers. This difference, as pointed by the X^2 test, is quite significant. In backward area, most of the farmers (i.e. about 43 percent), do not have any additional source of income and they depend on agriculture alone for their livelihood.

Nearly one third of the farmers have adopted animal husbandry, especially dairy, as the additional source of income but there may exist differences between the two areas with respect to the scale of operation of dairy business by the farmers. This scale difference becomes evident from the number of milch cattle owned by the farmers of the two areas (see Table 4.9).

[7] The level of education attainment by the farmers has been classified in these four basic categories in the light of the fact that farmers in the villages do not opt for much higher education as it is considered to be of the insignificant use in agriculture.

Table 4.6: Sources of Income of Farmers in the Two Areas

Area	Agriculture Only	Additional Source of Income					Total Farmers
		Animal Husbandry	Small Scale Business	Labor[8]	Service	Other	
Progressive	7 (4.7)	90 (60.0)	21 (14.0)	0	17 (11.3)	15 (10.0)	150
Backward	65 (43.3)	47 (31.3)	9 (6.0)	22 (14.7)	6 (4.0)	1 (0.7)	150
Total	72 (24.0)	137 (45.7)	30 (10.0)	22 (7.3)	23 (7.7)	16 (5.3)	300

$\chi^2 = 104.529, \chi^2_{0.05} = 11.070$, d f = 5

Note: The figures in parentheses are the percentage of total farmers within that area.
Source: Primary Survey

On the contrary, in progressive area, a small proportion (i.e. 4.7 percent), of farmers depends on agriculture alone to earn their livelihood and most of the farmers (i.e. 60 percent), have adopted the additional occupation of animal husbandry involving dairy, poultry, fishery etc. A relatively higher proportion of the farmers in progressive area are involved in some kind of small-scale business and service to augment their earnings. Interestingly, no single farmer in progressive area is doing labor along with agriculture to augment his income levels. But, more than one-tenth of the farmers of backward area are doing some kind of labor in addition to agriculture to supplement their earnings from agriculture (Table 4.6).

d. Ownership of Assets

Given the existence of wide disparities in terms of the sources of income between the two areas, the existence of differences in terms of farmers' ownership of assets in both areas may not be denied.

The farmers of the two areas enjoy different levels of asset ownership both for agricultural as well as non-agricultural use. The difference between the two areas on this account, as pointed out by the significant χ^2 value, may be due to differences in their levels of socio-economic development.

[8] Labor per se does not imply the manual labor alone as it also includes the service rendered in the shops of the nearby town.

Table 4.7: Number of assets for Agricultural and Non-Agricultural Use in Two Areas

Area	Asset Type	Number of Farmers having Assets							
		0	1	2	3	4	5	6	Total
Progressive	For Agricultural Use	34 (22.7)	8 (5.3)	30 (20.0)	55 (36.7)	11 (7.3)	10 (6.7)	2 (1.3)	150
Backward		55 (36.7)	16 (10.7)	39 (26.0)	29 (19.3)	8 (5.3)	3 (2.0)	-	150
Total		89 (29.7)	24 (8.0)	69 (23.0)	84 (28.0)	19 (6.3)	13 (4.3)	2 (0.7)	300
$\chi^2 = 23.086, \chi^2_{0.05} = 12.592$, d f = 6									
Progressive	For Non-agricultural Use	1 (0.7)	33 (22.0)	47 (31.3)	32 (21.3)	32 (21.3)	5 (3.3)	-	150
Backward		14 (9.3)	65 (43.3)	43 (28.7)	19 (12.7)	5 (3.3)	4 (2.7)	-	150
Total		15 (5.0)	98 (32.7)	90 (30.0)	51 (17.0)	37 (12.3)	9 (3.0)	-	300
$\chi^2 = 45.021, \chi^2_{0.05} = 11.070$, d f = 5									

Note: The figures in parentheses are the percentage of total farmers in that area.
Source: Primary Survey

Table 4.7 indicates very clearly that a relatively higher percentage of farmers of the backward area do not possess any asset for agricultural use[9] and they have to depend on the hired ones. The same is the position with the ownership of assets for non-agricultural use[10]. Though about two-fifths of the farmers own one asset for non-agricultural use in backward area, this asset may not be taken as an indicator of farmer's wealth as in most of the cases, it is only a bicycle that is often used for all sorts of activities.

The percentage of farmers having 4 or 5 assets for non-agricultural use is relatively higher in progressive area than that in the backward area (Table 4.7). This reflects the relatively higher levels of prosperity enjoyed by the farmers in the progressive area.

Apart from the possession of different number of assets for the agricultural and non-agricultural use, the farmers of the two areas differ in their ownership for bank accounts and urban property (Table 4.8).

[9] The numbers of assets like the tractor, harvester, spray-pump etc. are clubbed together, for simplicity of exposition, under the category of assets for the agricultural use.

[10] The number of assets like car / jeep, truck / bus, scooter / motorcycle have been clubbed under the category of the assets for non-agricultural use.

Table 4.8: Bank Account and Urban Property owned by Farmers in the Two Areas

Area	Bank Account			Urban Property		
	Yes	No	Total	Yes	No	Total
Progressive	123 (82.0)	27 (18.0)	150	61 (40.7)	89 (59.3)	150
Backward	53 (35.3)	97 (64.7)	150	27 (18.0)	123 (82.0)	150
Total	176 (58.7)	124 (41.3)	300	88 (29.3)	212 (70.7)	300
$\chi^2 = 67.357, \chi^2_{0.05} = 3.841, df = 1$				$\chi^2 = 18.589, \chi^2_{0.05} = 3.841, df = 1$		

Note: The figures in parentheses are the percentage of total farmers in that area.
Source: Primary Survey

It has been pointed out above that most of the farmers in the progressive area has adopted animal husbandry in general and dairy in particular as their additional source of income. This is very clear from Table 4.9. Though, almost all farmers in both the areas own at least one milch cattle, a relatively higher percentage of farmers in progressive area own a large number of cattle.

Table 4.9: Milch / other Cattle Owned by the Farmers in the Two Areas

Area	Number of Milch or Other Cattle						
	0	1-2	3-5	6 - 10	11 - 20	21 and more	Total
Progressive	10 (6.7)	56 (37.3)	19 (12.7)	1 (0.7)	45 (30.0)	19 (12.6)	150
Backward	3 (2.0)	14 (9.3)	64 (42.7)	28 (18.7)	39 (26.0)	2 (1.3)	150
Total	13 (4.3)	70 (23.3)	83 (27.7)	29 (9.7)	84 (28.0)	21 (7.0)	300

$\chi^2 = 92.695, \chi^2_{0.05} = 11.070$, d f = 5

Note: The figures in parentheses are the percentage of total farmers within that area.
Source: Primary Survey

This reflects the scale at which the farmers of the progressive area have adopted dairy farming as an additional source of income.

e. Type of Residential Buildings[11] and Perceived Quality of Electricity Available

There exist significant differences between the two areas regarding the type of house. All the farmers of the progressive area have pucca houses whereas about four-fifth of the total farmers in the backward area have the pucca houses.

[11] A house is classified as pucca / kacha depending upon the condition whether the walls, roof etc. are made of the concrete material like bricks, cement etc.

However, the possession of the pucca house may not be taken as the indicator of the economic prosperity of farmers in backward area because in one of the villages viz. Kahnewala, the farmers had to build the pucca houses due to water logging.

Table 4.10: House Type and Perceived Electricity Quality at House in Two Areas

Area	Type of House			Electricity Quality at Home		
	Pucca	Kacha	Total	Right Voltage	Low Voltage	Total
Progressive	150 (100.0)	-	150 (100.0)	142 (94.7)	8 (5.3)	150 (100.0)
Backward	119 (79.3)	31 (20.7)	150 (100.0)	116 (77.3)	34 (22.7)	150 (100.0)
Total	269 (89.7)	31 (10.3)	300 (100.0)	258 (86.0)	42 (14.0)	300 (100.0)
$\chi^2 = 34.572, \chi^2_{0.05} = 3.841$, d f = 1				$\chi^2 = 18.715, \chi^2_{0.05} = 3.841$, d f = 1		

Note: The figures in parentheses are the percentage of total farmers within that area.
Source: Primary Survey

The selected villages of both the areas are electrified. Though the electrification of the villages does not imply that all of the households in a village are electrified, no single household in the survey was found to be without electricity. This may be due to the fact that the selected households in each village belong to the agricultural classes and the non – electrified houses in a village, if any, may be of the non-agricultural classes.

However, there exist significant differences between the two areas regarding the quality of electricity supply in the households as perceived by the respondents. In progressive area, a large number of respondents perceived the availability of electricity at right voltage whereas, in backward area, about one-fifth of respondents do not perceive the same (Table 4.10). Also, the differences exist between the two areas even for the time, for which the farmers have to wait for electric current both at house and the field during power cut. In backward areas, such waiting period is relatively long.

f. Use of Electric Devices

The two areas differ on account of the use of electricity devices by the farmers. In progressive area, all of the farmers are having either 1 or 2 refrigerators but in backward area, one-tenth of the farmers do not have any refrigerator. Also, all of the farmers of the progressive area have the recreation equipment[12] of one sort or the

[12] The recreation equipment includes the radio, television, music system, and VCR / VCD.

other but there are some farmers (i.e. about 13 percent), in backward area who do not have even a common recreation equipment like radio, not to talk of televisions and VCRs (Table 4.14 in Annex 4).

About 43 percent of the farmers of backward area do not have coolers. This may be due to the fact that the farmers in rural Punjab prefer to sit / sleep in the open air so they do not need coolers but almost all of the farmers in progressive as well as backward areas own fans[13] though the number of fans in the household varies as per the requirement and the economic strength of the farmers.

The similar is the case with the ownership of washing machine, iron box or the water heater. Though air-conditioner is a luxury for the high gentry, there exist differences between the two areas on this account too. The number of the lighting equipments[14] in the household is between 6 to 10 and 10 to 20 for about 45 and 32 percent of farmers in progressive area. This is relatively high when compared with about 23 and 11 percent of farmers in the backward area (see Table 4.14).

g. Mode of Irrigation

Both the areas differ even in terms of mode of irrigation. The tube wells and canals serve as the two modes of irrigation in progressive area. Some of the farmers are dependent on purchased water also.

Table 4.11: Mode of Irrigation in the Two Areas

Area	Mode of Irrigation				
	Only Tube wells	Tube wells and Canal Water	Purchased Water	Canals and Purchased Water	Total Farmers
Progressive	68 (45.3)	68 (45.3)	9 (6.0)	5 (3.4)	150
Backward	107 (71.3)	28 (18.7)	13 (8.7)	2 (1.3)	150
Total	175 (58.3)	96 (32.0)	22 (7.3)	7 (2.4)	300

$\chi^2 = 27.371, \chi^2_{0.05} = 7.815$, d f = 3

Note: The figures in parentheses are the percentages of total farmers within each area.
Source: Primary Survey

[13] The category of fans includes ceiling fans, table fans and the exhaust fans.

[14] The lighting equipments include bulbs and the fluorescent lamps.

But, in backward area, the tube wells are the major mode of irrigation for most of the farmers. Though the canal water is also available to some of the farmers, its availability is for a very short time, for example, it is only 8 minutes per acre (as told by the respondents during the survey). It always remains inadequate to serve the irrigation requirements of the water-intensive crops grown in the fields. In this area too, some of the farmers are dependent on purchased water.

h. Cropping Pattern

Wheat and rice are the major crops grown by majority of the farmers in both the areas. The farmers of the progressive area cultivate the water-intensive crops of rice and sugarcane along with wheat. Some farmers use to grow potatoes also. In the present sample size, about two-third of the farmers cultivate wheat and rice, about one-tenth of the farmers cultivate wheat and sugarcane and about one-third of the farmers grow wheat, rice and sugarcane together on their plots of land (Table 4.12).

The farmers in the backward area too cultivate the water-intensive crop of rice along with cotton. Earlier in backward area, the farmers used to cultivate only the two crops viz. wheat and cotton. But later on, most of the farmers substituted rice in the place of cotton as they found the cultivation of cotton no more profitable because of its declining yield levels.

Table 4.12: Types of Crops Cultivated in the Two Areas

Area	Types of Crops Cultivated					Total
	Wheat and Rice	Wheat and Cotton	Wheat, Rice and Cotton	Wheat and Sugarcane	Wheat, Rice and Sugarcane	
Progressive	95 (63.3)	-	-	12 (8.0)	43 (28.7)	150
Backward	97 (64.7)	31 (20.6)	22 (14.7)	-	-	150
Total	192 (64.0)	31 (10.3)	22 (7.4)	12 (4.0)	43 (14.3)	300

Note: The figures in parentheses are percentage of total farmers within that area.
Source: Primary Survey

Thus, in the present sample size, about two-third of the farmers cultivate wheat and rice (equal to that in the progressive area), about one-fifth of the farmers cultivate wheat and cotton and about one-seventh of the farmers cultivate wheat, rice and cotton.

i. Crop Yield Per Acre

There exist differences between the two areas on account of the yield levels of the crops like wheat and rice. The average yield level of wheat and rice for the backward area stands at 19.58 and 24.99 quintal per hectare respectively, whereas the same for the progressive area stands at 22.94 and 30.31 quintal per hectare respectively.

Table 4.13: Crop-yield per Acre in the Two Areas

Area	Average Yield Level (Quintal)			
	Wheat	Cotton	Rice	Sugarcane
Progressive	22.94	-	30.31	27.05
Backward	19.58	5.09	24.99	-

Source: Primary Survey

Some farmers of the backward area cultivate cotton also. The average yield level of cotton stands at 5.09 quintal per hectare. In progressive area, the average yield level of sugarcane stands at 27.05 quintal per hectare.

These high yield levels of the crops in progressive area may be the result of high fertility of the soil and the use of more scientific techniques of production. Farmers of the progressive area, because of their higher levels of education, possess high awareness and are more inclined towards the use of scientific techniques of production.

4.6. Summing-up

The two selected areas differ from each other on account of their achievements in various socio-economic aspects of development. These significant differences between these two areas justify their classification as the progressive and the backward areas. These differences also get reflected in various socio-economic characteristics of the respondents in the selected villages of these two areas. Similar differences may also be present between the two areas on account of their access to the electricity for the agricultural purposes. The next chapter aims at exploring this issue more thoroughly.

Annex 4

Under OYT scheme, the PSEB gives the following guidelines:

1. Applicants shall deposit a non-refundable lump sum of Rs. 5000 as special fee.
2. Applicants shall pay Rs. 5000 per HP as service connection charges.
3. Applicants shall procure the 11.4 KV rating having copper winding and Hi-B core. The suppliers shall be standardized by Chief Engineer / MM and the list will be circulated by commercial organization. The various ratings of the transformer shall be 6.3 KVA for 5 HP, 10 KVA for 7.5 HP and 16.3 KVA for 10 HP motors.
4. The transformer shall be mounted on a single pole and the design shall be prepared and circulated by Chief Engineer / RE and SIL.
5. PSEB shall arrange on payment basis the material required for giving connections except transformer or the applicant may procure the material from the sellers approved by the PSEB.
6. The applicant shall bear the entire cost of 11 KV lines, LT cable and other allied equipment minus cost of the equipments supplied by him. The consumer shall also bear the cost of all other charges applicable, including cost of erection of transformers, 11 KV lines and any other equipment required for the release of connections. Two or more applicants can share the cost of common 11 KV lines. However, they shall be using their separate transformer for their respective tube-wells.
7. The replacement of damaged transformer shall be consumer's responsibility.
8. The scheme shall be operative throughout the Punjab state and shall remain in force from the issue of detailed commercial instruction.
9. The scheme shall be open to the new applicants. The applicants who have not been served with demand notice, can also opt under this scheme by depositing Rs. 5000 in lump-sum (non-refundable). The service connection charges, already deposited, if any, shall be adjusted against final charges to be intimidated through demand notice under this scheme.
10. These connections shall be released on priority by maintaining inter-se seniority of the applicants registered under the scheme.

Table 4.14: Use of Electric Equipments by Farmers in the Two Areas

Area	Equipment Name	Number of Equipments								Total Farmers
		0	1	2	3	4	5	6	More than 6	
Progressive	Refrigerator	-	147 (98)	3 (2)	-	-	-	-	-	150 (100.0)
Backward		15 (10)	133 (88.7)	2 (1.3)	-	-	-	-	-	150 (100.0)
Progressive	Recreation equipments	-	22 (14.7)	72 (48)	41 (27.4)	5 (3.3)	8 (5.3)	2 (1.3)	-	150 (100.0)
Backward		19 (12.7)	41 (27.3)	69 (46)	18 (12)	2 (1.3)	1 (0.7)	-	-	150 (100.0)
Progressive	Cooler	5 (3.3)	49 (32.7)	79 (52.7)	14 (9.3)	3 (2.0)	-	-	-	150 (100.0)
Backward		65 (43.3)	56 (37.3)	28 (18.7)	-	-	1 (0.7)	-	-	150 (100.0)
Progressive	Air-conditioner	121 (80.7)	29 (19.3)	-	-	-	-	-	-	150 (100.0)
Backward		142 (94.7)	8 (5.3)	-	-	-	-	-	-	150 (100.0)
Progressive	Fans	-	1 (0.7)	4 (2.7)	14 (9.3)	32 (21.3)	20 (13.3)	15 (6)	64 (42.7)	150 (100.0)
Backward		-	6 (4.0)	18 (12)	34 (22.7)	36 (24)	15 (10)	12 (8)	29 (19.3)	150 (100.0)
Progressive	Washing machine	79 (52.7)	71 (47.3)	-	-	-	--	-	-	150 (100.0)
Backward		121 (80.6)	28 (18.7)	1 (0.7)	-	-	-	-	-	150 (100.0)
Progressive	Iron box / Water heater	22 (14.7)	42 (28)	53 (35.3)	29 (19.3)	4 (2.7)	-	-	-	150 (100.0)
Backward		58 (38.6)	60 (40)	27 (18)	4 (2.7)	-	1 (0.7)	-	-	150 (100.0)
Progressive	Lighting equipments	-	-	-	1 (0.7)	5 (3.3)	6 (4.0)	22 (14.6)	116 (77.4)	150 (100.0)
Backward		-	-	-	11 (7.3)	37 (24.7)	23 (15.3)	27 (18)	52 (34.7)	150 (100.0)

Note: The figures in parentheses are the percentage of total farmers within that area.
Source: Primary Survey

Chapter 5

Distribution of Electricity Subsidy to Agriculture

5.1. Introduction

A huge and rising quantum of electricity subsidy, in general, and subsidy on electricity supply to the agricultural sector in particular, has been found, in Chapter 3, as the major factor responsible for the continuing dismal commercial performance of the PSEB. In view of such high magnitude of the electricity subsidy for agricultural sector (i.e. 2016.18 crore in 1999-2000, see Table 3.27), it is worth exploring further in order to trace out the real beneficiaries of this electricity subsidy.

A number of studies (Islam and Rahman, 1984; Subbarao, 1985; Singh and Chand, 1986) have found that the medium and large farmers corner a major share of agricultural input subsidies and the marginal and small farmers receive only a fraction of these subsidies.

Similar may be the case in respect of the electricity subsidy that is granted across the board through price concessions on sale of electricity to the agricultural sector by various state governments. This chapter seeks to analyze the existence of such trend in Punjab through an area-wise analysis of electricity received by different classes of farmers. In addition, the farmers' willingness to pay for electricity under the existing electricity supply conditions and the improved ones is examined to explore possibilities on the demand side to argue against the policy of free electricity supply.

This chapter is divided into eight sections. The next section highlights the peculiar character of electricity subsidy. It is followed by an analysis of disparities in access to electricity subsidy between different classes of farmers in selected progressive and backward areas. The fourth section explains the implications of granting across the board electricity subsidy to the agricultural sector. The nature of policies and practices implicit in granting of new electricity connections to the agricultural sector is discussed in fifth section. The sixth section analyzes farmers' willingness to pay the user charges in both the existing and alternative scenario of better electricity supply. The next section provides a promising insight that ensures benefits to both the utility and the farmers when the latter are willing to pay the user charges. The final section concludes.

5.2. Peculiar Character of the Electricity Subsidy

Electricity subsidy for irrigation differs from other types of subsidies that are granted either in cash or in kind to the agricultural sector. The basic difference lies in the nature of these subsidies. Most of these agricultural subsidies are granted on inputs that can be used directly and do not require any other means to facilitate their use in the production process.

The use of these direct inputs is independent of the farmer's economic position as it is made as per the crop requirements. Owing to this, there does not take place a complete exclusion of any class of farmers for having an access to subsidies on such sort of inputs though the distribution of these subsidies may be skewed among different farmer classes or different regions due to the existence of disparities in their initial factor endowment levels.

Such may not be the case for electricity subsidy that is granted across the board for irrigation to the agricultural sector due to the fact that the electricity unlike other inputs, does not act as an input that is used directly in the agricultural production process, rather its use requires beforehand the existence of capital equipment i.e. the electric motor and therefore, the electricity connection on the farm.

But, there is the possibility of non-availability of electricity connection on field of each and every farmer due to the huge fixed cost that is inherent in the installation of electricity connections on widely scattered farms. This incurring of huge fixed cost either fully or in part by the farmers is determined by their factor endowment levels. Those farmers who possess relatively higher levels of these factor endowments may be in a better position to have an access to a larger number of electric motors on their farms than that by other farmers.

The difference in the possession of these electric motors supplemented with duration and nature of electricity supply causes disparities in the quantum of electricity consumption and thereby the distribution of electricity subsidy. The sheer non-availability of electricity connection on certain farms leaves the room for complete exclusion of some classes of farmers from getting any sort of benefit out of this subsidy.

5.3. Disparities in Access to Electricity Subsidy

Due to its above mentioned peculiar nature, the subsidy arising from the use of electricity for irrigation purposes may be distributed in unequal proportions not only among different classes of farmers in a particular area but also among those across the two different areas. Such nature of electricity subsidy thus makes some classes of farmers or the areas as the major beneficiaries while excludes others fully or partially.

The presence of highly skewed distribution of electricity subsidy across farmer classes in different areas can be analyzed through a comparison of two areas that differ from each other (as explained in section 4.5) on account of their achievements in various socio-economic aspects of development. These differences may have had an impact on the farmers' access to electricity for irrigation purposes in these areas. Consequently, there may have been the presence of disparities between different classes of farmers in two areas on this account.

The presence of these 'electricity access' disparities between different farmer classes across the two areas can be analyzed under following sub-heads –

1. Availability of Electrified IPS
2. Possibilities of having Electricity Connections
3. Duration of Electricity Availability
4. Quality of Electricity

5.3.1. *Availability of Electrified IPS*

The presence of electrified IPS on the farm is a pre-requisite for having an access to electricity supply and thus a share in the electricity subsidy. It is determined by a number of economic and political factors. Due to this, the availability of electrified IPS cannot be expected to be uniform across different areas and classes of the farmers.

Similar are the findings from the primary survey conducted in the progressive and backward areas of Punjab. It is found that there exists a significant difference (χ^2 greater than $\chi^2_{0.05}$) between the two areas on account of the availability of electrified IPS on their farms (Table 5.1). The disparities between the two areas on this account are very large in the sense that the proportion of farmers having electrified IPS connections on their farms in progressive area is 51 percent higher than their counterparts in the backward area. This disparity thus, leaves no room for questioning the inference that a large quantum of electricity and thereby the subsidy resulting from its use is flowing to the progressive area. This inference holds good even under the conditions when the nature and duration of electricity availability is almost similar between the two areas.

Table 5.1: Availability of Electricity Connection on Fields of the Two Areas

Area	Yes	No	Total
Progressive	86 (86.0)	14 (14.0)	100
Backward	35 (35.0)	65 (65.0)	100
Total	121 (60.5)	79 (39.5)	200

$\mathcal{X}^2 = 54.420, \mathcal{X}^2_{0.05} = 3.841$, d f = 1

Note: The figures in parentheses are the percentages of the total.

Source: Primary Survey

Here, in this analysis, those agricultural households who got electricity connections under the 'Own Your Tube-well' (OYT, hereafter) scheme have been avoided to remove any sort of confusion in the analysis, as the 100 percent ownership of the electricity connections in this selected sample is of no significance to highlight the disparities between the two areas on this account. But, the ownership pattern of electricity connections by different classes of the farmers in the two areas under the OYT scheme has been analyzed after the completion of the subsequent discussion.

Hereafter, for convenience, the farms having connections under the OYT scheme will be termed as the OYT category and the farms having electricity connections under the general case will be termed as the non-OYT category.

The results presented in Table 5.1 turn out to be more meaningful when the ownership of electricity connections by different classes of the farmers is considered. It is found that there exists a strong association ($\mathcal{X}^2$greater than $\mathcal{X}^2_{0.05}$) between the farmer class differences and the ownership of electricity connection on the farm in backward area as a large proportion of the medium and large farmers own a major proportion of electricity connections whereas a negligible proportion (i.e. only 3.7 percent) of the small farmers own such connections (Table 5.2).

Table 5.2: Electrified IPS Ownership in the Backward Area

Electricity Connection on Field	Farmer Class			Total
	Small	Medium	Large	
Yes	2 (3.7)	23 (63.9)	10 (100.0)	35
No	52 (96.3)	13 (36.1)	-	65
Total	54	36	10	100

$\chi^2 = 55.026, \chi^2_{0.05} = 5.991$, d f = 2

Note: The figures in parentheses are percentages of the farmers within their class.
Source: Primary Survey

The situation of the ownership of electricity connection is almost similar in progressive area for the medium and large farmers but it is not so in the case of small farmers as a large majority (i.e. about 80 percent) of these farmers own electricity connections on their farm (Table 5.3). This proportion is quite high when compared with a small proportion of 3.7 percent in the backward area (Table 5.2).

Table 5.3: Electrified IPS Ownership in the Progressive Area

Electricity Connection on Field	Farmer Class			Total
	Small	Medium	Large	
Yes	54 (79.4)	25 (100.0)	7 (100.0)	86
No	14 (20.6)	-	-	14
Total	68	25	7	100

$\chi^2 = 7.661, \chi^2_{0.05} = 5.991$, d f = 2

Note: The figures in parentheses are percentages of the farmers within their class.
Source: Primary Survey

This implies that in progressive area, it is not only the medium and large farmers that reap the benefits of partial or full price concessions on electricity supply but a large proportion of the small farmers also fall in the same category whereas this is not the case in the backward area where a large difference exists between the different classes of the farmers in this respect.

In backward area, a major reason for existence of a very high proportion of small and medium farmers (i.e. 96 percent and 36 percent respectively; see Table 5.2) for not having the electricity connections is that most of these non-possessors of electricity connections (i.e. about 70 percent) have not applied for the electricity connection (Table 5.4). The main reason for most of them was the lack of economic capacity to incur the capital cost that has become very high under the OYT scheme. Also, a large proportion of farmers who have applied for electricity connection much earlier before introduction of the OYT scheme, have not got it due to the factors like the administrative restrictions, officials' demand for big bribes and favoritism etc.

Table 5.4: Reasons for Non-Availability of Electricity Connection in the Two Areas

Area	Reasons for Not Having Electricity Connection						Number of Farmers without Connection
	Not Applied		Applied				
	1	2	3	4	5	6	
Progressive	2 (14.3)	4 (28.6)	2 (14.3)	5 (35.7)	-	1 (7.1)	14
Backward	46 (70.8)	-	6 (9.2)	7 (10.8)	3 (4.6)	3 (4.6)	65

Note: The figures in parentheses are the percentages of farmers without connection.
Note: 1= lack of purchasing power; 2 = other; 3 = Administrative Restrictions; 4 = Favoritism; 5 = Bribe Demanded; 6 = other;
Source: Primary Survey

The situation is quite different in the progressive area where about 43 percent of the farmers have not applied for electricity connections as they are of the opinion that the availability of the canal water along with the purchased water is quite sufficient to irrigate their small plots of land. Due to this, they do not want to incur the unnecessary financial burden of buying the electricity connection under the OYT scheme.

But for the farmers, who have applied for electricity connection much earlier before the introduction of the OYT scheme, the administrative restrictions and favoritism are the main reasons for hitherto not getting the electricity connection (Table 5.4).

Table 5.5: Ownership of OYT Connections in the Two Areas

Area	Farmer Class			
	Small Farmer	Medium Farmer	Large Farmer	Total
Progressive	-	4 (8.0)	46 (92.0)	50 (100.0)
Backward	-	15 (30.0)	35 (70.0)	50 (100.0)
Total	-	19 (19.0)	81 (81.0)	100

Note: The figures in parentheses are percentages of farmers within that area
Source: Primary Survey

An analysis of the OYT connection ownership by different farmer classes across the two areas indicates that the electricity connections under this scheme has been taken by the medium and the large farmers irrespective of the area. A relatively large proportion of the medium farmers in the backward area took electricity connections under the OYT scheme (Table 5.5).

But, the two areas differ in terms of the mobilization of required finance to install the electricity connection in this scheme. This issue is discussed at length in section 5.5.1. Interestingly, no small farmer could manage to get the electricity connection under this scheme. This finding highlights the incidence of a systematic exclusion of small farmers to get any benefit from electricity subsidy.

5.3.2. *Possibilities of having Electricity Connections*

Along with the electrified IPS availability, an analysis of the flow of electricity subsidy across the two areas becomes more meaningful from a policy perspective when the pattern of electricity subsidy flow in future is considered. An idea about the probable pattern of electricity subsidy flow in the two areas is given by the position of electricity connection possibilities on farms using irrigation modes other than the electrified IPS.

An electricity connection possibility is implicit in the passing of electric wire through the vicinity of a farm, as it is the minimum requirement for a speedy access to the electricity connection. A huge cost is involved in the expansion of new electric wires and given the deteriorating financial position of the PSEB, an already existing network of electric wires (i.e. the electricity connection possibilities) assumes significance in determining the flow of electricity subsidy in the near future.

Table 5.6: Electricity Connection Possibility in the Two Areas

Area	Yes	No	Total
Progressive	5 (35.7)	9 (64.3)	14 (100.0)
Backward	13 (20.0)	52 (80.0)	65 (100.0)

$\chi^2 = 1.617, \chi^2_{0.05} = 3.841$, d f = 1

Note: The figures in parentheses are the percentages of the total.
Source: Primary Survey

In the backward area, a larger percentage (i.e. 65 percent compared to 14 percent in the progressive area) of the farms were not having the electricity connection (see Table 5.1). In such case, the position of connection possibility is of significance. Though no significant association is found between the area differences and the connection possibility, it is very clear from Table 5.6 that compared with the progressive area, there is a large proportion (80 percent) of the farms in the backward area with very little scope for connection possibility in the near future.

The main reason for such low incidence of connection possibility in the backward area is the relatively poor network of electric wires. In the backward area, no electric wire, not even by the distance of 300-400 meters, have been observed to be passing through the vicinity of most of the farms in the backward area whereas the situation is quite different in the other case due to the existence of better network of electric wires.

This lack of access to the basic infrastructure essential to ensure the flow of electricity supply to the fields of a large set of farmers in the backward area leaves these farmers excluded in the sense that they cannot dream of getting any benefit from electricity subsidy even in near future unless the PSEB becomes kind enough to ensure the speedy electrification of these IPS. But such situation seems to be doubtful in the conditions of deteriorating financial health of the PSEB.

The disparities in electricity connection possibilities across the two areas can be analyzed with respect to different classes of the farmers. No significant association is found between the electricity connection possibility and the farmer class differences in the backward area. Nevertheless, these are the medium farmers who within their farmer class, has a relatively high percentage for not having the connection possibilities. But, in absolute terms, a relatively large number of small farmers do not have the connection possibilities (Table 5.7). This implies that a large group of these small farmers will remain as the non-beneficiary of the electricity subsidy even in the near future. No large farmer falls in this analysis as all the large farmers are found to be having the effective electricity connections on their farms (see Table 5.2).

Table 5.7: Electricity Connection Possibility in the Backward Area

Electricity Connection Possibility	Farmer Class		Total
	Small	Medium	
Yes	11(21.2)	2 (15.4)	13
No	41(78.8)	11 (84.6)	52
Total	52	13	65

$\chi^2 = 0.216, \chi^2_{0.05} = 3.841$, d f = 1

Note: The figures in parentheses are percentages of farmers within their farmer class
Source: Primary Survey

But that is not the case in the progressive area where the proportion of small farmers having connection possibilities is higher than that in the backward area (see Tables 5.7 and 5.8). Also, unlike the backward area, these are only the small farmers here in this analysis as all the medium and large farmers are found to be having the effective electricity connections on their farms (see Table 5.3).

Table 5.8: Electricity Connection Possibility in the Progressive Area

Electricity Connection Possibility	Farmer Class	Total
	Small	
Yes	5 (35.7)	5
No	9 (64.3)	9
Total	14	14

Note: The figures in parentheses are percentages of farmers within their class
Source: Primary Survey

The disparities between the two areas on account of the flow of electricity subsidy in future will persist even if we assume that all those having the electricity connection possibilities get the electricity connection on their farm. In such case, the total number of farmers having the electricity connections in both the progressive and backward areas will be 91 and 48 respectively. This number of farmers in the progressive area is nearly twice of that in the backward area. This implies that the progressive area will remain as the major beneficiary of the electricity subsidy in near future also even if the conditions of nature as well as duration of electricity availability on the farm remain almost similar for the two areas.

But, it is not so as a significant difference exists between the two areas on account of the duration of electricity availability. This is discussed in the subsequent sub-section.

Here, the analysis of the OYT category is avoided in the light of the fact that all of these farmers possess effective electricity connections on their farms so the question of connection possibilities does not arise.

5.3.3. *Duration of Electricity Availability*

The average duration of electricity availability on the farms may be considered as another factor having a strong bearing on the determination of the quantum of flow of total electricity supply and hence the total electricity subsidy to the two areas. Given the disparities in the level of development between the two areas, a priority might have been given to the progressive area over the backward one on one pretext or the other as far as the total number of hours for electricity availability on the farm are concerned.

The survey results prove this by indicating that there exists significant difference between the two areas on account of the number of hours of electricity availability on the farm during both the peak time (i.e. the time of sowing crops) and during the off-peak time (i.e. at times other than sowing crops).

Table 5.9: Electricity Availability Across Areas During the Peak Period

Area	Electrified IPS Status	Hours of Electricity Availability During Peak Period							Total
		5	6	7	8	9	10	12	
Progressive	Non- OYT	-	-	-	11 (12.8)	4 (4.6)	71 (82.6)	-	86 (100.0)
	OYT	-	-	-	-	-	49 (98.0)	1 (2.0)	50 (100.0)
Backward	Non-OYT	-	14 (40.0)	9 (25.7)	10 (28.5)	1 (2.9)	1 (2.9)	-	35 (100.0)
	OYT	8 (16.0)	38 (76.0)	2 (4.0)	2 (4.0)	-	-	-	50 (100.0)

$\chi^2 = 259.468, \chi^2_{0.05} = 28.869$, d f = 18

Note: The figures in parentheses are the percentages of total.
Source: Primary Survey

The average duration of electricity availability is more in progressive area than that in the backward area. In progressive area, 8 is the minimum number of hours, as reported by all the farmers in non-OYT category, for electricity availability on their farms at the time of sowing crops though a major proportion (i.e. about 83 percent) of the farmers perceived the availability of electricity on their farms for 10 hours during this period.

On the contrary, the situation is not much attractive in backward area where all farmers in the non-OYT category perceived the availability of electricity on their farms for a minimum of 6 hours at the time of sowing crops. A very small proportion (i.e. about 3 percent in each group) of the farmers observed the electricity availability for 9 to 10 hours – equal to that in the progressive area - during this period but a majority of the farmers (i.e. 40 percent) noticed its availability for 6 hours at this time (Table 5.9).

The situation is almost similar for farmers in the OYT category in both the areas. The sample of these farmers is collected from a number of villages that are scattered here and there in both the districts (as mentioned in section 4.3). This implies that this trend of electricity availability during the peak period is not specific to the selected villages but is uniform across the whole area.

The adequate availability of electricity at farm is also needed during the off-peak period, though not in the same quantity as that during the peak period, to ensure sufficient irrigation to the crops. But, there exist sharp differences between the two areas on this account too (Table 5.10). All the farmers, in progressive area, observed the availability of electricity for a minimum of 5 hours though the majority (i.e. about 60 percent) of the farmers perceived it for 8 hours.

Table 5.10: Electricity Availability Across Areas During the Off-Peak Period

Area	Electrified IPS Status	Hours of Electricity Availability During Off-Peak Period								Total
		3	4	5	6	7	8	9	10	
Progressive	Non- OYT	-	-	3 (3.5)	11 (12.7)	12 (14.0)	51 (59.3)	9 (10.5)	-	86 (100.0)
	OYT	-	-	-	2 (4.0)	1 (2.0)	28 (56.0)	18 (36.0)	1 (2.0)	50 (100.0)
Backward	Non-OYT	8 (22.9)	9 (25.7)	13 (37.1)	5 (14.3)	-	-	-	-	35 (100.0)
	OYT	20 (40.0)	18 (36.0)	9 (18.0)	2 (4.0)	1 (2.0)	-	-	-	50 (100.0)

$\chi^2 = 232.401, \chi^2_{0.05} = 32.671$, d f = 21

Note: The figures in parentheses are the percentages of total.
Source: Primary Survey

But the situation is quite different in case of the backward area where the duration of electricity availability during the off period has remained much below than that in the progressive area. Here, all the farmers perceived the availability of electricity for a minimum of 3 hours during this period. About half (i.e. 51 percent) of the farmers reported the electricity availability for 5 to 6 hours (Table 5.10).

The duration of electricity availability during this period in case of the OYT category is almost similar to the non-OYT category in the progressive area. But, the differences exist on this account between the OYT and the non-OYT categories in the backward area. A majority (i.e. 76 percent) of the farmers in the OYT category reported the average electricity availability for only 3 to 4 hours during the off-peak period. The duration is 5 to 6 hours for a majority of farmers in the non-OYT category.

This implies that the duration of electricity supply is much worse in other villages than that in the selected villages of the backward area. Along with duration, the quality of the available electricity is of significance to have an idea about the total electricity subsidy flow to these two areas. Its status in both the areas is discussed below.

5.3.4. *Quality of Electricity*

The quality of available electricity affects strongly the flow of electricity subsidy across the two areas because the efficient operation of electric motors can be ensured only under the conditions of quality electricity supply. This quality is reflected by the nature of electricity supply and the degree of presence of voltage fluctuations in it.

Table 5.11: Perceived Quality of Electricity Supply Across Areas

Area	Electrified IPS Status	Quality of Electricity Supply						
		Nature			Voltage Fluctuations			
		Uninterrupted	Interrupted	Total	Frequent	Moderate	Rare	Total
Progressive	Non-OYT	77 (89.5)	9 (10.5)	86 (100.0)	3 (3.5)	30 (34.9)	53 (61.6)	86 (100.0)
	OYT	47 (94.0)	3 (6.0)	50 (100.0)	-	18 (36.0)	32 (64.0)	50 (100.0)
Backward	Non-OYT	14 (40.0)	21 (60.0)	35 (100.0)	20 (57.1)	11 (31.5)	4 (11.4)	35 (100.0)
	OYT	8 (16.0)	42 (84.0)	50 (100.0)	15 (30.0)	31 (62.0)	4 (8.0)	50 (100.0)
		$\chi^2 = 105.039, \chi^2_{0.05} = 7.815$, d f = 3			$\chi^2 = 97.673, \chi^2_{0.05} = 12.592$, d f = 6			

Note: The figures in parentheses are the percentages of total.
Source: Primary Survey

There exists significant difference between the two areas regarding the nature of electricity supply. The presence of uninterrupted electricity supply has been perceived by a major proportion (i.e. 89.5 percent) of farmers in the non-OYT category in progressive area whereas such nature of electricity has been observed by only 40 percent of the non-OYT farmers in the backward area i.e. the proportion of farmers getting interrupted electricity supply is quite high (i.e. 60 percent) in backward area as compared to that (i.e. 10 percent) in the progressive area (Table 5.11).

The differences in the nature of electricity supply in the two areas become sharp when the OYT connection holders are considered. It has been found that a majority (i.e. 94 percent) of the OYT connection holders in progressive area observed uninterrupted electricity supply but the proportion of such farmers have been relatively small in the backward area i.e. only 16 percent (Table 5.11).

The situation when compared with the nature of electricity supply in case of non-OYT category provides inference that there exists uniformity in the provision of uninterrupted electricity to almost all the villages of the progressive area. But the situation is not attractive in the backward area where a majority of the farmers in different villages have perceived an interrupted supply of electricity.

There also exist differences in terms of the degree of voltage fluctuations that are present in electricity supply to the fields of both areas. A very small proportion (i.e. 3.5 percent) of the non-OYT farmers in the progressive area observed frequent voltage fluctuations in electricity supply to their fields and a large proportion (i.e. about 62 percent) of these farmers reported that the electricity supply to their fields is free from all sorts of voltage fluctuations (Table 5.11). Similar trend is observed for farmers in the OYT category in the progressive area.

On the contrary, this is not the situation of electricity supply in the backward area where a high proportion (i.e. about 89 percent) of the non-OYT farmers perceived the presence of frequent and moderate voltage fluctuations – the share of those reporting the frequent voltage fluctuations being the highest (i.e. 57 percent) - in electricity supply to their fields. The presence of frequent voltage fluctuations in electricity supply has caused the frequent failure of motors and this has had implications for farmer's cost of production as the repair of electric motor involves both huge monetary cost as well as the opportunity cost of time.

The frequent occurrence of voltage fluctuations also adds to unnecessary cost burden by compelling farmers to incur expenditure on devices such as stabilizers. It is found that a large majority of the farmers in the backward area are using stabilizers to neutralize the effect of these voltage fluctuations on their electric motors.

Though a majority of farmers in the OYT category reported the presence of moderate voltage fluctuations in electricity supply, the overall trend is quite similar as a small proportion (i.e. 8 percent) of these farmers reported the absence of voltage fluctuations in electricity supply. This trend is quite opposite to that in progressive area where a majority (i.e. 64 percent) of the farmers in the same category reported the absence of voltage fluctuations in electricity supply (Table 5.11).

This reveals the difference in the quality of electricity supply in the villages of both the areas. This difference is bound to have an impact on the quantum of electricity subsidy flow to the two areas in the sense that it will leave the farmers of the progressive area as the major beneficiaries whereas the farmers of the backward area will remain as the relatively small beneficiaries of electricity subsidy.

A perusal of these four aspects of access to electricity in both the areas indicates the presence of sharp differences not only among the classes of farmers but also across these two areas. All this resulted, directly or indirectly, from long continuing practices of granting across the board electricity subsidy to the agricultural sector. This has had many implications. These implications are discussed in detail in the next section.

5.4. Implications of Granting across the board Electricity Subsidy

Since the very beginning, no differentiation across various farmer classes has been made in the provision of electricity subsidy that continued to be granted across the board to the agricultural sector. The classes of farmers having strong economic and political power managed to have an early access to electricity connections. This enabled them to corner a major share of electricity subsidy through consumption of a large quantum of electricity. This trend has had a number of implications for the agricultural sector. These implications are discussed below:

5.4.1. Emergence of 'Haves' and 'Have-nots' in the Agricultural Sector

The analysis of electricity access to different classes of farmers between the two areas has pointed out that the granting of across the board electricity subsidy has resulted in huge disparities among different areas and the classes of farmers. This presence of disparities has divided the agricultural society into the categories of haves and have-nots. The haves possessing electricity connections with an access to relatively better quantity and quality of electricity (as farmers of the progressive area), are better than the have-nots who either do not have access to electricity or are not getting its adequate supply (as farmers of the backward area) both in quantity and quality.

Table 5.12: Electricity Status and Average Expenditure (Rs.) on Crops

Electricity Status	Wheat	Rice	Cotton	Sugarcane
Availability of Connection				
Progressive Area (the haves)	3018.6	4279.48	-	4472.22
Backward Area (the have-nots)	3358.82	5621.87	6200	-
Non-Availability of Connection				
Progressive Area (the have-nots)	3219.64	7800.25	-	6166.66
Backward Area (the have-nots)	3388.46	8017.85	6382.75	-

Source: Primary Survey

It is found that there exists a large gap in terms of the cost of production between the haves and the have-nots. This difference in cost of production arises due to the differences in the means by which the production is carried out. Irrigation is one major input in the agricultural production process. Owing to this, the ownership of electricity connection by a farmer in the presence of subsidized electricity has a significant bearing on his cost of production.

The availability of either free or partially priced electricity has contributed towards increasing income inequalities within the agricultural sector by making the irrigation cost almost nil for the haves. But this is not the case for the have-nots or the haves who hold access to inadequate, unreliable and poor quality electricity because, in absence of access to reliable electricity, these farmers have to irrigate their crops through the use of diesel pump-sets.

Such practice in the presence of very high and continuously rising diesel prices entails huge cost burden on farmers for producing the same quantity of output. It is due to this reason that the average cost of production has remained quite low for the haves whereas it is relatively high for farmers in the other category (Table 5.12). Given the same output price for both categories of producers, this has implications for economic returns to them. The haves continue to have better economic returns whereas these economic returns from the sale of same output have been quite low for the have-nots, depending on diesel pump-sets. All this led to increasing income inequalities among the haves and the have-nots.

5.4.2. No Welfare Maximization

The process of granting across the board electricity subsidy has implications on welfare grounds too. The provision of any subsidy whether in cash or in kind is justified only when it is able to satisfy the implicit objective of welfare maximization in a society. It has been proved by the analysis of disparities in access to electricity that the large farmers, irrespective of the area, are the major beneficiaries of electricity subsidy. Due to this, the distribution of electricity subsidy tends to be highly skewed.

Such nature of electricity subsidy leaves much room for questioning the desirability of continuation of such policy of granting across the board electricity subsidy to the agricultural sector. But, even under such conditions, the desirability of continuing with such policy can very well be argued on the grounds that the welfare maximization of the society is possible even through the provision of across the board electricity subsidy, provided the instruments facilitating the redistribution of income are active in the economy.

But, such redistribution mechanisms are not under play in the agricultural sector as the existing taxation structure of the Indian economy provides an outright exemption to the agricultural income from any sort of taxation. Consequently, it implies that no increase in social welfare is taking place through the mechanism of granting across the board electricity subsidy to the agricultural sector. Thus, this argument supports the undesirability of continuing with such policies of granting subsidies to the agricultural sector.

5.4.3. Development of Water Markets

The provision of fully subsidized or partially priced electricity has led to the development of water markets in rural areas of Punjab. It is found that some farmers, in both the areas, in spite of possessing already a sufficient number of electricity connections to provide adequate irrigation to their crops, have taken additional electricity connections under the OYT scheme because they considered the OYT scheme as a business opportunity to earn additional profits.

Table 5.13: Water Sale Practices of the Farmers in the Two Areas

Number of electricity connections already owned	Progressive		Backward	
	Farmers Selling Water	Farmers already having connections	Farmers Selling Water	Farmers already having connections
No Connection	0	2	0	15
One connection	1 (9.1)	11	1 (5.6)	18
Two Connections	3 (21.4)	14	1 (7.1)	14
More than two Connections	10 (43.5)	23	1 (33.3)	3
Total	14 (28.0)	50	3 (6.0)	50

Note: The figures in parentheses are percentages of farmers as per their earlier possession of electricity connections.
Source: Primary Survey

These are only the medium and large farmers who got electricity connections under the OYT scheme (see Table 5.5). They took connections mainly to reap benefits from the sale of water to other poor fellows cultivating in their vicinity. The rates at which the water is sold ranged from Rs. 35 to Rs. 45 per hour in the two areas. These farmers managed to earn huge profits through such practices of selling water as the marginal operating cost of supplying water on their part has been almost nil under the conditions of free electricity supply to the agricultural sector.

Though the farmers of both the areas have pursued the similar practices of selling water, there have been differences between the two areas in terms of the scale at which such business is conducted in the informal rural economy. It is found that a relatively large proportion of farmers (i.e. 28 percent) in the progressive area are involved in water sale practices whereas it has been only 6 percent in the backward area (Table 5.13). This shows that though less in number, the rich farmers of the backward area are trying to emulate the business practices of their counterparts in the progressive area.

Thus, it is very clear that the availability of free electricity has not only enabled the rich farmers to be benefited directly from the negligible irrigation cost but also indirectly through the sale of water to other poor farmers who do not have the economic power to finance an electricity connection.

5.4.4. Depletion of Under-Ground Water

The granting of across the board electricity subsidy has had implications for the depletion of under-ground water in both the areas in general and the backward areas in particular. The subsidized sale of electricity has reduced the marginal cost of irrigation to almost zero level. Due to which, there has taken place a non-optimal use of electricity and thereby the scarce under-ground water resources by the farmers. This has led to a continuous depletion of the under-ground water.

The availability of this cheap mode of irrigation has been a major factor that persuaded the farmers of the backward area to shift to the cultivation of water-intensive crops like rice, from their old practices of growing cotton. A large majority (i.e. 94.2 percent) of the farmers in this area are growing rice chiefly due to subsidized / free electricity supply (Table 5.14).

Table 5.14: Choice of Cultivation of Water-intensive Crops by Electrified IPS Owners

Reason for Cultivation of Water-Intensive Crops	Progressive		Backward	
	Non-OYT	OYT	Non-OYT	OYT
Subsidized Electricity Supply	81 (94.2)	50 (100.0)	33 (94.2)	42 (84.0)
Assured Marketing	3 (3.5)	-	1 (2.9)	-
Relatively More Profitable	2 (2.3)	-	1 (2.9)	8 (16.0)
Total Electrified IPS	86 (100.0)	50 (100.0)	35 (100.0)	50 (100.0)

Note: The figures in parentheses are the percentages of total electrified IPS.
Source: Primary Survey

This crop diversification has been a major factor causing the depletion of ground water at a fast pace in the backward area because the rice is a water intensive crop. Due to this, more extraction of water takes place than its reimbursement through rain etc.[1]

The average level by which the ground water depleted during the last 5 years in the backward area has been estimated to be about 42 feet from the survey data[2] whereas in the progressive area, it has not depleted as much (i.e. by 22.5 feet). This difference in ground water depletion levels has been due to simultaneous reimbursement of water due to adequate rainfall in the progressive area.

5.4.5. Increased Theft of Electricity

The provision of subsidized electricity for the agricultural sector has had implications for encouraging the electricity use for domestic purposes also. The farmers generally prefer to make their house in the field so that a proper care to the crops can be ensured. In the selected sample size, the residential places for some of the respondents especially in the OYT category have been found in their fields.

It has been found through discussions that the farmers of both the areas are involved in electricity theft either at their own risk or in collusion with the board officials. But, the percentage of such farmers is relatively high in the backward area (i.e. 50.6) than those (i.e. 30.9 percent) in the progressive area.

[1] The degree of rainfall in this backward area is relatively low as this area falls into the dry zone of Punjab.

[2] These estimates are based on approximate levels of ground water as told by the farmers during the survey. However, no scientific technique has been applied to measure the actual level of ground water.

5.5. Granting of New Electricity Connections - Policy and Practices

Though, the above analysis provides a good discussion on the distribution of electricity subsidy among different classes of the farmers across these two areas during the later phase of the state policy on free electricity supply to the agricultural sector i.e. under the OYT scheme, it does not highlight the nature of state policy and certain underlying political economy elements like corruption etc. in granting new electricity connections. A further analysis of 100 households, who have taken electricity connections under the OYT scheme, may provide some insights on these issues.

5.5.1. Nature of the State Policy

In the absence of adequate subventions from the state, the PSEB has suffered on the financial sphere due to the state policy of free electricity supply. The PSEB, following the directions of the state, on the pretext of resource crunch announced, in June 2000, a scheme by which it restricted the granting of new electricity connections to only those farmers who can incur the full expenditure of electricity connection installation.

The installation of an electricity connection involves a huge cost. It is very difficult for small farmers to incur such cost. Therefore, it can be argued that this policy excluded systematically the small farmers from claiming any share in the free electricity supply. The same has been proved by our survey results (see Table 5.5). It has been found that the medium and large farmers, irrespective of the area, have owned electricity connections under the OYT scheme.

Large farmers cornered a major share of electricity connections in both the areas. In backward area, a relatively high proportion (i.e. 30 percent) of medium farmers got electricity connections under the OYT scheme (see Table 5.5). This is due to the fact that these farmers visualized this scheme as an opportunity to get the electricity connection, as most of them were not able to get it earlier either due to administrative restrictions or favoritism etc.

These farmers, keeping in view the trade-off between the dearer 'diesel pump-set based' irrigation and free 'electricity based' irrigation, considered the purchase of electricity connection under this scheme as an asset.

But, most of these farmers having relatively lower levels of income were not able to mobilize enough cash for the purchase of electricity connections. The banks were not ready to provide them credit for the development of this infrastructure on their farm. Consequently, they had to either depend on non-institutional sources for credit or sell their property to arrange money to finance the purchase of electricity connections.

It is found that only a small proportion (i.e.10 percent) of farmers in backward area could manage loans from the banks and a relatively large proportion (i.e. 56 percent) of these farmers took credit from the non-institutional sources (Table 5.15).

Table 5.15: Financing of Electricity Connections under the OYT Scheme

Channels for Financing Electricity Connection	Area	
	Progressive	Backward
Cash	23 (46.0)	9 (18.0)
Loan from bank	11 (22.0)	5 (10.0)
Credit from non-institutional sources	8 (16.0)	28 (56.0)
Credit from Relatives	2 (4.0)	-
Foreign Remittances	6 (12.0)	-
Sale of Property	-	8 (16.0)

Note: Figures in parentheses are the percentage of total OYT connection holders
Source: Primary Survey

This practice has left these poor farmers in the debt trap due to relatively high interest rates charged by moneylenders. Some farmers (i.e. 16 percent) had to sell their property in order to arrange money to finance the purchase of electricity connection (Table 5.15). In most of the cases, this property has been a part of land that was sold to either moneylenders or to big farmers.

Such practice of arranging resources reflects the nature of the state policy implicit in the OYT scheme. It was very well known beforehand to the state that this scheme will either wipe out the small farmers completely or will force them to arrange the finances through the sale of their assets such as a part of land.

Similar has been the experience in the backward area. The poor farmers sold a part of their land to get the electricity connection. This practice facilitated the concentration of land in few hands. This emerging trend of large inequalities in land-ownership points towards the turn of the agricultural society to a system similar to the feudal one where few hands own the land and a large majority stays as landless, paying rent to the lord to get an access for cultivation on his land.

5.5.2. Implicit Practices of Granting Electricity Connections

The 'X-inefficiency' culture among the PSEB's employees has developed to such an extent that they are not willing to perform their duties with the required efficiency, rather they are always interested in performing the assigned task only if they are either pressurized politically or given some economic incentive to do so. Their attitudes towards work remained the same in granting connections under the OYT scheme also. Even the self-financing nature of this scheme could not guarantee an access to electricity connection through fair means.

Table 5.16: Influence-use in the Two Areas

Area	Use of Influence			Approach to Authority				
	Yes	No	Total	No Approach	Panchayat Members	SEB Officials	Local Politicians	Total
Progressive	39 (78.0)	11 (22.0)	50 (100.0)	11 (22.0)	-	38 (76.0)	1 (2.0)	50 (100.0)
Backward	50 (100.0)	-	50 (100.0)	-	1 (2.0)	38 (76.0)	11 (22.0)	50 (100.0)

Note: The figures in parentheses are percentages of total OYT connection holders.
Source: Primary Survey

It is found that a majority of the farmers had to either make use of some political approach or bribe the concerned staff of the PSEB to speed up the pace of granting effective electricity connections on their farm. The incidence has been relatively high in the backward area where all the farmers had used some sort of influence to get the electricity connection (Table 5.16).

Table 5.17: Bribery Practices in the Two Areas

Area	Bribe to Officials			Form of Bribe			
	Yes	No	Total	No Bribe	Cash	Both Cash and Kind	Total
Progressive	38 (76.0)	12 (24.0)	50 (100.0)	12 (24.0)	24 (48.0)	14 (24.0)	50 (100.0)
Backward	39 (78.0)	11 (22.0)	50 (100.0)	11 (22.0)	17 (34.0)	22 (44.0)	50 (100.0)

Note: The figures in parentheses are percentages of total OYT connection holders.
Source: Primary Survey

The farmers have approached a number of authorities like the panchayat members, SEB officials and the local politicians. A careful analysis of Tables 5.16 and 5.17 reveals that the farmers who approached the local politicians did not bribe the officials but others had to do so. The bribe was made either in the form of cash alone or both cash and kind. This bribe in kind comprised liquor in most of the cases. A large set of farmers in the backward area gave bribe in both cash and kind whereas most of the farmers of progressive area bribed the officials only with cash.

Table 5.18: Lag Length in Getting Effective Electricity Connection

Area	Lag in Getting Effective Connection				Total
	Less than 10 Days	Less than 15 Days	Less than 1 Month	More than 1 Month	
Progressive	39 (78.0)	-	10 (20.0)	1 (2.0)	50 (100.0)
Backward	40 (80.0)	10 (20.0)	-	-	50 (100.0)

Note: The figures in parentheses are percentages of total OYT connection holders.
Source: Primary Survey

On delving further, it is found that those farmers who did not use any sort of influence had to wait for a relatively larger time period to get the effective electricity connection on their field after the completion of all the pre-requisites on their part. It is very clear from Tables 5.16 and 5.18 that those 22 percent of the farmers in progressive area who did not use any sort of influence for getting an effective connection had to wait for about 1 month. This finding reveals, in a sense, the correlation between the bribe and the tendency of the officials to do work at the earliest.

5.6. Willingness to Pay Electricity Charges

It has been found in the earlier sections that there exist large disparities in access to electricity between different classes of farmers across the two areas. These disparities emerged, among other factors, due to the continuing practices of granting across the board electricity subsidy for irrigation purposes to the agricultural sector. The beneficiaries of agricultural electricity subsidy i.e. the farmers, have remained a major interest group pressing for the continuation of these subsidies.

But, at this juncture, the financial health of the PSEB had deteriorated to such an extent that it started supplying inadequate, unreliable and poor quality of electricity to their fields. In order to restore the PSEB's financial health to ensure the availability of quality and reliable electricity, it is pertinent to know the farmers' willingness to pay the user charges. This opinion of the farmers can be sought in two circumstances:

1. Under the existing electricity supply conditions
2. Under an alternative scenario of improved electricity supply

5.6.1. Opinion Under the Existing Electricity Supply Conditions

Before analyzing farmers' willingness to pay electricity charges under the existing conditions of electricity supply, it would be better to evaluate their opinion about the major changes viz. the re-introduction of HP-based electricity tariff and the privatization of the PSEB, that have been taking place at this juncture in the electricity utility in Punjab as it may help in understanding the farmers' response in respect of their willingness to pay electricity charges in the present circumstances.

i. State's Re-introduction of HP-based Electricity Tariff

Since 1997, the electricity had been supplied to the agricultural sector free of any charge. But, this policy was withdrawn in 2002 by the state on account of various factors and it was replaced by a flat-rate based tariff system for the agricultural sector.

This policy change had a dramatic impact on the farmers who had been enjoying the benefits of free electricity since 1997. It is found from the survey results that a majority of the electrified IPS holders in both the areas are not comfortable with the removal of free electricity supply policy (Table 5.19).

Table 5.19: Farmers' Reaction to the Removal of Free Electricity Supply

IPS Status	Progressive			Backward		
	Yes	No	Total	Yes	No	Total
Non-electrified	12 (85.7)	2 (14.3)	14 (100.0)	60 (92.3)	5 (7.7)	65 (100.0)
Electrified						
Non-OYT	24 (27.9)	62 (72.1)	86 (100.0)	6 (17.1)	29 (82.9)	35 (100.0)
OYT	9 (18.0)	41 (82.0)	50 (100.0)	1 (2.0)	49 (98.0)	50 (100.0)

Note: The figures in parentheses are percentage of farmers as per their IPS status.
Source: Primary Survey

But, such is not the case with non-electrified IPS holders. This policy change has disappointed a relatively smaller proportion of these farmers in both the areas. A major proportion of these farmers considered this policy change in their favor because they are of the opinion that this will enable the PSEB to mobilize financial resources and thereby, the financial health of the PSEB will be improved. They further told that this improved financial health of the PSEB will, in turn lead to more development of the electricity infrastructure that is needed to supply electricity to their farms and hence will generate more possibilities for them to get the electricity connection.

ii. Privatization of the PSEB

Farmers' opinion about the privatization of the PSEB has also been sought because it was thought that it would be better to know the perception of the ultimate consumers to whom the utility is going to serve after its privatization. It is found that the perceptions of the farmers in both the areas do not differ much, as a majority of the farmers in the non-OYT category, irrespective of their status of IPS, do not support the privatization of the PSEB (Table 5.20).

Table 5.20: Farmers' Opinion on the PSEB's Privatization

IPS Status	Progressive			Backward		
	Yes	No	Total	Yes	No	Total
Non-electrified	1 (7.1)	13 (92.9)	14 (100.0)	-	65 (100.0)	65 (100.0)
Electrified						
Non-OYT	6 (7.0)	80 (93.0)	86 (100.0)	1 (2.9)	34 (97.1)	35 (100.0)
OYT	4 (8.0)	46 (92.0)	50 (100.0)	13 (26.0)	37 (74.0)	50 (100.0)

Note: The figures in parentheses are percentage of farmers as per their IPS status.
Source: Primary Survey

But, the two areas differ in terms of perceptions of farmers in the OYT category. A relatively high proportion (i.e. 26 percent) of these farmers support the privatization of the PSEB in the backward area. The continuing sufferings of these farmers on account of access to inadequate (see Tables 5.9 and 5.10) and poor quality of electricity, (see Table 5.11) have structured their reaction in favor of privatization of the PSEB. These farmers visualize the privatization of the utility in terms of the provision of adequate, reliable and quality electricity.

iii. Farmer's Experience of the Quality of Electricity Supply

The long continuing practices of subsidizing farmers on one pretext or the other have caused resource crunch on the supply side and thus resulted in an inadequate and poor quality of electricity supply to the agricultural sector.

Table 5.21: Farmers' Response to Existing Electricity Supply Conditions

Variable	IPS Status	Area	
		Progressive	Backward
Satisfied with existing situation of electricity supply	Non-OYT	0	0
	OYT	0	0
Want Reliable and Quality Electricity	Non-OYT	100 (100.0)	100 (100.0)
	OYT	50 (100.0)	50 (100.0)

Note: The figures in parentheses are percentage of total farmers.
Source: Primary Survey

It is found especially in the backward area where the availability of electricity both in quantity and quality is relatively poor. No farmer is found to be satisfied with the existing situation of electricity supply in both the areas (Table 5.21). This dissatisfaction with present position of electricity supply got reflected in their reluctance to pay the electricity charges in the present situation of electricity supply. Almost all the farmers responded in the negative i.e. they were not willing to pay the user charges (Table 5.22).

Table 5.22: Reaction of the Electrified IPS Owners Towards Payment of User Charges

Variable	IPS Status	Progressive			Backward		
		Yes	No	Total	Yes	No	Total
Farmers willing to pay under present conditions of electricity supply	Non-OYT	4 (4.7)	82 (95.3)	86	0 (0.0)	35 (100.0)	35
	OYT	0 (0.0)	50 (100.0)	50	1 (2.0)	49 (98.0)	50

Note: The figures in parentheses are percentage of farmers as per their IPS status.
Source: Primary Survey

Apart from their change in attitude towards payment of electricity charges due to their access to free electricity for the long time, the farmers of both the areas have different reasons for their reluctance to pay the user charges.

In the progressive area where the electricity availability is relatively better in both quantity as well as quality, the farmers are not willing to pay merely because they are getting electricity at night and they want electricity at the day time. This attitude of farmers towards the payment of user charges is nothing but a reflection of their lobbying power. Such attitude of using the lobbying power is also found, to some extent, in the backward area but, for most of the electrified IPS owners, the availability of inadequate and poor quality electricity has been the main reason for their reluctance to pay the electricity charges.

Thus, it is clear that besides the variations in duration and quality of electricity supply, there is another major factor hidden behind farmers' reluctance to pay for electricity supply in the present circumstances. This factor is nothing else but their belief that they can influence the utility through their vote-bank and lobbying power. This belief arises because of the dominance of the political interference in the day-to-day functioning of the PSEB. This belief of farmers also gets reflected in their disappointment with removal of free electricity supply and privatization of the PSEB.

Thus, these are the political factors that are responsible for the farmers' reluctance to pay even in those circumstances when they are getting the quality electricity (as in the progressive areas). As an examination of farmers' original willingness to pay user charges is required to examine the response on the demand side for a diversion from free electricity supply policy, it becomes necessary to consider a hypothetical situation in which there are no price concessions on sale of electricity. This is discussed in next sub-section.

5.6.2. Opinion under an Alternative Scenario of Improved Electricity Supply

It is found that all the farmers are not satisfied with the existing position of the electricity supply due to one reason or the other and they want the availability of adequate, reliable and the quality electricity. But, by economic logic, the farmers have to pay the user charges to the utility in order to get the reliable and quality electricity.

On the basis of this economic logic, the farmers of both the areas were introduced, through two different kinds of statements, to two situations quite different from the existing one. Here, they were first educated about the new alternative scenario and then they were asked to respond to different bids that were proposed to them in return for the availability of adequate, reliable and quality electricity.

It is been found that all the farmers in both the areas, under this alternative scenario, are willing to pay the user charges in return for the availability of reliable and quality electricity on their farm (Table 5.23). This finding strengthens the hypothesis that if the availability of reliable and quality electricity is ensured then there will be willingness on the part of farmers to pay electricity charges regularly and this will create the possibilities to divert from practices of granting electricity subsidies to agricultural sector.

Though some of the farmers due to their long developed habits are willing to pay the electricity charges at flat rate, a high proportion of farmers agreed to pay the same at metered rate in both the areas. It has been found that the two areas differ significantly on account of electrification status of IPS (see Table 5.1). Does this electrification status of IPS along with the conditions of electricity availability matter in determining the farmers' willingness to pay the user charges at the metered rate? Such question can be answered explicitly with the use of the odds ratio[3]. The odds ratio in favor of farmers' willingness to pay at the metered rate with respect to the non-electrified or the electrified IPS in the backward area is equal to 22.37 (Table 5.23). This implies that in the backward area, there is a stronger willingness to pay the user charges at the metered rate by the non-electrified IPS holders as against the electrified IPS holders. In this case, the electrification status of the IPS clearly matters. On the other hand, in the progressive area, an odds ratio of 0.97 indicates that the odds are almost equal in both statuses of the IPS. Therefore, there are other factors that determine farmers' willingness to pay the user charges at the metered rate.

Table 5.23: Distribution of Farmers Willing to Pay for Quality and Reliable Electricity

Willingness to pay	Progressive Area		Backward Area	
	IPS Non-Electrified	IPS Electrified	IPS Non-Electrified	IPS Electrified
At Metered Rate	12 (85.7)	117 (86.0)	64 (98.5)	63 (74.1)
At Flat Rate	2 (14.3)	19 (14.0)	1 (1.5)	22 (25.9)
Total	14 (100.0)	136 (100.0)	65 (100.0)	85 (100.0)
Observed Odds for Willingness to Pay at Metered Rate	6	6.16	64	2.86
Odds Ratio	0.97		22.37	

Note: The figures in parentheses are percentages of farmers as per electrification status of their IPS.
Source: Primary Survey

An analysis of the willingness to pay electricity charges with respect to the farmer class reveals that a large majority of farmers who are willing to pay the electricity charges at flat rate in both the areas, are the medium and large farmers (Table 5.24).

Table 5.24: Willingness to Pay by Farmer Class

Willingness to Pay	Progressive Area				Backward Area			
	Small Farmer	Medium Farmer	Large Farmer	Total	Small Farmer	Medium Farmer	Large Farmer	Total
At Metered Rate	65 (95.6)	23 (79.3)	43 (81.1)	131	52 (96.3)	40 (78.4)	35 (77.8)	127
At Flat Rate	3 (4.4)	6 (20.7)	10 (18.9)	19	2 (3.7)	11 (21.6)	10 (22.2)	23
Total	68 (100.0)	29 (100.0)	53 (100.0)	150	54 (100.0)	51 (100.0)	45 (100.0)	150

Note: The figures in parentheses are percentages of farmers within their farmer class.
Source: Primary Survey

[3] The odds ratio is *"a ratio of odds defined with respect to the dependent variable (a dichotomous variable) at different values of the explanatory variables"* (Mukherjee, et al., 1998: 310). An odds ratio equal to one indicates that the odds are equal in both circumstances.

As there is no consideration of the bids made at flat rate based tariff in this alternative scenario, these bids can be considered as the missing values. Following Bateman, et al. (2002), these missing values have been dropped in the subsequent analysis of farmers' willingness to pay the user charges for the reliable and quality electricity.

Table 5.25: Farmers' Willingness to Pay as per Electrification Status of their IPS

Willingness to Pay (Rs.)	Progressive Area			Backward Area		
	IPS Electrified	IPS Non-Electrified	Total	IPS Electrified	IPS Non-Electrified	Total
0.50	18 (15.4)	-	18	-	-	-
0.50-2.50	98 (83.7)	3 (21.4)	101	50 (79.4)	9 (14.1)	59
2.50-3.50	1 (0.9)	11 (78.6)	12	12 (19.0)	50 (78.1)	62
3.50	-	-	-	1 (1.6)	5 (7.8)	6
Total	117 (100.0)	14 (100.0)	131	63 (100.0)	64 (100.0)	127

Note: The figures in parentheses are percentages of farmers as per electrification status of their IPS
Source: Primary Survey

In both the areas, a large proportion of the farmers with non-electrified IPS made higher bids for paying electricity charges than those who are already having the electrified IPS in return for the availability of the reliable and quality electricity on their field (Table 5.25).

The average bid made by the non-electrified IPS holders remained at around Rs. 3 in both the areas. But the level of average bid made by the electrified IPS holders differed between the two areas in the sense that the farmers in the progressive area made relatively lower bid (i.e. Rs. 1.5) than that by the farmers in backward area (i.e. Rs 2.38) (Table 5.26).

Table 5.26: Summary Statistics of Farmers' Bids as per Their IPS Status

Summary Statistics	Progressive Area		Backward Area	
	IPS Electrified	IPS Non-Electrified	IPS Electrified	IPS Non-Electrified
Mean (Rs.)	1.5	3.01	2.38	3.1
Standard Deviation	0.54	0.45	0.5	0.51
Coefficient of Variation (%)	36	14.95	21.01	16.45
Minimum (Rs.)	0.5	2.25	1.5	1.5
Maximum (Rs.)	2.75	3.5	4	4

Source: Based on Primary Survey

The farmers with electrified IPS in the progressive area made the lowest bid of 50 paise per unit but the same has been Rs. 1.50 for both the electrified and non-electrified IPS holders in the backward area. The minimum bid level of the non-electrified IPS owners in the progressive area has been, however, higher than their counterparts in the backward area. This set of farmers also showed relatively more consistency in their bid levels. But these were the farmers of the backward area who made the highest bids of Rs. 4 per unit (Table 5.26). The absence of electricity connections along with an inadequate availability of electricity in the backward area may be the main factor for their relatively higher levels of bids.

An area-wise comparison of willingness to pay electricity charges by different classes of farmers' reveals that a large proportion of the small farmers in the backward area has made higher bids (Table 5.27). These higher bids of small farmers reflect the higher levels of utility that they are expecting of deriving from the availability of reliable and quality electricity on their field.

Table 5.27: Distribution of the Farmer Classes Willing to Pay Electricity Charges

Willingness to Pay (Rs.)	Progressive Area				Backward Area			
	Small Farmer	Medium Farmer	Large Farmer	Total	Small Farmer	Medium Farmer	Large Farmer	Total
0.50	-	2 (8.7)	16 (37.2)	18	-	-	-	-
0.50-2.50	53 (81.5)	21 (91.3)	27 (62.8)	101	6 (11.5)	26 (65.0)	27 (77.1)	59
2.50-3.50	12 (18.5)	-	-	12	42 (80.8)	13 (32.5)	7 (20.0)	62
3.50	-	-	-	-	4 (7.7)	1 (2.5)	1 (2.9)	6
Total	65 (100.0)	23 (100.0)	43 (100.0)	131	52 (100.0)	40 (100.0)	35 (100.0)	127

Note: The figures in parentheses are percentages of farmers within their farmer class.
Source: Primary Survey

But, on the other hand, a large proportion of the medium and large farmers made relatively lower bids. This proportion of large farmers making lower bids to the tune of not more than 50 paise is large (i.e. 37 percent) in progressive area than their counterparts in the backward area who made their bids within the range of 50 paise and Rs. 2.50 (Table 5.27).

It is found that the medium and large farmers in the progressive area kept their minimum bid level at 50 paise whereas their counterparts kept the same at Rs. 1.50 in the backward area. In some cases, it has been even at Rs. 4 per unit (Table 5.28).

Table 5.28: Summary Statistics of Farmers' Bids as per Their Class

Summary Statistics	Progressive Area			Backward Area		
	Small Farmer	Medium Farmer	Large Farmer	Small Farmer	Medium Farmer	Large Farmer
Mean (Rs.)	2.03	1.59	1.13	3.1	2.59	2.4
Standard Deviation	0.61	0.52	0.56	0.48	0.62	0.53
Coefficient of Variation (%)	30.05	32.70	49.56	15.48	23.94	22.08
Minimum (Rs.)	1.25	0.5	0.5	1.5	1.5	1.5
Maximum (Rs.)	3.5	2.5	2.5	4	4	4

Source: Based on Primary Survey

This difference in bids by the same class of farmers between the two areas may be due to the difference in their experience of electricity supply at this juncture. This along with the wish to enjoy the better conditions of electricity supply at the farm might have persuaded farmers of the backward area to make relatively higher bids.

Here lies one paradox. It is found that the rich farmers of the progressive area who have high capacity to pay (reflected in their economic prosperity, as discussed in section 4.5.2) have low willingness to pay and the relatively poor farmers of the backward area who have low capacity to pay have higher willingness to pay for electricity charges in return for the availability of the reliable and quality electricity. The survey results highlight that more than one-third of the large farmers of the progressive area kept their bid levels up to 50 paise only (see Table 5.27). Under such circumstances, there is a need to evolve some sort of balancing strategy.

Thus, in the new alternative scenario of improved electricity supply, a majority of the farmers are willing to pay the user charges. This new scenario has its merit in benefiting both the utility and the farmers. The next section explains this merit.

5.7. Merits of the New Scenario

In the new scenario, the average level of bids made by farmers stood at Rs. 2.20 per unit. This bid level is too high in comparison to the free availability of electricity. But even then, we argue that the new scenario of reliable and quality electricity supply has its merits for both the utility and the farmers.

In new scenario, the farmers will be able to reduce their irrigation cost even after paying electricity charges as per their average bid level because a timely payment of these tariffs will improve utility's financial health that will, in return facilitate the granting of more electricity connections to the agricultural sector and thus, the benefits will accrue to the farmers in terms of irrigation cost reduction. It is proved empirically in the subsequent paragraphs.

In order to arrive at some meaningful estimates about the magnitude of avoidable additional cost burden that the farmer has to incur due to his dependence on the diesel pump-set, we focus on some water-intensive crop like rice that is cultivated in both the areas. This may facilitate the applicability of same results of avoidable cost burden for the farmers in both the areas.

Since most of the small farmers in the backward area (i.e. 65 percent, see Table 5.1) do not have electrified IPS, the cost analysis can be made with respect to the irrigation practices in this area. Also, it is better to confine the analysis to the unit of per acre in order to get a good estimate of the additional cost burden that a farmer has to bear following his dependence on diesel pump-set.

It is better to know the water requirements of the rice crop before going into the cost analysis. The gestation period for the hybrid variety of the rice crop is 3.5 months. The water requirements of the rice crop are comparatively more than those of the wheat or cotton crop. But, the water requirements of the rice crop do not remain uniform during its gestation period rather these show some variation. The crop of rice requires irrigation on every alternate day and with a gap of 3 days during the first and the next 2.5 months respectively. This variation in irrigation needs affects the diesel and electricity requirement for irrigating a single acre of land. First, we will consider the diesel requirements and consequently, the diesel cost incurred to irrigate one acre of land. The discussion on electricity cost incurred to irrigate the same plot of land will follow this.

Table 5.29: Time and Resource Needs of Irrigating One Acre of Rice Crop

Period	Irrigation Needs (Number of Times)	Time Needed (Hours)	Diesel Required (Liters)	Electricity Use by 5 Hp Electric Motor (kWh)
First Month	15	5	7	18.39
Next 2.5 Months	25	3.5	5	12.87

Source: Primary Survey

In the first month, the irrigation of one acre of the rice crop requires 7 liters of diesel during 5 hours of diesel pump-set operation and during the next 2.5 months, 5 liters of diesel are consumed in the irrigation of the same plot of land by 3.5 hours continuous operation of diesel pump-set (Table 5.29). The diesel requirements during the former period are more than those during the latter period because usually during the initial period, the summer season is at its peak and the water evaporation takes place rapidly.

This diesel pump-set based irrigation during both periods involves a cost of Rs. 138.88 and Rs. 99.2 respectively if current diesel price of Rs. 19.84 is considered (Table 5.30). Assuming if the same acre of land is irrigated through the operation of an electric motor with an in-built capacity of 5 HP. It is also assumed that the electric motor too takes the same time as the diesel pump-set to irrigate one acre of land during the both periods. The continuous operation of this electric motor for 5 hours and 3.5 hours during the period of 1st month and the next 2.5 months will consume 18.39 kWh and 12.87 kWh of electricity respectively (see Table 5.29).

Table 5.30: Estimates of Irrigation Cost Reduction with Electricity Use

Period	Diesel Cost (Rs.)	Electricity Cost (Rs.)	Irrigation Cost Savings (Rs.)	
			Once	Total
First Month	138.88	40.45	98.43	1476.41
Next 2.5 Months	99.2	28.32	70.88	1772.08

Source: Primary Survey

Though the cost of electricity supply to agricultural sector is Rs. 2.44 per kWh in 1999-2000 (see Table 3.23), we would consider the average bid level of Rs. 2.20 per kWh, as reported by respondents during survey. At this rate, total cost of irrigating one acre of rice once is equal to Rs. 40.45 and Rs. 28.32 respectively for both time periods (Table 5.30).

Thus, it is clear from above estimation that a farmer can get a benefit of Rs. 98.43 and Rs. 70.88 respectively in the two periods from the one time irrigation of the rice crop. Provided the farmer will pay his electricity bills honestly and in time, he will get a benefit of Rs. 3,248 in terms of cost reduction (Table 5.30) – an amount almost near to his average cost of producing wheat (see Table 5.12).

Thus, it is found that in the new scenario, both the sides i.e. the utility as well as the farmer, are getting the economic benefit in the sense that the utility is getting the adequate return on the sale of electricity to the agricultural sector and the farmers are able to save some money in terms of their cost reduction.

5.8. Conclusion

The distribution of electricity subsidy, like other agricultural subsidies, is highly skewed and is cornered mainly by the rich farmers. Though the progressive areas cornered a big proportion of electricity subsidy, a large proportion of the medium and large farmers even in backward area remained major beneficiary of subsidized supply of electricity whereas majority of the small farmers in backward area are using the diesel pump-sets due to non-availability of electricity connections. This has a major impact on their cost of production.

This skewed distribution of electricity subsidy is a clear manifestation of its provision to all classes of the farmers without any discrimination. This apart from having many other implications for the agricultural sector has affected the social aspect too as it facilitated the division of agricultural society among 'haves' and 'have-nots' in the sense that one set of farmers is getting richer whereas the other set is becoming poorer day by day.

It is found that the eternity of such trend has been ensured by state policy through the OYT scheme, as these were mainly the medium and large farmers in both areas that got electricity connections under this scheme. It is also found that the corrupt practices in granting new electricity connections are widely prevalent in both the areas.

The experience of the farmers especially in the backward area, with the present conditions of electricity supply has not been much attractive and they remained dissatisfied with the existing conditions of electricity supply. The farmers of both the areas have shown reluctance to pay any tariff in the present conditions of electricity supply due to a variety of reasons. But, on enquiring their willingness to pay electricity charges under conditions of reliable, adequate and quality electricity, they have agreed to pay different levels of user charges. The average levels of bids made by them stood at Rs. 2.20 per unit for both areas.

On the basis of this average level, a hypothesis has been posed as well as proved by highlighting empirically, on the basis of survey information, how the new alternative scenario with availability of adequate, reliable and quality electricity is beneficial to every farmer and the utility.

Chapter 6
Summary and Conclusions

A major part of the ESI in India has grown in the state sector since independence. Several legislations, amended from time to time, facilitated the growth of the ESI in this sector. However, the performance of the state level bodies like the SEBs, EDs etc. has not remained much attractive over the period of time due to several factors. But, the reforms process initiated during the 1990s has been considered as a panacea for all the ills of the SEBs and the EDs. The passing of the legislations like the 'Electricity Regulatory Commission Act, 1998' and the 'Electricity Bill, 2003' are the significant steps taken to speed-up the reform process. The PSEB too, like other SEBs, has started its voyage on the reforms path.

This study is a modest attempt to understand the factors responsible for the present plight of the PSEB. It has analyzed the PSEB's performance in the operational, organizational and commercial aspects of its functioning. It discusses the PSEB's approach towards maintaining a balance between its resources and loads. It analyzes the PSEB's performance in electricity generation. Besides quantifying the cost of inefficiency in transmission and distribution of electricity by the PSEB, the study evaluates the PSEB's relative performance in organizational aspect through a consideration of its labor productivity and the stability in tenure of its top officials. It also highlights that the PSEB's deteriorating commercial performance is mainly due to the rising magnitude of subsidies granted by the state to those consumers who constitute its major vote banks.

The rising magnitude of these subsidies especially to the agricultural sector facilitates the extension of the study in the direction of pointing out the beneficiaries of electricity subsidy among different classes of farmers across the progressive and the backward areas of Punjab. In addition to discussing the implications of granting across the board electricity subsidy to the agricultural sector, the study highlights the nature of the state policy and the practices inherent in granting new electricity connections to the agricultural sector. The study also evaluates farmers' willingness to pay the user charges in both the existing and alternative improved conditions of electricity supply. Based on this willingness to pay, the study emphasizes if the non-electrified farms are electrified on the condition of paying electricity charges regularly as per the average bid level of Rs. 2.20 per unit, then it is beneficial for not only the utility but also for the farmers. The main findings of this study are summarized as below:

Imbalances in Resources and Loads

The PSEB could not augment its generation potential at the pace by which its loads have increased over the years. The capacity additions proved to be so inadequate that it was not possible to serve the peak load requirements even if the PSEB operates its generating units at their full potential without caring for regular planned reserve schedules especially during the post-1994-95 period. These inadequate additions to the generation capacity caused an imbalance between its loads and resources. However, the PSEB has maintained this imbalance but not by making the required additions to its generation potential rather by opting for a relatively dearer alternative of power purchase from the Central sector corporations and the SEBs of neighboring states.

This dearer option has contributed to an increase in the average cost of supply to the consumers' premises. But the PSEB could have avoided this if it could have used its resources in an efficient manner. A large part of the total power sector outlay has been allocated to the augmentation of generation potential comprising both hydro and thermal capacity but it has been found that the hydro potential developed by the PSEB alone has not increased even by a single megawatt during the last decade. Also, the growth rate of the PSEB's share in hydro capacity from the common pool projects has shown a declining trend over the years.

The most probable reason for such drastic decline in hydro capacity additions lies in the presence of huge cost and time overruns in the completion of projects. But, this study could not analyze as well as quantify the inefficiency in this preliminary stage of project execution solely because of the unreliability of the available data.

Relatively Sound Position in Thermal Electricity Generation

The overall position of the PSEB's capacity utilization has not remained much attractive. The board could exploit only half of its hydro potential during most of the years. But, it performed well in terms of the utilization of its thermal potential by keeping its various technical performance indicators like the plant load factor, plant availability factor, forced outage rates, auxiliary consumption and the fuel consumption per kWh of electricity generation etc. at par with other best performing SEBs like Andhra Pradesh, Gujrat, Maharashtra etc.

Inefficient Supply of Electricity:

The PSEB has performed quite inefficiently in its other technical dimension of supplying electricity from the generation end to the consumers' premises. The sub-transmission and distribution lines are found to be fully loaded with electricity due to their inadequate expansion over the period of time. This caused a rise in the level of T and D losses but the PSEB continued to report its T and D losses at a stagnating level ranging between 17 to 19 percent over the years because a convenient dumping place was provided by the un-metered electricity supply to the agricultural sector.

But, an estimation of the T and D losses, on the basis of some plausible assumptions, has shown that these reported T and D loss figures are the underestimates and the actual level of T and D losses is much more than the reported ones. This inefficiency in transmission and distribution of electricity could have been avoided with optimal expansion of the required transmission and distribution network, and the additional electricity resulting from the reduced levels of these T and D losses could have generated a potential saving of a huge installed generating capacity along with providing a revenue of hundreds of crores of rupees through the sale of this additionally available electricity to the consumers at the prevailing average tariff rate.

Over-staffing and Tenure Instability at Key Posts

In addition to this technical aspect, the PSEB has been found to be relatively inefficient in terms of its organizational performance. The productivity of its employees remained quite low when compared with some of the best performing SEBs. The PSEB's labor productivity *vis-à-vis* other best performing SEBs has been compared by taking into account the ratios like the number of consumers served, electricity sales and connected load, per thousand employees.

The study finds the presence of a great degree of instability in the tenure of the officials holding the key posts. The political pressure is found to be the major factor for the incidence of such instability in the PSEB's top positions. This information has been gathered through interviews with some retired bureaucrats,

Rising Subsidy Burden: a Major Factor for Dismal Commercial Performance:

The third and most important commercial aspect of the PSEB's functioning also has been found in the same line of continuing poor performance over the years because of the widening gap between the average operating expenditure and the average realization from the sale of electricity. This gap widened because the average operating expenditure increased rapidly and a parallel hike in the average tariff was not made mainly due to various non-economic factors.

This gap resulting from the price concessions on sale of electricity is nothing but a manifestation of subsidy on electricity consumption. Though the tool of cross-subsidy was used to offset the impact of this subsidy on the PSEB's financial health, it did not prove to be much effective because the magnitude of subsidies has been too high to be offset merely with cross-subsidization in the absence of adequate subventions from the state.

Consequently, the PSEB continued to incur huge commercial losses on account of providing electricity subsidies especially to the agricultural sector from which it did not recover fully even its fuel cost that might have been incurred to supply electricity to this sector. The magnitude of electricity subsidy to this sector has risen to a large extent over the period of time.

Uneven Distribution of Electricity Subsidy in the Agricultural Sector:

The electricity subsidy to the agricultural sector, a major factor for the PSEB's dismal commercial performance, is found unevenly distributed across different areas and the classes of the farmers. Owing to its peculiar character, this electricity subsidy has been received mainly by the medium and large farmers in general and the progressive areas in particular.

The distribution of electricity subsidy became more asymmetrical during the later phase of the free electricity supply policy when the granting of new electricity connections was restricted to only those who can afford to incur the full cost of its installation. This policy change has either wiped away a large set of small and medium farmers completely or forced them to arrange finances through one way or the other to get the electricity connection to ensure proper irrigation for their crops.

Such skewed distribution of electricity subsidy classified the agricultural society between the haves and the have-nots. The provision of subsidized electricity has bestowed the haves with riches whereas the plight of the have-nots has continued in the presence of continuously rising diesel prices. Also, such provision of electricity has been found to be a major factor for the development of water markets in rural Punjab and the depletion of scarce under-ground water at a rapid pace. It also provided, in some cases, a persuasion for the theft of electricity.

The study also finds the wide presence of corrupt practices in granting the new electricity connections irrespective of the area. A direct correlation between the bribe and the willingness of the PSEB's staff has been noticed because those farmers who did not bribe the officials had to wait for a relatively larger time period to get access to an effective electricity connection on their farm.

Possibilities on Demand Side to End-up the Subsidy Regime

The continuation of subsidy regime has affected the financial health of the utility and consequently, it started supplying inadequate and poor quality of electricity to the agricultural fields. This has had an impact on efficient functioning of the electric motors along with the irrigation cost that increased due to alternative use of diesel pump-sets at times of the non-availability of electricity.

Such conditions of electricity availability have disappointed a major section of farmers especially in the backward area. But, the disappointment of the farmers in the progressive area has been not because of poor conditions of electricity supply as they are having access to reliable and quality electricity, rather their disappointment was due to some other factors. This dissatisfaction of farmers in both the areas have structured their mind-set in such a way that they reacted against the payment of any sort of electricity charges. But, they agreed to pay the same by accepting the different bids proposed to them in return for the availability of reliable and quality electricity at their field. The average bid level made by these farmers of both the areas stood at Rs. 2.20 per unit.

Such bid level when compared with the provision of free electricity supply may leave one with the notion that it will exploit poor farmers. But, this doubt is well considered by pointing out, on the basis of survey data, empirically how the granting of an electricity connection is beneficial to a farmer who has a non-electrified IPS on his field. It is shown that the availability of electricity connection to this farmer will enable him to save a large sum of about Rs. 3,248 per acre in terms of irrigation cost reduction for only one crop that matures within a period of 3.5 months. Obviously, the new alternative scenario of electricity supply is beneficial for the utility too as it ensures the reasonable return to the utility on electricity sale to the agricultural sector.

Conclusion and Suggestions

The main conclusion of the study is that the present plight of the PSEB is due to the internal factors. But, these factors can be corrected with much ease if there is the spirit to do so. The PSEB too like other best performing SEBs *viz.* Andhra Pradesh, Gujrat and Maharashtra etc., because of its sound performance in thermal electricity generation, has a good chance to get classified among them. But it is possible only when these internal disturbing factors will get rectified.

The willingness of the farmers to pay the electricity charges regularly under the conditions of reliable and quality electricity availability provides a ray of hope to tackle the problem of subsidy burden arising out of the obligation to supply electricity to the agricultural sector at the subsidized rates. The PSEB's possession of a huge hydro potential enables it to meet this obligation efficiently without affecting its financial health.

But this requires a slight reallocation of the resources. The average cost of generating electricity through the hydro sources is relatively lower (Kannan and Pillai, 2000: 47). If the PSEB utilizes its hydro potential to serve the electricity requirements of the agricultural sector then it can supply electricity to this sector at a tariff much lower than the farmers' average bid level and thus, can mobilize sufficient resources that can be utilized for strengthening its transmission and distribution infrastructure. We emphasize that it can do so as the estimated electricity demand by the agricultural sector during 1999-2000 was much below than the PSEB's electricity generation through the utilization of its hydro potential.

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Q. No.

CENTRE FOR DEVELOPMENT STUDIES

Thiruvananthapuram-695011 (Kerala)

M. Phil Programme in Applied Economics, 2001-2003

(*Pro forma* for Primary Data Collection from Agricultural Households)

Performance of The Punjab State Electricity Board and Distribution of Electricity Subsidy to Agriculture

Name of Investigator – VARINDER JAIN	Date of Survey: ______November, 2002

Identification:

Name of Respondent	Area P ( ) B ( )	District Name	Block Name	Village Name

Note: P for Progressive; B for Backward.

A. Household Characteristics:

1 Demographic Particulars of the Respondent:

Name	Age	Sex (M/F)	Educational Level	Occupation	Relation to Head of Household

Note: M for Male; F for Female

2 Number of Family Members [ ] 3. Family Status

Nuclear		Joint	

4. Additional Sources of Income:

1	Agriculture Only	3	Money-lending	5	Small-scale business	7	Dairy	9	Service
2	Foreign Remittances	4	Poultry / Fishery	6	Piggery / Bee-Keeping	8	Labor	10	Any Other

5. Ownership of Assets:

Name	No	Yes	Number	Name	No	Yes	Number
Tractor				Harvester			
Car / Jeep				Spray Pump			
Scooter / Motor Cycle				Bank Account			
Truck / Bus				Urban Property			
Milch / Other Cattle				Any Other			

6. Use of Electric Devices:

Name	No	Yes	Number	Name	No	Yes	Number
Refrigerator				Table Fan			
Television				Ceiling Fan			
VCR / VCD player				Washing Machine			
Radio / Music system				Iron Box			
Cooler				Water Heater			
Air Conditioner				Electric Bulbs			
Exhaust Fan				Fluorescent Lamps			

7 Condition of House

7 (a) Type of House

1	Pacca	2	Kacha

7 (b) Whether House is electrified?

1	Yes	2	No

8 How is the quality of electricity at house?

1	Right Voltage	2	Low Voltage	3	High Voltage

9 Are you experiencing load shedding / power cut?

1	Yes	2	No

If yes,

9 (a) During which time-period of the day?

Day Time	Evening	Night

10 Do you sometimes use farm connection to get electricity for domestic use?

1	Yes	2	No

B. Field Characteristics:

1 Cultivated Land

------------------ Acres

2 Irrigation

	Tube wells	Canals	Buy Water	Canals and Tube wells	Canals and Buy Water
Mode of Irrigation					
More dependence on					

3 Type of Tube well / Number of Tube wells

Diesel Operated	Electricity Operated	Both

4 Do you sell water to other farmers?

1	Yes	2	No

4 (a) If yes, at what price?

Rs. ________ per acre

5 Ground Water level (feet)

Presently	Last year	Five Years Earlier

6 Types of crops cultivated

1	Wheat	2	Rice	3	Cotton	4	Sugarcane	5	Other

7 Yield Per Acre (Quintal) (for example, at previous harvest)

Wheat	Rice	Cotton	Sugarcane	Other

8 Reason for Cultivation of water-intensive crops

1	Subsidized Electricity Supply	2	Assured Marketing	3	Relatively More Profitable	4	Other

9 Irrigation Requirements of Crops (Number of Times)

Wheat	Rice	Cotton	Sugarcane	Other

10 Total Expenditure on Crop per acre

Wheat	Rice	Cotton	Sugarcane	Other
Rs.	Rs.	Rs.	Rs.	Rs.

C. Farm Power Supply Information:

C.I General Case:

1 Do you have electric wire passing by your field? (If no, go to C.III)

1	Yes	2	No

2 Do you have electricity connection on your field?

1	Yes	2	No

2 (A) If no, what is the reason for not having electricity connection?

2 (A) I Not applied because of

1	Lack of Awareness	2	Lack of Purchasing power	3	Any Other

2 (A) II Applied but not got yet due to

1	Administrative Restrictions	2	Favoritism	3	Bribe Demanded	4	Any Other

(Go to C III)

C.II OYT Case:

1 How many electricity connections you already have at your field?

2 When you got the OYT connection for your field?

2 (A) Is it Self-financed?

1	Yes	2	No

2 (B) How did you manage to finance OYT electricity connection?

1	Paid Cash	2	Credit from non-institutional sources
3	Loan from bank	4	Credit from Relatives
5	Sale of Property	6	Foreign Remittances

3 Did you make use of political influence to get electricity connection?

1	Yes	2	No

If yes,

3 (A) Approached to authority for getting immediate electric connection.

1	Panchayat members / Sarpanch	2	SEB's Officials	3	Local Politicians	4	Other

3 (B) Have you bribed the PSEB officials to get the electricity connection?

1	Yes	2	No

4 Average time lag involved in completion of all required formalities and getting effective electricity connection on the field.

C.III. Diesel Pump-Set Information:

1 Do you have diesel pump-set on your field?

	Yes	No
Also		
Only		

2 Reason for buying diesel pump-set

1	No electric connection on the field	2	Irregular and Inadequate electricity supply	3	Any Other

3 Quantity of diesel required to irrigate one acre of land (liters). [ ]

4 From where you get credit for buying diesel?

1	Institutional Sources	2	Non-Institutional Sources

5 Being dependent on diesel pump-set for irrigation, how much is your net income per acre? Rs.

C.III (a) Diesel Pump-Set Owner's Opinion:

1 Are you satisfied with the use of diesel pump-set?

1	Yes	2	No

1 (a) i. If yes, why? [ ]

1 (a) ii. If no, why? [ ]

2 Are you willing to have electricity connection? (If yes, go to D).

1	Yes	2	No

C.IV Farmer's Experience of Electricity Supply:

1 Are you experiencing load shedding / power cut at the farm?

1	Yes	2	No

If yes,

1 (a) During which time-period of the day?

Day Time	Evening	Night

2 Except this year, for how many hours, were you getting electricity for your field?

At Time of Sowing Crops	Otherwise
hours	hours

3 Nature of Electricity Supply at field.

1	Uninterrupted	2	Interrupted

4 Voltage fluctuations in electricity supply.

1	Frequent	2	Moderate	3	Very rare

5 How do you manage with voltage fluctuations in electricity supply at your field? [ ]

6 Do you think that the voltage fluctuations have something to do with this motor failure problem?

1	Yes	2	No

7 Visits to the mechanic for getting electric motor repaired.

1	Never	2	Sometimes	3	Frequently

8 Expenditure on getting electric motor repaired. Rs.

9 Number of days lost for getting the electric motor repaired. [ ]

10 Do you find any difference in electricity availability at home and at farm?

1	Yes	2	No

10 (a) If yes, where electricity supply is better in availability and quality?

1	To Farm	2	To House

C.V ***Farmer's Opinion about electricity:***

		Yes	No	Don't Know
I.	Do you favor Punjab Government's decision for withdrawal of free electricity supply to the agricultural sector?			

Reason --

		Yes	No	Don't Know
II.	Do you support the privatization of the PSEB?			

Reason --

		Yes	No	Don't Know
III.	Are you satisfied with the present situation of subsidized / free power supply with no quality and reliability? (If no, go to D)			

Reason --

		Yes	No	Don't Know
IV.	Are you willing to pay in present situation of electricity supply? (If no, go to D)			

Reason --

		Yes	No	Don't Know
V.	Do you want to get reliable and quality electricity? (If yes, go to D)			

D. Willingness to Pay:

Opening Statement A:

The Punjab Government, at present, is facing severe fiscal crisis. The state is unable to compensate the PSEB for supplying free electricity to the agricultural sector. Owing to this, the PSEB's losses are mounting up. Let me tell you that the PSEB incurs an actual cost of Rs.2.44 per unit to supply electricity at your fields. It can provide reliable and quality electricity only when it is able to recover its cost fully along with some profit to ensure its sustainability. Please answer truthfully, Would you be willing to pay the electricity charges to enable the PSEB to recover its cost so that the reliable and quality electricity supply to your fields can be ensured.

Opening Statement B:

Punjab Government is facing severe fiscal crisis. The state is unable to compensate the PSEB in return for supplying free electricity to the agricultural sector. Owing to this, the PSEB's losses are mounting up. I want to inform you that the PSEB incurs an actual cost of Rs.2.44 per unit to supply electricity at your fields. It can provide reliable and quality electricity only when it is able to recover its cost fully along with some profit to ensure its sustainability. Think for a while that the electric utility is privatized and it decides to cease electricity sale at subsidized rates with the condition that the electricity will be supplied only if it is assured of some minimum level of profit. It is obvious that in the absence of electricity supply, one has to rely on the diesel pump-set for irrigation purposes and, as you know, this will entail relatively high financial burden on your pocket as it involves huge direct as well as indirect cost. Under these circumstances, would you be willing to pay electricity charges to get reliable and uninterrupted electricity supply to your fields.

(a) Do you think that you would be willing to pay Rs. 2.50 per unit as electricity charge for electricity supply to your fields?
   i. Yes --------- Go to (b)
   ii. No --------- Go to (c)
   iii. I don't know --------- Go to (f)

(b) We do not know how much the utility is planning to fix as the per unit charge for reliable and quality electricity supply to your field. If the decision is to pay Rs. 3.50 per unit, would you be willing to pay this?
   i. Yes --------- Go to (f)
   ii. No --------- Go to (d)
   iii. I don't Know --------- Go to (f)

(c) We do not know how much the utility is planning to fix as the per unit charge for reliable and quality electricity supply to your field. If the decision is to pay Rs. 2 per unit, would you be willing to pay this?
   i. Yes --------- Go to (e)
   ii. No --------- Go to (f)
   iii. I don't Know --------- Go to (f)

(d) Would you be willing to pay Rs. 3 per unit as electricity charge for electricity supply to your fields?
   i. Yes --------- Go to (f)
   ii. No --------- Go to (f)
   iii. I don't Know --------- Go to (f)

(e) Would you be willing to pay Rs. 2.25 per unit as electricity charge for reliable and quality electricity supply to your fields?
   i. Yes --------- Go to (f)
   ii. No --------- Go to (f)
   iii. I don't Know --------- Go to (f)

(f) Think for a moment, what is the largest amount of money that you would be willing to pay per unit in return for reliable and quality electricity supply to your fields?
   i. Amount of money: Rs. ________________
   ii. I don't Know ________________

Thank You

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