ON SOME ASPECTS OF ELECTRICITY SECTOR IN INDIA: A STATE WISE ASSESSMENT

Dissertation Submitted to the Jawaharlal Nehru University in Partial Fulfillment of the Requirements for the Award of the Degree of

MASTER OF PHILOSOPHY

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CERTIFICATE

This is to certify that the dissertation titled, **'On Some Aspects of Electricity Sector in India: A State Wise Assessment'** submitted by me to the Jawaharlal Nehru University in partial fulfillment of the requirement for the award of the degree of **Master of Philosophy**, is my own work and has not been submitted so far for any degree or diploma in this university or any other university.

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Dedicated to

Ma & Daddy

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Chapter I

Introduction

Electricity is a basic part of nature and it is one of the most widely used forms of energy. It is a critical infrastructure on which the socio-economic development of the country depends. The availability of reliable and quality power at competitive rates to Indian industry is very important to make it globally competitive and to enable it to exploit the tremendous potential of employment generation. Hence a sustained growth of this segment is very crucial.

Electricity cannot be stored economically. The electrical power industry is evolving from a highly regulated, monopolistic industry with traditionally structured electric utilities to a less regulated, competitive industry. Electricity Sector exhibits tremendous economies of scale. It is capital intensive, involves direct connections with consumers, non storable and subject to fluctuating demands. Because of these characteristics electricity industry is considered as a natural monopoly.

Electricity is measured in units of power called watts. One watt is a very small amount of power. A kilowatt-hour (kWh) is equal to the energy of 1,000 watts working for one hour. The amount of electricity a power plant generates or a customer uses over a period of time is measured in kilo watt hours (kWh).

a) Sources of Electricity:

We now briefly discuss the major sources of electrical power. There are mainly five major sources of electricity, viz., water, coal, oil, gas and radioactive elements. Water is source for hydel power. Coal, oil, gas are the sources of thermal power and atomic power is generated from radioactive elements.

Hydro Power, the source for electricity generation, is a process in which flowing water is used to spin a turbine connected to a generator. There are two basic types of hydroelectric systems that produce electricity. In the first system, flowing water accumulates in reservoirs created by the use of dams. The water falls through a pipe and applies pressure against the turbine blades to drive the generator to produce electricity. In the second system, called run-of-river, the force of the river current (rather than falling water) applies pressure to the turbine blades to produce electricity. The share of hydel generation in total generation of power in India has come down from 34 per cent at the end of the Sixth Plan to about 20 per cent at present[1].

Thermal Power use coal, oil and natural gas to generate electricity. In the industrial countries thermal power accounts for more than 60per cent of total power generated. In India, thermal power has been developed on a very extensive scale. In the case of thermal plants the initial cost is low but their maintenance costs and power generation costs are high. It also causes pollution. Therefore, in future attempts should be made to reduce coal use for power generation.

Nuclear power is a method in which steam is produced by heating water through a process called nuclear fission. In nuclear power plants, a reactor contains a core of nuclear fuel, primarily enriched uranium. Under controlled conditions, these other neutrons can strike more uranium atoms, splitting more atoms, and so on. Thereby, continuous fission can take place, forming a chain reaction releasing heat. The heat is used to turn water into steam that, in turn, spins a turbine that generates electricity. The rate of growth of nuclear power is currently limited by the financial constraints.
Apart from the above three conventional sources there are some other sources of electrical power in the economy. They are as follows.

Geothermal power comes from heat energy buried beneath the surface of the earth. In some areas of the country, enough heat rises close to the surface of the earth to heat underground water into steam, which can be tapped for use at steam-turbine plants. This energy source generates less than 1% of the electricity in the country.

Solar power is derived from the energy of the sun. However, the sun's energy is not available full-time and it is widely scattered. The processes used to produce electricity using the sun's energy have historically been more expensive than using conventional

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[1] S K Chopra, 2005, New Delhi.

fossil fuels. Photovoltaic conversion generates electric power directly from the light of the sun in a photovoltaic (solar) cell.

Wind power is derived from the conversion of the energy contained in wind into electricity. Wind power, like the sun, is a rapidly growing source of electricity.

Biomass includes wood, municipal solid waste (garbage), and agricultural waste, such as corncobs and wheat straw. These are some other energy sources for producing electricity. These sources replace fossil fuels in the boiler. The combustion of wood and waste creates steam that is typically used in conventional steam-electric plants.

It may be noted that electricity reaches the final consumers after three basic processes - generation, transmission and distribution. *Generation* is the process of conversion or transformation of energy from different sources- coal, oil, gas, wind, nuclear energy and other alternative energies into electrical energy. It is generally performed by the power plants or utilities. Generation usually occurs at a considerable distance away from consumers. *Transmission* is the function by which electricity is transported from a large number of generators through high voltage wires to the substations. Electricity then travels to the ultimate consumers where transformers step down the voltage for *distribution* through low voltage wires. The electricity produced by a generator travels along cables to a transformer, which changes electricity from low voltage to high voltage. Electricity can be moved to long distances more efficiently using high voltage. Transmission lines are used to carry electricity to a substation. Substations have transformers that change the high voltage electricity into lower voltage electricity. From the substation, distribution lines carry the electricity to homes, offices and factories, which require low voltage electricity. Prior to power sector reforms in India, in each State, the *State Electricity Boards* (SEBs) were generally in charge of generation, transmission and distribution of electricity in the whole state.

b) Essential Features of the Electricity Sector:

The electric power sector in India is characterized by the following features

1. low per capita energy use,
2. rapid growth in demand,
3. heavy losses in transmission and distribution,
4. tariffs well below average costs,
5. coal (which is main polluting) dominates usage, and provides about 60% of the country's power,
6. the power sector contributes about half of India's carbon, sulphur and nitrogen oxide emissions,
7. as per Census 2001, about 44% of the households do not have access to electricity.

c) Brief History of Indian Electricity Sector:

The per capita consumption of electricity is one of the major indicators of economic development of a country. At the very beginning of 1950s, electricity consumption per capita was extremely low in India. It was merely 15 Kwh. By the end of this century, electricity consumption per capita was 355 Kwh[2]. The power sector has registered significant progress since the process of planned development of the economy began in 1950. Hydro -power and coal based thermal power have been the main sources of generating electricity. Nuclear power development is at slower pace, which was introduced, in late sixties. The concept of operating power systems on a regional basis crossing the political boundaries of states was introduced in the early sixties. From, the Fifth Plan onwards i.e. 1974-79, the Government of India got itself involved in a big way in the generation and bulk transmission of power to supplement the efforts at the State level and took upon itself the responsibility of setting up large power projects to develop

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[2] **IEA, 1999 C II 490-95**

the coal and hydroelectric resources in the country as a supplementary effort in meeting the country's power requirements. The National Thermal Power Corporation (NTPC) and National Hydro-electric Power Corporation (NHPC) were set up for these purposes in 1975. North-Eastern Electric Power Corporation (NEEPCO) was set up in 1976 to implement the regional power projects in the North-East. Subsequently two more power generation corporations were set up in 1988 viz. Tehri Hydro Development Corporation (THDC) and Nathpa Jhakri Power Corporation (NJPC). To construct, operate and maintain the inter-State and interregional transmission systems the National Power Transmission Corporation (NPTC) was set up in 1989. The corporation was renamed as POWER GRID in 1992. The major initiatives were taken by Central and State Governments for development of the Power Sector through the process of Power Sector Reforms. Hence meeting the target of providing universal access is a daunting task requiring significant addition to generation capacity and expansion of the transmission and distribution network. In spite of the overall development that has taken place, the power supply industry has been under constant pressure to bridge the gap between supply and demand.

"Developing countries today have no good solution to the dual nature of electricity – commercial good and public service. The traditional answers– retain policy control with Government but develop ownership to private companies and regulation to independent bodies"[3].

Recognizing that electricity is one of the key drivers for rapid economic growth and poverty alleviation, the nation has set itself the target of providing access to all households in next five years. Indian Power sector is witnessing major changes. Growth of power sector in India since independence has been noteworthy. However, the demand for power has been outstripping the growth of availability. Substantial peak and energy shortages prevail in the country. This is due to inadequacies in generation, transmission and distribution as well as *inefficient use of electricity.*

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[3] **Dubash & Singh, 2005.**

d) Objectives:

Given the above scenario in the electricity sector, we want to focus on certain aspects of it. The main objectives of our study are the following –

1) to measure how far the Power Sector Reforms are effective on the financial as well as on the technical front.

2) to rank the States in India according to their relative contributions of the Scale effect, Structural effect and Intensity effect in the total change of electricity consumption using 'Period wise Decomposition' analysis for two benchmark periods, the early 1990s and the late 1990s for capturing the sectoral contributions of the reforms impact;

3) to examine the reliability of State wise sectoral consumption of electricity data provided by the State Electricity Boards;

4) to rank the major Indian States according the outcomes in terms of board based efficiency (composite index) in the use of electricity measures.

e) Plan of the Study:

The present study has been divided into five chapters, including the present one. The second chapter describes trends and progress of Indian Electricity Sector. The third chapter analyses inter state disparities in consumer category wise sale of electricity. Such disparities arise mainly due to three factors, viz. change in total production of the economy (Scale effect), structural composition of the sectors (Structural effect) and technical efficiency (Intensity effect). In this chapter, the relative contributions of the Scale effect, Structural effect and Intensity effect in the change of total electricity consumption will be estimated individually for 18 major states in India using period wise 'Decomposition analysis' and the impact of power sector reforms in this context. Chapter four examines the efficiency in the use of electricity. We use multi dimentional quality index of electricity use (proposed composite index of indicators which influnce the consumption of electricity) for the periods 1990-91 and 2000-01. This study also examines the reliability of State wise sectoral consumption of electricity data provided by the States Electricity Boards. Chapter five provides the conclusions and recommendations of our study.

Chapter II

Trends and Progress of Indian Electricity Sector

Introduction:

Power is the key infrastructure required for sustained economic growth. Since independence, the Indian electricity sector has grown manifold in size and capacity. The Electricity (supply) Act, 1948, provides an elaborate institutional framework and financing norms of the performance of the electricity industry in the country. The Act envisaged creation of State Electricity Boards (SEBs) for planning and implementing the power development programmes in their respective states. During the post independence period, the various states played a predominant role in the electricity sector development. There are State Electricity Boards (SEBs), which own, operate and sell electricity from a clutch of generating units within the state boundaries. Apart from SEBs, there are other state owned utilities also known as Central Sector Utilities (CSUs). In 2001-02, hydel power accounted for about 14.3 per cent of total electricity generated in India by the public utilities. It was 39 per cent in 1980-81. Since then it has steadily declined. In India, thermal power has been developed on an extensive scale. In 2001-02, the total power plant capacity in public utilities was 104.9 Thousands MW, of which thermal plants accounted for 75.9 Thousands MW, that is 72.4 per cent. At present, about two third of coal production is used for power generation[4]. The structure, ownership, patterns and regulatory set up of the power sector has witnessed radical changes.

Power sector reforms were expected to focus on two areas- first, the rationalization of tariff structure through independent Electricity Regulatory Commissions (*ERCs*) and the second, the restructuring of Electricity Board, separating generation from transmission and distribution and to bring about greater efficiency in each area[5]. Thereafter, State Electricity Commissions (*SECs*) have been set up in several states of India. The challenge of implementing electricity restructuring is compounded by unfavorable initial conditions. The reforms are no doubt important but they lack focus[6]. Due to the history of state owned public utilities, privatization has been an essential part of electricity restructuring in most developing countries. Since the establishment of competition is a

[4] **Misra, Puri, 2003**
[5] **WGSEBs,2002**
[6] **Parikh & Parikh, 1999**

slow and amorphous process, privatization has been the most visible and controversial face of reforms in the developing world[7].

Before going to detailed empirical analysis on some aspects of electricity sector we should know the history and the present condition of electricity sector of the States and all over India. Hence this chapter provides necessary information about the status and performance of Indian Electricity Sector over the years. The present study is based on both secondary data and information. The data have been collected from various publications of Central Electricity Authority, Ministry of Power, Annual Report of State Electricity Boards, Planning Commission, The Energy Research Institute, New Delhi. In this chapter some important parameters of the performance of Indian Electricity Sector have been discussed. According to the characteristics of the parameters, the performance has been divided into two parts, viz., Physical Performance and Financial Performance. In order to bring the developmental condition of Indian Electricity Sector, Rural Electrification, Policy Initiatives, Reforms in Power Sector, Status of the States in Reforms of Power Sector also have been discussed.

A. Physical Performances:

The power sector in India is characterized by the vertical integration between generation, transmission and distribution. The installed generation capacity of the utilities in the country on March 2002 was 104917.5 MW of which 59.33% was owned by the States, 30.12% by the centre and 10.55% was owned by the private sector. The share of hydro capacity is about 25.03 per cent. Against the 9th Plan target of 40245 MW capacity additions, the actual addition is about 19015 MW. Capacity addition in the Central Sector is 450.0MW i.e. 37.8 per cent as against the target of 11909 MW whereas capacity addition by the States Sector is 9450.1 MW i.e. 87.9 per cent as against the target of 10748 MW.

a. Installed Generating Capacity:

The net capacity measured at the terminals of the stations, i.e., after deduction of the power absorbed by the auxiliary installations and the losses in the station

[7] **Dubash, Singh , 2005.**

transformers[8]. Presently, India has an installed generating capacity of nearly 112 GW (Giga Watts). This includes thermal (coal, gas and liquid fuel) hydro, nuclear and winds power. Out of total installed capacity 90% is owned by public sector[9].

Table2.1: Installed Generating Capacity of Electricity in Utilities and Non-utilities in India (Unit is Mega Watt) = (103 x Kilo Watt)

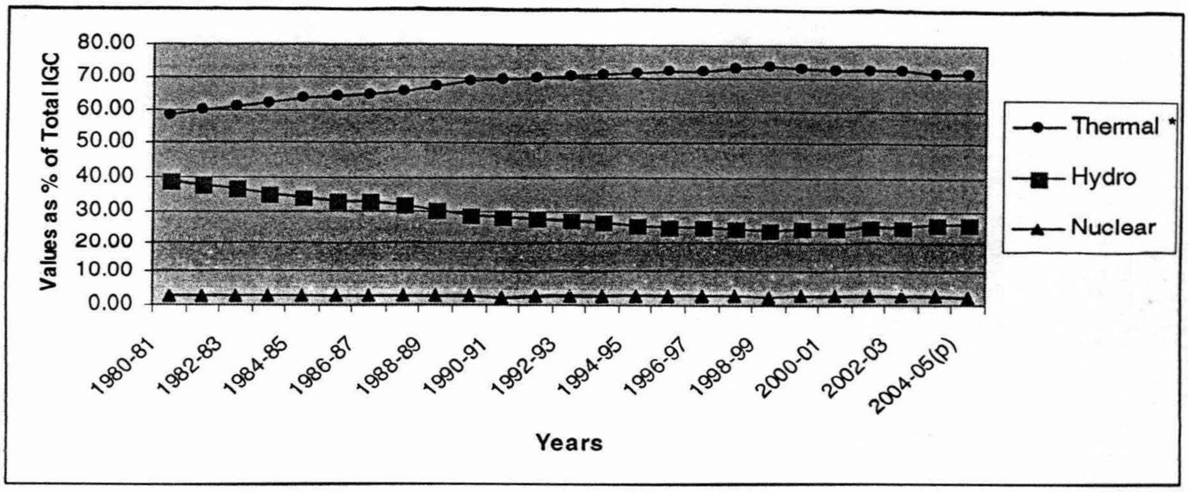
	Utilities[10]				Non Utilities			
Year	Thermal *	Hydro	Nuclear	Total	Railway	Self-Generating Industries	Total	Grand Total
1980-81	17,563	11,791	860	30,214	60	3,041	3,101	33,315
1981-82	19,312	12,173	860	32,345	60	3,376	3,436	35,781
1982-83	21,447	13,056	860	35,363	66	3,806	3,872	39,235
1983-84	24,388	13,856	1,095	39,339	68	4,298	4,366	43,705
1984-85	27,030	14,460	1,095	42,585	82	5,038	5,120	47,705
1985-86	29,967	15,472	1,330	46,769	85	5,419	5,504	52,273
1986-87	31,740	16,196	1,330	49,266	86	5,628	5,714	54,980
1987-88	35,560	17,265	1,330	54,155	87	6,258	6,345	60,500
1988-89	39,677	17,798	1,565	59,040	88	6,432	6,520	65,560
1989-90	43,763	18,308	1,565	63,636	109	8,007	8,116	71,752
1990-91	45,768	18,753	1,565	66,086	111	8,502	8,613	74,699
1991-92	48,086	19,194	1,785	69,065	133	9,168	9,301	78,366
1992-93	50,749	19,576	2,005	72,330	140	9,905	10,045	82,375
1993-94	54,369	20,379	2,005	76,753	148	10,575	10,723	87,476
1994-95	58,113	20,833	2,225	81,171	148	11,013	11,161	92,332
1995-96	60,083	20,986	2,225	83,294	158	11,629	11,787	95,081
1996-97	61,912	21,658	2,225	85,795	163	11,916	12,079	97,874
1997-98	64,972	21,905	2,225	89,102	162	13,004	13,166	102,268
1998-99	68,590	22,479	2,225	93,294	159	13,932	14,091	107,385
1999-00	71,347	23,857	2,680	97,884	-	15,336	15,336	113,220
2000-01	73,613	25,153	2,860	101,626	-	16,157	16,157	117,783
2001-02	76,057	26,269	2,720	105,046	-	17,145	17,145	122,191
2002-03	78,390	26,767	2,720	107,877	-	18,363	18,363	126,240
2003-04	80,457	29,507	2,720	112,684	-	18,740	18,740	131,424
2004-05(p)	84,714	30,942	2,770	118,426	-	19,103	19,103	137,529

Source: Central Electricity Authority. From 1995-96 onwards, *Thermal includes wind also. Note: MW means Mega Watt.

[8] Energy Statistics, 2004-05; http://www.mospi.nic.in/mospi_energy_stat.htm
[9] TEDDY, 2003-04
[10] Utilities: undertakings of which the essential purpose is the production, transmission and distribution of electric energy. These may be private companies, cooperative organisations, local or regional authorities, nationalized undertakings or governmental organisations.

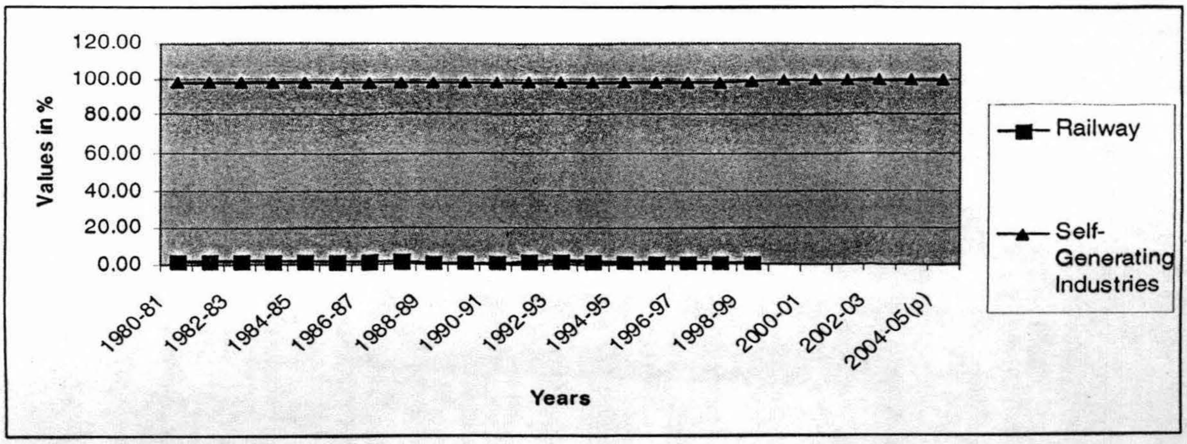
The above table shows a sharply increasing trend in the total installed generating capacity of electricity from both utilities and non utilities from 1980-81 to 2005. In the case of the utilities, the installed generating capacity of the thermal plants increased at a higher rate than the hydel plants and nuclear plants (see charts 2.1 & 2.2).

Chart 2.1: Trends of Installed Generating Capacities (IGC) by the Sources of Utilities as a % of Total IGC



Calculated from table 2.1

Chart 2.2: Trends of Installed Generating Capacities (IGC) by the Sources of Non Utilities as a % of Total IGC



Calculated from table 2.1

The annual gross electricity generation in the utility is currently about 558 BU (billion units) with a net availability of 519 BU. The peak period demand for power during 2003-

04 was 559 BU and 84.6 GW. The availability of power was short of demand and as a result, the country experienced a shortage of 7.1% in energy and 11.2% in peak-period power[11]. The actual power supply position as on March 2002, an assessment by CEA, indicates a peak deficit of 12.6% and an energy deficit of 7.5% at an al' India level as against a peak deficit of 18% and energy deficit of 11.5% during 1996-97. The per capita electricity consumption of India was 355 KWH during 1999-2000 as against 334 KWH in 1996-97, whereas in China it was 719 KWH during 1997.

b. The Elasticity of Consumption of Electricity:

The Elasticity of Consumption of Electricity with respect to Gross Domestic Product for the period 1980-81 to 1998-99 works out to 1.41. This implies that an increase in GDP by 1 per cent accompanied by 1.41 per cent increase in electricity consumption. In the Plan periods, the elasticity has declined from over 3 per cent to nearly 1.5 during the Seventh Plan and further to 0.97 in Eighth Plan.

Table 2.2: Elasticity of Consumption and Generation of Electricity

Plan Period	Elasticity w. r. t GDP for consumption	Elasticity w. r. t GDP for generation
First Plan	3.14	3.06
Second Plan	3.38	3.45
Third Plan	5.04	5.11
Fourth Plan	1.85	2.15
Fifth Plan	1.88	1.88
Sixth Plan	1.39	1.47
Seventh Plan	1.5	1.57
Eighth Plan	0.97	1.02

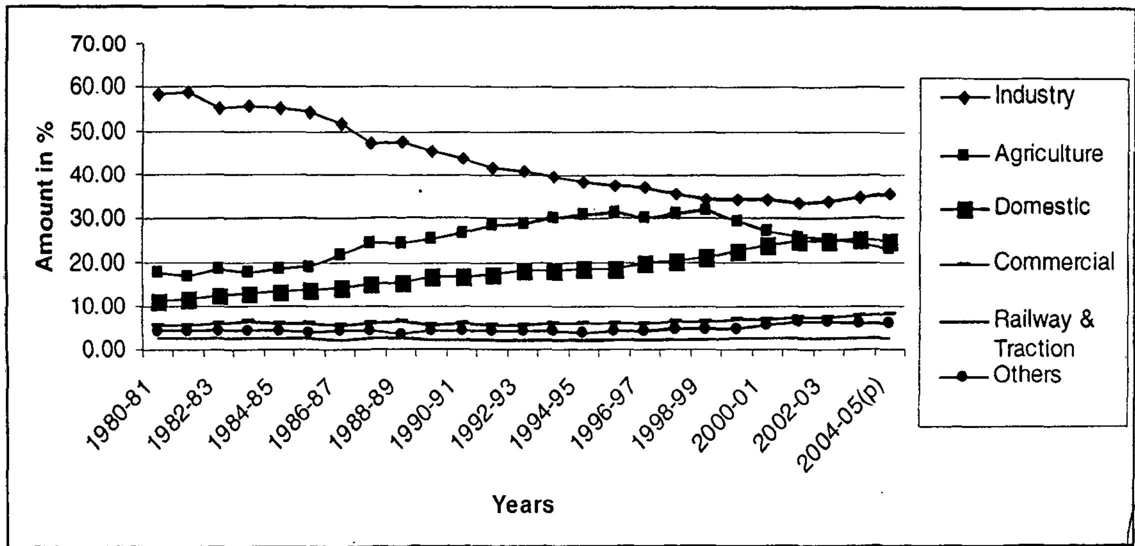
Source: Annual report WG S E Bs, May 2002.

The elasticity of electricity generation and consumption visa-a-vis GDP has declined over the time after an increase till the Third Plan. Each figure in the above table that an one per cent increase in GDP was accompanied by an increase of that particular figure (in %

[11] **TERI Data and Directory Yearbook, 2003-04.**

term) of elasticity generation, or consumption. The following chart (data collected from Energy Statistics, 2004-05) reveals drastic change in the trend of sectoral share in total electricity consumption for industry, agriculture and domestic sectors. It is evident that the share of domestic consumption in the total sales of electricity has been increasing over the years. The share of agricultural sector in total sold was rising upto 1998-99 but thereafter it has been declining.

Chart 2.3: Trends of Sectoral Consumption of Electricity as a % of Total Consumption



Source: Estimated from the Report of Central Electricity Authority, New Delhi

This could be due to realistic assessment of agricultural consumption and higher reported T & D losses by the reforming states. The share of industrial sector has been exponentially decreasing since 80s and the share industrial sector in overall sales appears to be slightly opposite after 1998-99. The industrial sector has remained a major contributor to the revenue of State Electricity Boards despite declining trend in the share in total sale of power. There has been slight change in the share of electricity consumption in total sale by the commercial sector and the transport sector, mainly, railway traction in the recent years.

c. Power Sector Plan Outlay and Expenditure:

With the exception of the Second and Third Plans, the share of the electricity sector in the total plan outlay has been about 15-20 per cent. Out of the allocated outlays, the provision for T&D schemes has been lower than the desired level of investment in the past. Electricity sector suffered from serious under investment (both public and private) in the Ninth Plan period (*1997-2002*), and going by progress, is further expected to have a significant short fall in the Tenth Five-Year Plan (*2002-2007*). Apart from the regular investment by the States, Government is providing investment through Accelerated Power Development Programmes (APDP) as part of reform package to the States. This may facilitate higher investment in T&D system during the Tenth Plan. But according to Regulatory, TERI, 2003, 'Decline in the private sector involvement in generation reflects the fact that the distribution segment of the power sector remains financially enviable. Under such circumstances, the recent National Electricity Policy of GOI aiming to meet the power demand fully by 2012 sounds far more ambitious'.

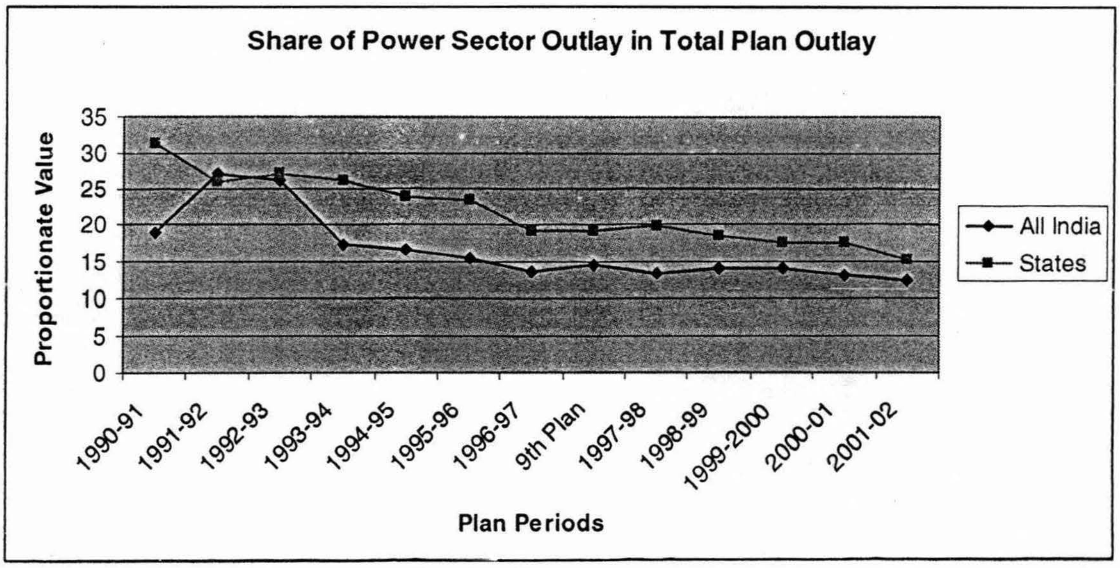
Table 3 below gives the outlays and expenditure in the Power Sector and the total outlay and expenditure since First Five Year Plan for the country as a whole. It indicates that the share of power sector outlay in the total outlay has been gradually declining in the past one decade. This may be partly due to the policy of the Government to encourage private sector participation in the development of the Power Sector. It is seen that the share of power sector in the total outlay declined during the Eighth Plan and subsequent periods of Ninth Plan.

Table 2.3: Power Sector Plan Outlay and Expenditure

Plan periods	Outlay (Rs. Cr)		Outlay as %of all sector	Expenditure (Rs. Cr)		Exp. as %of all sector
	Power Sector	All Sector		Power Sector	All Sector	
First Plan (1951-56)	393.44	2068.76	19.02	260	1960	13.27
Second Plan (1956-61)	426.87	4800	8.89	445.49	4600	9.68
Third Plan(1961-66)	1019.72	8094.53	12.6	1252.3	8576.5	14.6
Annual Plan (1966-69)	1063.96	6665.04	15.96	1212.5	6625.4	18.3
Forth Plan (1969-74)	2447.57	15902.2	15.39	2931.7	15778.9	18.58
Fifth Plan (1974-79)	7293.9	39287.5	18.57	7399.5	39426.2	18.77
Annual Plan (1979-80)	2395.99	12549.6	19.09	2240.5	12176.5	18.4
Sixth Plan (1980-85)	19265.4	95700	20.13	18298.7	109291	16.74
Seventh Plan (1985-90)	34273.5	180000	19.04	37895.3	218730	17.33
Annual Plan (1990-91)	12479.6	64716.9	19.28	13147.5	62421	21.06
Annual Plan (1991-92)	13678.3	72316.8	18.91	12463.3	64953	19.19
Eighth Plan (1992-97)	79589.3	434100	18.33	76677.4	485457	15.79
Annual Plan (1992-93)	14943.9	80772	18.5	12396.7	72852.4	17.02
Annual Plan (1993-94)	16419.9	100120	16.4	14521.6	88080.7	16.49
Annual Plan (1994-95)	18445.5	112197	16.44	16310.2	98167.3	16.61
Annual Plan (1995-96)	19637.4	128590	15.27	16511.4	107380	15.38
Annual Plan (1996-97)	19084.5	146107	13.06	16937.5	118976	14.24
Ninth Plan (1997-2002)	124526	859200	14.49	NA	NA	NA
Annual Plan (1997-98)	20830.5	155905	13.36	19396.3	129757	14.95
Annual Plan (1998-99)	25741.8	185907	13.85	21159	149403	14.16
Annual Plan (1999-2000)	26825	192263	13.95	21327.4	160608	13.28
Annual Plan (2000-01)	26554.4	203359	13.06	22066.4	187931	11.74
Annual Plan (2001-02)	27842.7	228493	12.19	NA	NA	

Source: Annual Report S E Bs, 2002. Excluding Jharkhand

Chart 2.4



Data collected from Annual Report, Planning Commission, 2002.

The relative share of power sector in total outlay both at the all India and the State levels has also been declining. The decline in case of states could be due to two reasons. First reason could be the expectation of some of the states regarding the private sector investment from the beginning of the Ninth Plan and the second could be the declining plan allocation to the S E Bs from the State Governments.

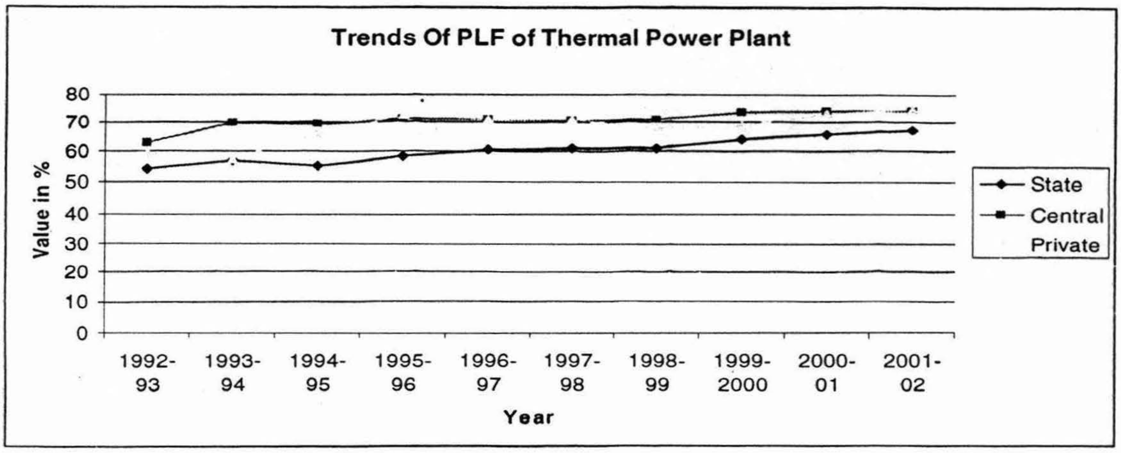
d. Plant Load Factor:

The capital productivity as indicated by the Plant Load Factor (PLF) is the resultant of maintenance downtime, forced outage and peak load management, where force outage is the function of maintenance quality among others. The PLF is an important indicator of technical efficiency of thermal power plants. The PLF of thermal power plants in our country has shown an improvement during the reforms periods[12]. The operational performance (highest load factor of a plant) of the utilities in terms of plant availability has been improving over the years. The average PLF increased from 55.3 % in 1991-92

[12] **Gupta, Gupta, 2005**

to 69.9 % in 2001.02. The gap between the plant availability and plant load factor indicates that though the plants are available at 80 % of the time, they are forced to back down in some of the States, particularly in the eastern region, during the off peak hours due to lower demand. There are wide variations in the Plant Load Factor in the Various States.

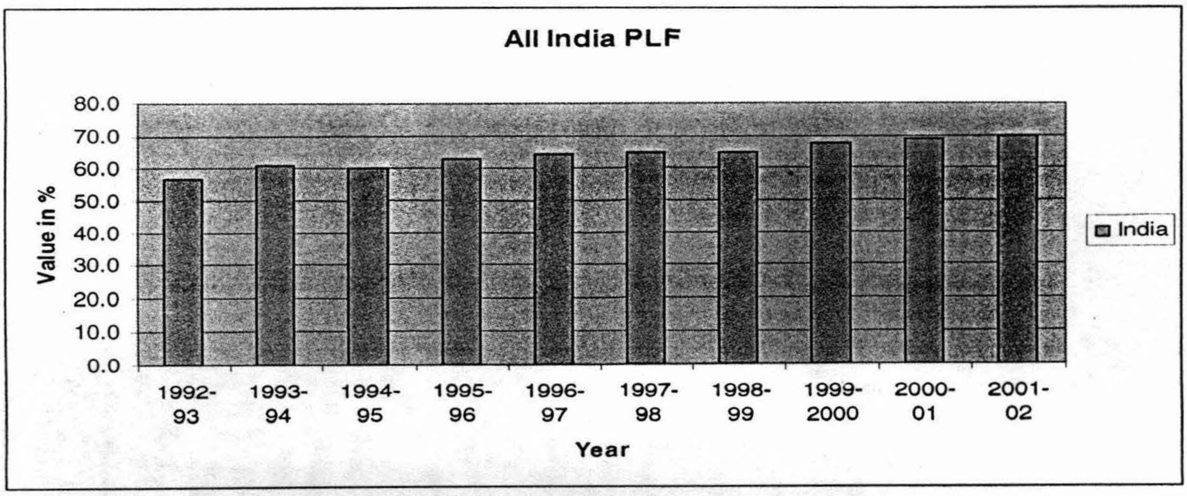
Chart 2.5



Source: Data Collected from Planning Commission, 2002.

It is clear from the above graph that while the average PLF for the Central and Private Sectors has been higher than that of the State Sector, it is the State Sector that has registered maximum improvement in the PLF since 1992-93.

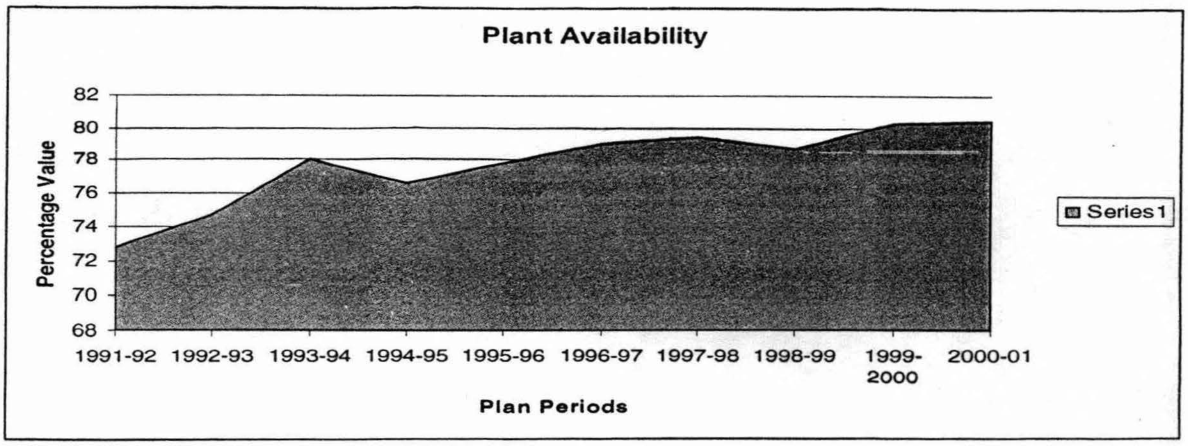
Chart 2.6



Source: Data Collected from Planning Commission, 2002.

The Trend in All India average PLF is slightly in upward direction. That means it does not increase much more from 1992 to 2002.

Chart 2.7



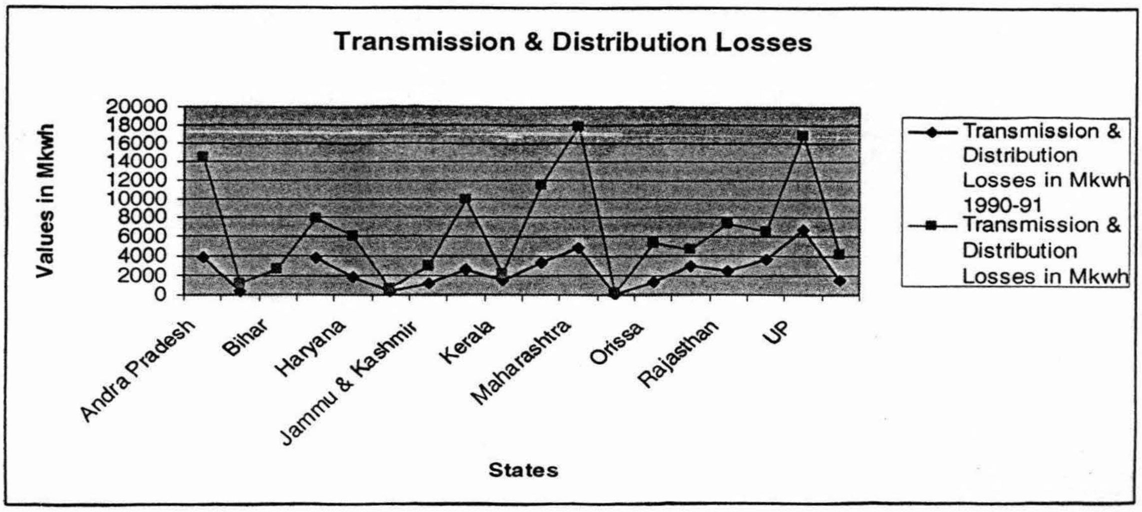
Source: Data Collected from Planning Commission, 2002.

With the continued emphasis on better utilization of the existing assets, there has been a drastic improvement in the all India average PLF in recent years; currently it is around 69.9 %. Significant improvement in the PLF has been due to successful Research and Modernization (R &M) Programmes taken up by some of the states. The low PLF could be attributed to inappropriate quality of the coal, size of units, equipment deficiency and failure of the units due to low demand.

e. Transmission and Distribution Losses:

Government of India realized that there is inadequate investment in transmission and distribution network. At present the reported Transmission and Distribution (T & D) Losses are very high in India compared to other countries although it is reported lower than the actual losses in different States in the country. The all India T& D losses as a percentage of availability have increased from 34% in 2001-02 to 38.3% in 2002-03. The unsatisfactory and deteriorating financial health of S E Bs has been a constraint not only for adding new capacity, improving the T&D system and carrying out renovation and modernizing programmes; but also for carrying out much needed reforms in electricity utilities[13]. The T&D losses increased from a level of 24.53% in 1996-97 to 27.8% in 2001-02 (May 02, P.C).

Chart 2.8



Source: Data Collected from Annual Report, 1993 and 2002.

The chart above, explained that the reforming States have started reporting higher and higher T & D losses. Orissa, Andhra Pradesh, Haryana, Karnataka, West Bengal, Uttar Pradesh and Rajasthan have reported much higher T & D losses after the start of Power Sector Reforms. It may be because of forced under estimation by some SEBs, un metered supply of electricity in the agriculture sector and domestic sector and technological deficiency in the measurement of Transmission and Distribution Losses.

[13] **Annual Report, Working Group of State Electricity Board 2002**

Table 2.4: Electricity Generated, Distributed sold and Lost in India

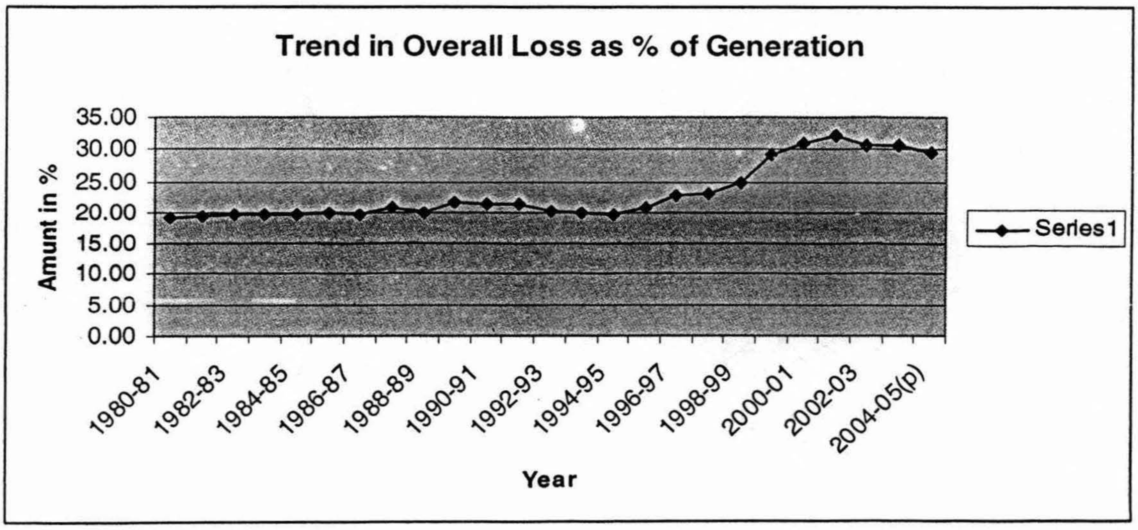
(Units: Giga watt Hour)

Year	Gross Electricity Generated from Utilities	Consumption in Power Station Auxiliaries	Net Electricity Generated from Utilities	Purchases from Non-Utilities + Imported from Other Countries	Net Electricity Available for Supply	Sold to Ultimate Consumrs & Other Countries	Loss
1	2	3	4=2-3	5	6=4+5	7	8=6-7
1980-81	110,844	7,230	103,614	120	103,734	82,367	21,367
1981-82	122,101	8,287	113,814	114	113,928	90,245	23,683
1982-83	130,264	9,029	121,235	70	121,305	95,667	25,638
1983-84	140,177	10,142	130,035	87	130,122	102,433	27,689
1984-85	156,859	11,650	145,209	184	145,393	114,179	31,214
1985-86	170,350	13,157	157,193	107	157,300	123,106	34,194
1986-87	187,713	14,704	173,009	316	173,325	136,129	37,196
1987-88	202,093	16,317	185,776	2,097	187,873	145,643	42,230
1988-89	221,382	17,185	204,197	1,745	205,942	161,436	44,506
1989-90	245,438	18,674	226,764	2,020	228,784	175,524	53,260
1990-91	264,329	19,604	244,725	2,216	246,941	190,420	56,521
1991-92	287,029	21,011	266,018	3,118	269,136	207,698	61,438
1992-93	301,362	22,060	279,302	3,082	282,384	220,819	61,565
1993-94	324,050	23,670	300,380	3,301	303,681	238,670	65,011
1994-95	350,490	24,795	325,695	3,560	329,255	259,687	69,568
1995-96	379,877	27,220	352,657	3,784	356,441	277,078	79,363
1996-97	395,890	28,805	367,085	4,310	371,395	280,290	91,105
1997-98	421,747	30,684	391,063	3,926	394,989	297,070	97,919
1998-99	448,535	31,423	417,112	4,367	421,479	310,004	111,475
1999-00	481,055	32,889	448,166	5,039	453,205	313,042	140,163
2000-01	501,204	34,932	466,272	5,596	471,868	316,795	155,073
2001-02	517,439	36,606	480,833	7,969	488,802	322,691	166,111
2002-03	532,693	38,256	494,437	8,219	502,656	339,773	162,883
2003-04	565,102	39,801	525,301	9,730	535,031	360,996	174,035
2004-05(p)	594,456	41,590	552,866	8,843	561,709	386,174	175,535

Source: Central Electricity Authority, (p) - Provisional

The actual loss of electricity is the overall loss in the process from generation in the plants to use by the final consumers. The table 4 above depicts the overall electricity generated, distributed, sold to ultimate consumers and the estimated loss from the process over 1980-81 to 2004-05. The data reveals that the loss increased drastically from the year 1998-99, after the initiation of Power Sector Reforms in the States (see also chart 1.9).

Chart 2.9



Source: **Data Collected from Central Electricity Authority,**

The actual power supply position as on March 2002, an assessment by CEA, indicates a peak deficit of 12.6% and energy deficit of 7.5% at all India level as against a peak deficit of 18% and energy deficit of 11.5% during 1996-97. The per capita electricity consumption of India was 355 KWH during 1999-2000 as against 334 KWH in 1996-97, where as in China it was 719 KWH during 1997.

B. Financial Performances:

The problematic issue in the electricity sector had been unsatisfactory performance of the S E Bs for a very long period. The unit cost of supply of electricity represents the cost incurred by the utility to supply electricity to ultimate consumers. It has been progressively increasing over the years. The components are the cost of fuel, O&M expenditure, establishment & administration cost, interest payment liability, depreciation and cost of power purchase. During the last one decade, the increase in the unit cost of supply has been steep and reached the level of 327 Paise per unit in 2000-01 as compared to 108.6 Paise/ KWH in 1990-91.

a. Average Cost:

Cost of power supply represents the cost incurred by utilities to supply electricity to the ultimate consumers. It includes the cost of fuel, operation and maintenance expenditure, establishment and admission cost, interest payment liability, depreciation and cost of power purchase. The components of the cost of supply for the years 1997-98 and 2001-02 are given below in unit cost form.

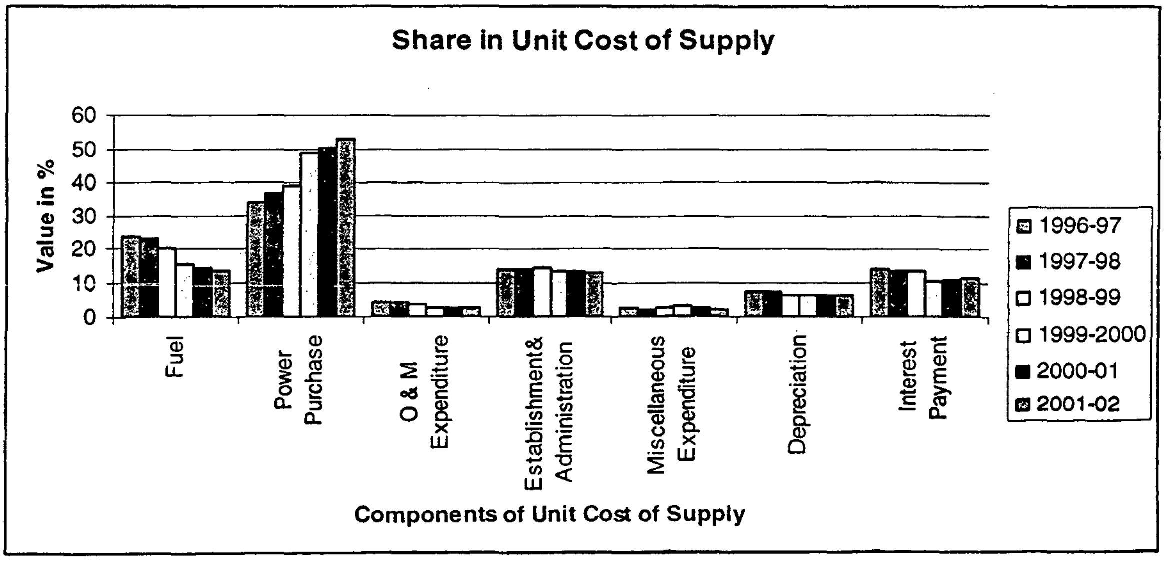
Table 2.5: Unit Cost of Power Supply

Components	1997-98 (Actual)	2001-02(AP)
Fuel	55.26	45.84
Power Purchase	87.2	185.05
O & M Expenditure	9.84	9.1
Establishment& Administration	32.6	44.4
Miscellaneous Expenditure	5.22	6.35
Depreciation	18.53	21.08
Interest Payment	31.09	38.03
Total	239.73	349.85

Source: Planning Commission, New Delhi

All these components are taken into account in the unit cost of supply. The expenditure on fuel in total cost of supply has started declining after beginning of reforms and restructuring process in the Power Sector.

Chart 2.10



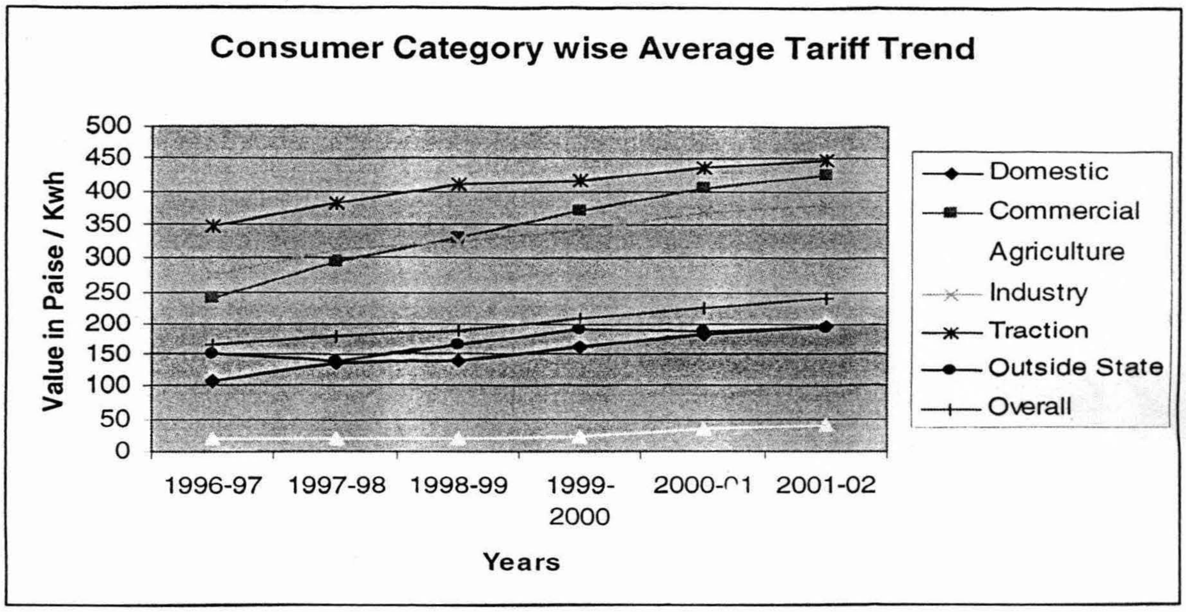
Source: Data Collected from Planning Commission, Various Years.

The expenditure on fuel is dependent on the specific consumption of coal, oil and the transportation cost. The cost of coal per unit of generation of electricity has increased from 53.4 Paise/ KWH in 1992-93 to 100.3 Paise/ KWH in 2000-01 (RE). This is mainly, because of higher transportation cost for carrying coal to the states. The cost of secondary oil increased from 3.7 Paise/ KWH in 1992-93 to 6.8 Paise/ KWH in 1995-96 and then declined to 4.3 Paise/ KWH in 2001-02. This could be because of specific R & M Programmes, better maintenance and higher level of Plant utilization. The share of expenditure on purchase of has been increasing since the reforms of S E Bs. The cost of purchase as a proportion of average unit cost increased from 27.9 % in 1992-93 to nearly 52.9 % in 2001-02. The share of O & M Expenditure in the average unit cost of supply has been declining. Establishment and Administration charges comprise mainly the wages and salaries of the staff and pension payments. It has declined from 15.2 % in 1992-93 to 12.9 % in 1995-96 and then increased to 14 % in 1998-99. This is partly due to revision of pay scales after the Fifth Pay Commission Award. Since 1999-2000 the share of Establishment and Administration Expenditure has again started declining. This decline could be because of improved productivity in terms of improvement in number of employees. The share of depreciation and interest payments, in average cost of supply declined from 25 % in 1992-93 to 18 % in 2000-01.

b. Average Tariff:

The tariff charged by the utilities to the ultimate consumers is called Average Tariff. Average tariff has increased substantially during the past few years. The average tariff has been observed, particularly, from the early 90s.

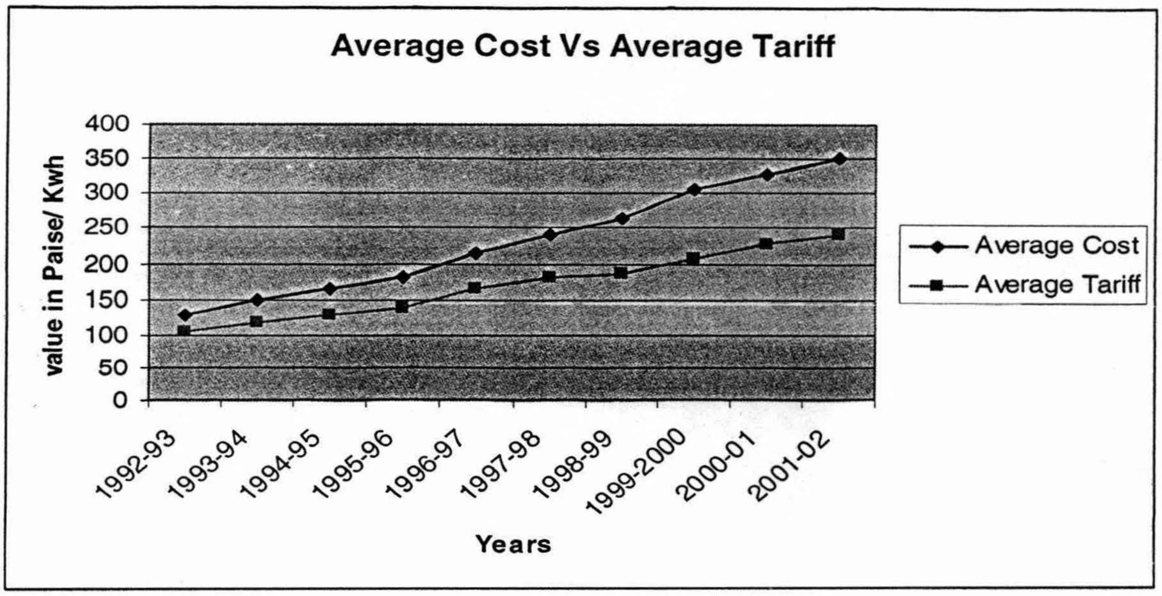
Chart 2.11



Source: Data Collected from Annual Report, SEBs, 2002.

A sharp increase in the average tariff has been observed since 1996-97. Average tariff charged in the Agricultural Sector and Domestic Sector is significantly lower than that of Overall average. Again, in the Commercial Sector and Railway Traction the average tariff is charged at significantly higher rates than the average cost of supply.

Chart 2.12



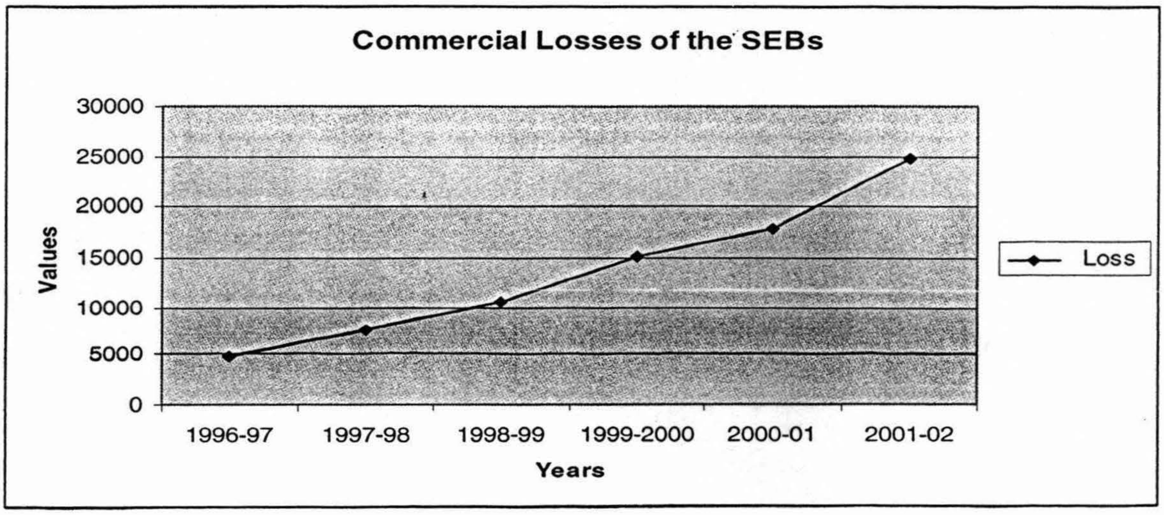
Source: Data Collected from Planning Commission, 2002.

Though the average tariff has increased substantially during the past few years, the rise has not been commensurate with the increase in the cost of supply. As a result, the gap between the cost of supply and the average tariff has been widening over the years. State Government should take policy initiatives to reduce the gap between the cost of supply and average tariff.

c. Commercial Losses

The commercial loss of the Electricity Board is the gap between the total revenue receivables and total expenditure in a given year. The total revenue includes subvention given by the State Government in lieu of subsidized power supplies to the Domestic and Agricultural Sectors. The total expenditure includes payments towards depreciation and interest payable to State Government as well as financial institutions.

Chart 2.13



Source: Data Collected from Planning Commission, Various years.

The above chart reflects the sharp increase in commercial losses of the State Electricity Boards. It depends largely on the effective subsidies incurred towards sales to Agriculture and Domestic Sectors, efforts to neutralize them through cross subsidization and the level of subventions provided by the State Governments.

d. Subsidy

Gross subsidy on the Electricity sales has been increasing over the years because of the policy of some states to provide electricity at subsidized rates to the agriculture and domestic consumers. The gross subsidy on agriculture, domestic and inter-state sales is likely to increase from a level of Rs. 7449 Crore in 1991-92 to Rs. 43060.10 Crore in 2001-02 (AP).

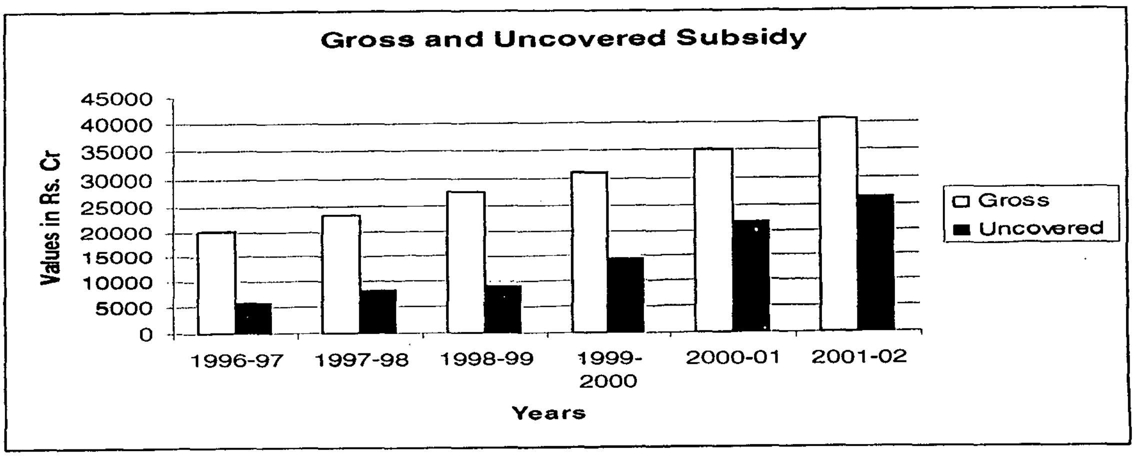
Table 2.6: Subsidy for Agriculture and Domestic Sector and Uncovered Subsidy (Rs. Cr)

Year	Agriculture	Domestic	Inter State Sale	Gross	Subvention received from States	Net Subsidy	Surplus from other Sector	Uncovered
1996-97	15585.2	4386.01	238.75	20210	6630.6	13579.4	7774.33	5805.03
1997-98	17706.67	5258.43	457.13	23422.2	6364.75	17057.5	9010.87	8046.61
1998-99	20693.87	6332.48	455.88	27482.2	10351.55	17130.7	8345.26	8785.42
1999-2000	22508.61	8121.11	373.56	31003.3	11264.53	19738.8	5307.06	14431.69
2000-01	24699.18	10036.1	344.6	35079.9	7465.33	27614.5	5747.23	21867.29
2001-02	28123.27	12238.5	359.81	40721.6	8339.62	32382	5743.55	26638.42

Source: Annual Report, 2002

Net subsidy on account of sales to agriculture and domestic consumers was Rs. 54.4 Crore in 1991-92, which works out 46 % of Normal Central Assistance to the states and U Ts (Rs. 11749 Crore) to the states in that year. This increased to s. 34735.93 crore in 2001-01 (AP), which could be 71.02 % of Normal Central Plan Assistance (Rs. 48905.63 Crore) to the States.

Chart 2.14



Even if we considered Rs. 5759.01 Crore surplus generated by the S E Bs by the way of cross subsidization from other sectors, the uncovered subsidy will be of the order of Rs. 28976.92 Crore for the year 2001-02.

e. Rate of Return:

According to Electricity Supply Act, the SEBs are required to earn a minimum rate of return of 3 percent on their net fixed assets in service after making provision for depreciation and interest charges. But, average tariff has increased from a level of 165.3 paisa in 2001-02. Gross subsidy for domestic, agriculture and inter state sale has increased from a level of RS. 20210 Crore in 1996 to RS. 43060.1 Crore in 2001-02. The pattern of sales to various consumers has undergone significant changes in the last ten years and there has been a general deterioration in rate of return of the S E Bs (without Subsidy) from (-) 12.7 % in 1992-93 to (-) 44.1 % in 2001-01. Though subvention was received from the states to improve the rate of return, it still remains negative.

Table 2.7: Rate of Return on Capital (%)

Year	With Subsidy	Without Subsidy
1992-93	- 7.6	-12.7
1993-94	-6.6	-12.3
1994-95	-5.7	-13.1
1995-96	-2.2	-16.4
1996-97	-8.0	-19.6
1997-98	-12.5	-22.9
1998-99	-17.2	-34.2
1999-2000 (p)	-24.7	-43.1
2000-01 (RE)	-27.5	-39.1
2001-02 (AP)	-33.0	-44.1

Source: Planning Commission, New Delhi.

If the suggested national minimum agricultural tariff of 50 paise/ Kwh had been implemented by all S E Bs, the ROR would still be -38 % in 2001-01. For S E Bs to achieve financial brake-even, they have to mobilize substantial revenue. From the above observation it can be stated that the financial position of the S E Bs has deteriorated over the years.

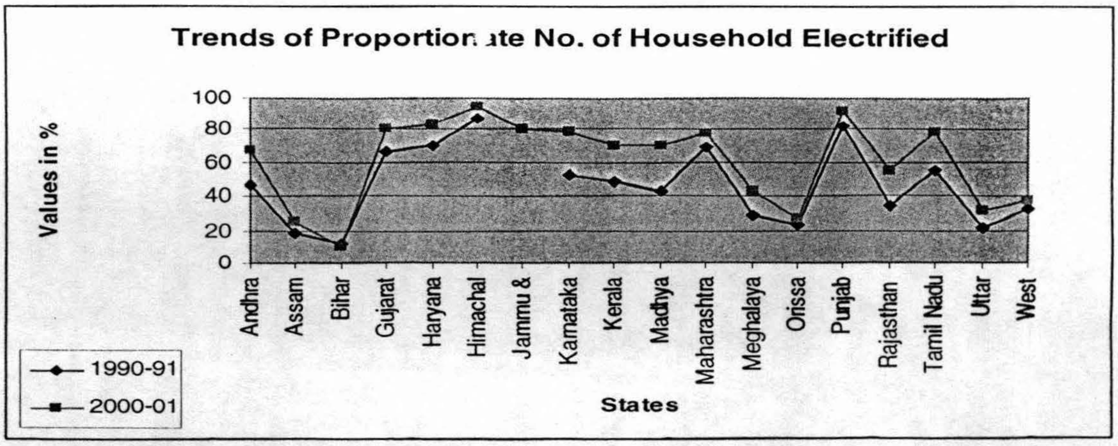
f. State Electricity Duty:

The State Electricity Duty Constitutes an important source of revenue in some States. The State Electricity Duty collection increased from Rs. 1131 Crore in 1992-93 to about Rs. 3135 crore in 2000-01 (RE).

C. Rural Electrification:

As per the present estimates, around 80000 villages in the country are yet to be electrified in the basis of current definition of village electrification. The villages yet to be electrified are mostly located in Assam, Bihar, Jharkhand, Madhya Pradesh, Arunachal Pradesh, Orissa, Uttar Pradesh, Rajasthan, West Bengal and Uttaranchal.

Chart 2.15:



Source: Teri Data Directory Year book, 2003-04

The Tenth Plan proposes to cover all 62000 villages that can be electrified by grid extension. The balance 18000 remote villages are to be electrified by 2011-12 through use of non conventional technologies. According to 1991 census the total number of villages electrified in States is 586165 and in Union Territories 1093, where as cumulative account on 03, 2002 shows that the total number of villages electrified in States, is 507773 and in Union, it is 1090. During 2002-03, 2626 villages were electrified. On the regional basis, the southern region top with 99.6 % of villages electrified followed by the western region 97.7 %, eastern region 76.7 %, northern region 76.2 % and north-eastern region 74.4 %. As regard electrification of tribal villages, out of a total 107045 tribal villages in the country, 82976 (provisional) villages and 301019 villages Harijan basis have been electrified (as on March 31, 2004). Various Schemes initiated by the GOI to promote rural electrification viz. Kutir Jyoti Scheme in 1988-89, PMGY (Pradhan Mantri Gramodaya Yojana) in 2001-02, Minimum Needs Programmes in 2004, REST (Rural Electricity Supply Technology Mission) in 2002.

D. Table 2.8: Current Report for Power Sector "ALL INDIA":

The current status of the important indicators is listed below.

I. Total Installed Capacity **Data reported on 31st January, 2006**

Sector	MW	%age
State Sector	70,572	57
Central Sector	39,909	32.2
Private Sector	13,420	10.8
Total	1,23,901	

Fuel		MW	%age
Total Thermal		82,298	66.4
	Coal	68,433	55.2
	Gas	12,663	10.2
	Oil	1,202	1
Hydro		32,135	26
Nuclear		3,310	2.7
Renewable		6,158	4.9
Total		123,901	

II. High Voltage Transmission Capacity:

Capacity	MVA	Circuit KM
765/800 KV	--	1,323
400 KV	76,010	63,129
220 KV	1,42,242	1,07,625
HVDC	3,000	5,876

MVA means mega Voltage Ampere

III. Per Capita Consumption of Electricity:

Year 2004-05	606 KWH / Year

IV. Rural Electrification

No. of Villages (Census 1991)	593,732
Villages Electrified (31st March 2004)	474,982
Electrification %age	80%
Rural Households (Census 2001)	138,271,559
Having access	60,180,685
Electrification %age	44%

V. Power Situation: (April 2005-January 2006)

	Demand	Met	Surplus/ Deficit
Energy	521,872 MU	480,242 MU	-8.00%
Peak Demand	91,187550 MW	80,631 MW	-11.60%

Source: http//:powermin.nic.in

E. Policy Initiatives:

In order to improve investments into the power sector, especially from private players, the government has undertaken a number of policy initiatives[14]. Some of the major initiatives include:

1 Private player both domestic and foreign is allowed to set up power generation facilities (with the exception of nuclear fuel) without restriction on capacities.

[14] **Source: Ministry of Power (http//:powermin.nic.in)**

2. Private participation has been permitted both in transmission and distribution. Private players can construct, operate and maintain transmission lines. However, the lines need to be under the supervision and control of the central or state transmission utility.

3. Private transmission facilities may either take the form of an independent power transmission company or a joint venture with the state-owned transmission utilities.

4. There are no ceilings on foreign direct investment limits in either power generation, transmission or distribution projects.

5. The government is seeking significant reforms in this sector and has introduced a new electricity bill in the parliament.

6. Government intervention has been minimized and an independent central regulatory authority has been set up to review the electricity tariff and other related issues. Several states have also set up electricity regulators.

7. Measures to stop theft of power and to reduce transmission and distribution losses are being planned to improve the revenue generation of the state electricity boards (SEBs), which are the main suppliers of power to consumers. Reforms have been initiated to allow for state level tariff rationalization.

8. The government has adopted a new Programme – the Accelerated Power Development Programme (APDP) through which it will provide funds to state electricity boards for renovation and modernization of older power projects. The government has allocated US$ 150 million for this purpose.
9. Many states have formulated Captive Power Policy in order to support their domestic industries.

F. **Reforms in Power Sector:**

In 1993, a new World Bank policy explicitly required countries to encourage private investment, corporatise state agencies establish independent regulators as conditions of continued funding[15]. This new policy all but foreclosed the option of fixing public power. Reforms in the industrialized world took place in the context of well functioning electricity systems providing reliable power to all in a financially viable basis[16]. By contrast, the developing world faced quite different problems: public debt in Latin America, capacity shortfalls in Asia and crumbling facilities and mismanagement in many different countries[17]. Power Sector Reforms had been in vogue in many countries.

The reforms process in India has started in 1991. During the reform period, some major policy decisions were taken by the Government in order to accelerate the growth of Power Sector. The sole objective in launching of the Power Sector Reforms was to mobilize private sector for power generating capacity addition. Government of India (GOI) enacted Electricity Regulatory Commission Act, 1998 for setting up of independent regulatory bodies, Viz. State Electricity Regulatory Commission (SERC), at the State level and Central Electricity Regulatory Commission (CERC) at the central level. The goal of restructuring of power sector is to make the basic components of the supply chain (generation, transmission and distribution) as viable entities to enhance efficiency. The response of the Private Sector was encouraging and a number of independent Power Producers came forward for participation in the process of electricity generation, transmission and distribution. Hence it was realized by the GOI that in order to get adequate private investment in the Electricity Sector, Power Sector Reforms are essential. Recognizing this, Government enacted the Electricity Act and further reforms were introduced restoration of financial health of SEBs. Under the '*New Electricity Act-2003*', enacted by the Government of India, all states were required to unbundle their SEBs by 10th June 2004.

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[15] **World Bank, 1993.**
[16] **Dubash, 2002; Willam and Dubash, 2004.**
[17] **Dubash 2002; Willam and Dubash, 2004; Karkezi and Kimani 2002.**

In some states, this became a debatable issue and created technical, financial as well as administrative problems. But, afterwards it was seen that reforms were woefully short of expectation. "*...implementation of reforms will be more based on ideology and economic theory rather than economic evidence*"[18].

The main reason of this shortfall in capacity addition of private sector in power generation is delay in financial closure of the project and absence of adequate arrangements for ensuring payment security due to financial position of most of the S E Bs. Under the present structure, the private producers' security package is crucial for success of reform process. The private producers demanded a guarantee from the concerned State Government and counter guarantee from Central Government for timely payment to them, in case Electricity Boards fail to provide payment to them for the power purchases from the Boards. For comparative analysis of the performance of State Electricity Sector we need to know the present condition of the States on the eve of reforms and after the initiation of power sector reforms.

G. The following table provides the information of the Stand of the States individually for power sector reforms.

Table 2.9: Status of the States in Reforms of Power Sector:

State	Status of Reform
Andhra Pradesh	SERC constituted, functional and two tariff orders issued, reform law enacted, S E B unbundled, distribution privatization strategy has been finalized, MOU signed with GOI.
Assam	Single member SERC constituted, MOU signed with GOI.
Bihar	MOU signed, tariff revised by SEB.
Delhi (DVB)	SERC constituted, functional, first tariff order issued, reform law enacted, committed to distribution privatization, REP for distribution privatization issued.

[18] **Jamasb etal 2005.**

Gujarat	SERC constituted, functional, first tariff order issued, reform law approved by the GOI and introduced in State Assembly, MOU signed.
Haryana	SERC constituted, functional, first tariff order issued, reform law approved by the GOI and introduced in State Assembly, MOU signed.
Himachal Pradesh	One member HPSERC constituted, first tariff order issued, MOU signed.
Jammu Kashmir	Appointed Administrative Staff College of India as consultant of conducting reform studies, reform law approved
Karnataka	SERC constituted, functional, first tariff order issued, reform law approved by the GOI and introduced SEB unbundled, MOU signed, distribution privatization completed by Dec 2001.
Kerala	SERC constituted, MOU signed.
Madhya Pradesh	SERC constituted, functional, first tariff order issued, MOU signed.
Maharashtra	SERC constituted, functional, Two tariff order issued, reform law approved by the GOI and introduced in State Assembly, MOU signed.
Meghalaya	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Orissa	SERC constituted, functional, Four tariff order issued, reform law approved by the GOI SEB unbundled, distribution privatized, MOU signed.
Punjab	SERC constituted.
Rajasthan	SERC constituted, functional, first tariff order issued, reform law approved by the GOI, MOU signed.
Tamil Nadu	SERC constituted, MOU signed.

Uttar Pradesh	MOU signed.
West Bengal	SERC constituted, functional, first tariff order issued, reform law approved by the GOI and introduced in State Assembly, MOU signed.
Meghalaya	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Manipur	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Mizoram	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Nagaland	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Sikkim	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Tripura	Have shown willingness to constitute Joint Electricity Regulatory Commission.
Uttaranchal	MOU signed with GOI.
Chattisgarh	MOU signed with Madhya Pradesh
Arunachal Pradesh	SERC notified yet to be constituted.

An expert group under the chairmanship of Montek Singh Ahliwalia, was constituted to address the issue of the SEBs. This group recommended a scheme for one-time settlement of dues payable by the SEBs to the CPSUs (Central Public Sector Undertakings) and the railways. The recommendations were accepted by the GOI. All the State Government signed the tripartite agreement envisaged under the scheme. The APDP (Accelerated Power Development Programme) was launched by the MOP

(Ministry of Power) in 2000-01. The APDP provided financial assistance to the States for undertaking renovation & modernization programmes. The APDP was renamed as the APDRP in 2002.

Conclusion:

This Chapter traced some trends in the Indian electricity sector over the last few decades. Prior to mid seventies, State Electricity Boards were mainly responsible for the growth of Power Sector in India with the only exception of small contribution from private enterprises and the captive power plants owned and operated by the industrial units primarily to cater to their own needs. The major problems faced by almost all State Electricity Boards in India for last two decades are

1. improper tariff structure not based on any economic principles;
2. subsidization;
3. un remunerative tariffs charged by SEBs from the agriculture and domestic sectors;
4. high Transmission & Distribution Losses coupled with mounting power pilferage component.

The State power utilities have indeed provided a yeoman service in taking the electricity to remote areas of the country. Yet there are large scope for improvement in the performance of SEBs both technical and financial parameters. Having recognized the importance of electricity as a prerequisite for development, Indian Planners placed considerable emphasis on adequate investments on power development in successive five year plans. This explains the progress made by the electricity industry in India during the last four and a half decades. The SEBs rate of return had been negative. The poor financial performance of SEBs had led to reduced access to market borrowings and their inability to utilize multilateral and bilateral assistance. The SEBs does not have enough

resources to finance future programmes of electricity generation, transmission and distribution. Economic reforms were initiated from 1991.
The basic components of the State Power Sector Reforms are the following;

a) Setting up of Electricity Regulatory Commissions.

b) Unbundling of State Electricity Board into separate entities dealing with generation, transmission and distribution.

c) To encourage private sector participation in electricity generation, transmission and distribution.

The process of reforms cannot achieve the desired results overnight, nor can change be brought about overnight. The success of the reform process depends on its acceptance by all stakeholders including consumers, employees and investors. Power Sector Reforms had been in vogue in many countries of world both developing and developed. Power Sector Reforms started in our country in June 1991. Despite large investment in the power sector over a couple of decades of planned development, there has been a persistence shortage of electricity in our country. A number of private sector entrepreneurs showed overwhelming interest in setting up generating units where the main objective of the reforms is to mobilize resources from private sector for speedy Power Sector development. The Power Sector Reforms Programme requires assistance and long term commitments to ensure that the sector ceases to be a huge drain on the resources of the Government and ultimately it is able to finance itself.

Chapter III

Decomposition analysis of Electricity Consumption: State wise assessment in India

A. Introduction:

Power generation and capacity expansion have always been the essential requirements for the power sector and for economic growth of the country. As seen in the second chapter the pattern of sales to various consumer categories has undergone significant changes in the last few years in India. The country experienced that the share of domestic and agricultural sectors in the total sales increased from 39% in 1989-90 to nearly 50%in 2001-02, whereas the share of industry declined from over 50% to about 30% in the same period (Planning Commission, 2002). This has adversely affected the profitability of the State Electricity Boards (SEBs) because the tariff charged from agriculture and domestic sectors is lower than the cost of supply of electricity. The policy of the State Governments over the years to provide subsidized power supplies to domestic and agricultural consumers has been increasing the gap between the average tariff and the cost of supply and as a increased the commercial losses of the SEB s, which can not be sustained any further. There are large inter state variations in the sectoral consumption of electricity. This inter state disparities in consumer category wise sale of electricity arise mainly due to three factors, viz. change in total production of the economy (Scale effect), structural composition of the sectors (Structural effect), technical efficiency (Intensity effect). Since a well-managed and adequate supply of electrical power enhances the economic activities of a country, our attempt is to gather sufficient information regarding the relative change in scale of the economy, structural composition and technical efficiency in the increasing level of consumption of electrical power for the States in India to reduce the problems of inefficient management of electricity supply by states. Sectoral disaggregation in the demand analysis required to promote efficiency, and safety in the allocation of electricity to the states.

In this chapter the relative contributions of the Scale effect, Structural effect and Intensity effect in the total change of electricity consumption have been estimated individually in the major 18 states in India using Period wise Decomposition analysis. The process of restructuring of the SEBs has been started in late 90s in several states in India. The SEBs should function on sound reform principle to become financially viable and generate internal resources for development. In order to get the reform effect we have applied the decomposition method for estimating three said effects for two bench mark periods, early 1990s and late 1990s. The Sectoral disaggregation in the demand analysis is necessary to promote efficiency, and safety in the allocation of electricity to the states.

B. Methodology:

The energy crisis in the 1970s and the unprecedented high levels of energy prices, which had detrimental effect on growth, called for implementation of energy conservation processes. Since the end of 1970s, there has been fairly extensive empirical research interest on energy consumption and economic growth, with neither conclusive results nor persuasive explanations. It is often debated how the total quantity of energy resources produced or consumed in a nation or region should be measured for use as a variable in the economic models. In economic models, the aggregate consumption of energy resources is normally expressed either in terms of total heating value or in terms of its economic value (*Divisia Indices or Expenditure*). Divisia method is, basically, an important statistical tool for disaggregation or decomposition of the energy demand.

Beginning with Berndt (1985), many economists have suggested Divisia Energy Aggregates which combines different resources based on their economic value. Zarnikau et al. (1996) trace the micro-economic foundations of the divisia energy aggregate and discusses how the form value attributes of different energy resources are reflected in divisia aggregation approaches. Hong (1983) demonstrated how the divisia and heating value indices lead to very different conclusions regarding trend in energy-output ratios for the US economy. Nguyen and Andrews (1989) showed the superiority of divisia aggregates in estimating elasticity of demand for factor inputs in the manufacturing sector in US economy. Arising from the fact that divisia index is a generally expressed economic index as pointed out in Vogt; Liu et al (1978) have proposed two general Parametric Divisia Methods through transforming the integral path problem in this index into a parameter estimation problem. A number of studies in energy economics have examined and used some methods of decomposition analysis.

In India not much attention has been devoted to investigate the analysis of energy use. Paul and Bhattacharya (2004) identified the factors influencing the sectoral changes in GHG emissions, particularly, CO_2 using complete decomposition technique.

Parametric Divisia Method (PDM) has now been widely accepted as a useful tool in energy demand analysis. The divisia index has number of desirable properties. It can be measured in any unit. It is useful for time series data as well as period wise data. It also permits the development of energy aggregate when relevant production function is not known. Being able to disaggregate total energy demand into components suitable to specific end uses provides useful information and represents a primary input into any attempt to stimulate the impact of policies aimed at encouraging consumers to use less energy.

Following the complete decomposition method, in the present study, we take a fresh look at the state wise variations of the effects of volume of production change, change in sectoral composition and change in actual intensity in use of electricity among the sectors in the State wise total consumption of electricity in India. The basic methodology involves the decomposition of either energy consumption or aggregate energy intensity (i.e. ratio of total energy use to sectoral output) into two or more distinct components. We shall call the former the '*energy consumption*' approach and the latter '*energy intensity*' approach. This decomposition study is based on what we shall call 'Period Wise Decomposition'. The study is useful for understanding the methods of decomposition analysis to explore, among others, the relative contribution of different factors affecting the changes in energy consumption. This involves the electricity consumption data for three benchmark years, 1990-91, 1995-96 and 2000-01.

Our empirical work considers two specific decomposition methods as follows –

1. ***Laspeyres-based Parametric Divisia Method (LAS-PDM)***: A special case of Parametric Divisia Method where the values of the parameters are assigned as '0' to the appropriate variables in both initial and terminal periods as in the 'Laspeyres indices'.

2. ***Simple Average Parametric Divisia Methods (AVE-PDM)***: *Boyd e.t .al* proposed this method such that an equal weight of 0.5 is assigned to the appropriate variables in the years, '0' and 't'.

The formulation of some specific methods in each approach is discussed in *Ang* (1993), *Ang* and *Lee* (1994). An outline of some decomposition methods used in the literature is given below.

Decomposition method has been proposed by *Boyd et. a l*(1988), *Park* (1992) and *Reitler* et al (1987) as:

Let E_0, E_1, E_2 denotes the total energy consumption of the years 1990-91, 1995-96, and 2000-01.

The year wise change in energy consumption,

$$\Delta E_t = \Delta E_{pt} + \Delta E_{st} + \Delta E_{it} + D \qquad (1)$$

Where the four terms in right hand side of the equation (1) are changes in energy consumption arising from aggregate production (ΔE_{pt}) i.e. production effect, structural effect (ΔE_{st}) and energy intensity effect (ΔE_{it}) and a residual term (D) . Divisia index is a generally expressed economic index by which we can see the decomposition effect of overall energy change. Here Divisia Index can be measured by the following variables:

E_K = total energy consumption for k^{th} state

$E_{j,k}$ = energy consumption in sector j

Y_k = total GSDP for state k

$Y_{j,k}$ = production or output of sector j

$S_{j,k}$ = production share of sector j (= $Y_{j,k} / Y_k$)

I_k = aggregate energy intensity (= E_k / Y_k)

$I_{j,k}$ = energy intensity for sector j (= $E_{j,k} / Y_{j,k}$)

Where 'j' belongs to commercial sector 'c', agriculture sector 'a', industrial sector 'i', railway sector 'r'.

The decomposition formulae for the Parametric Divisia Methods, referred to as following two methods:

1. $\Delta E\ pt = [E_0 + \alpha (E_t - E_0)] \ln (Y_t / Y_0)$ (2)

   $\Delta E\ st = \sum [E_{j,0} + \beta (E_{j,t} - E_{j,0})] \ln (S_{j,t} / S_{j,0})$ (3)

   $\Delta E\ it = \sum [E_{j,0} + \Upsilon (E_{j,t} - E_{j,0})] \ln (I_{j,t} / I_{j,0})$ (4)

2. $\Delta E\ pt = [I_0 + \alpha (I_t - I_0)] (Y t - Y0)$ (5)

   $\Delta E\ st = \sum [I_{j,0} + \beta (I_{j,t} - I_{j,0})] (S_{j,t} - S_{j,0})$ (6)

   $\Delta E\ it = \sum [Y_{j,0} + \Upsilon (Y_{j,t} - Y_{j,0})] (I_{j,t} - I_{j,0})$ (7)

Where $0 \leq \alpha, \beta, \Upsilon \leq 1$ and sum are taken respect of I and over all level of energy consumption is disaggregated form in the various sectors like agriculture, industry, service. In our study data are available at discrete form in time and integral path is undefined. As a result the analysis needs some assumptions about the value of the parameters. For instance, $\alpha = \beta = \Upsilon = 0$ is Laspeyres's Indices, $\alpha = \beta = \Upsilon = 1$ is Paache's, and $\alpha = \beta = \Upsilon = 0.5$ Marshall- Edworth Indices. We consider four specific decomposition methods proposed by many researchers as follows:

Absolute Consumption approach:

1. Laspeyres-based Parametric Divisia Method (LAS-PDM 1) :

   $\Delta E\ pt = E_0 \ln (Y_t / Y_0)$

   $\Delta E\ st = \sum E_{j,0} \ln (S_{j,t} / S_{j,0})$

   $\Delta E\ it = \sum E_{j,0} \ln (I_{j,t} / I_{j,0})$

   Here $\alpha = \beta = \delta = 0$.

2. Simple Average Parametric Divisia Methods (AVE-PDM 1):

   $\Delta E\ pt = 0.5 (E_t + E_0) \ln (Y_t / Y_0)$

   $\Delta E\ st = 0.5 \sum (E_{j,t} + E_{j,0})] \ln (S_{j,t} / S_{j,0})$

   $\Delta E\ it = 0.5 \sum (E_{j,t} - E_{j,0}) \ln (I_{j,t} / I_{j,0})$

   Here $\alpha = \beta = \delta = 0.5$. This method proposed by Boyd et al (1988).

Intensity of Sectoral Output approach:

3. Laspeyres-based Parametric Divisia Method (LAS-PDM 2):

   $\Delta E\ pt = \sum I_{j,0} Y_t\ S_{j,0} - E_0$

   $\Delta E\ st = \sum I_{j,0} Y_0 S_{j,t} - E_0$

   $\Delta E\ it = \sum I_{j,t} Y_0\ S_{j,0} - E_0$

   Here $\alpha = \beta = \delta = 0$.

   Park (1992) proposes this method.

4. Simple Average Parametric Divisia Methods (AVE-PDM 1):

   $\Delta E\ pt = 0.5\ (I_t + I_0)(Y\ t - Y_0)\ldots$

   $\Delta E\ st = 0.5\sum(I_{j,0}\ Y_0 + I_{j,t} Y\ t)(S_{j,t} - S_{j,o})$

   $\Delta E\ it = 0.5\sum(Y_{j,0} + Y_{j,t})(I_{j,t} - I_{j,0})$

   Here $\alpha = \beta = \delta = 0.5$.

This method is proposed by Reitler et al (1987). Generally, the analyst fixes parametric values.

We are using this above formulae to compare the estimated values of 'production effect', 'structural effect' and 'intensity effect' in the change of electricity consumption by the major states in India for periods, 1995-96 and 2000-01. In the two Laspeyres-based methods, each effect is isolated by measuring a change in energy consumption associated with a change in corresponding variable between year '0'and 't' while holding all the other variables constant at their respective values in the year '0' which is taken as the base year. In the two Simple-average based methods, no base year is specified and the mean values of relevant variables between year '0' and year't' are used in decomposition.

C. Data

Decomposition of electricity consumption is purely a statistical technique in energy demand analysis. Several methodological issues related to the technique of the decomposition analysis discussed in the past studies are special cases of two general parametric methods based on Divisia Index. The study is mainly for the determination of the impact of structural change (i.e shifts in the composition of the total production), change in aggregate production and intensity of the electricity used. Virtually all the decomposition analysis, using energy consumption approach, has been based on 'period wise' data. The basic methodology involves the decomposition of either energy consumption ('energy consumption approach') or aggregate energy intensity ('energy intensity approach').

Basically, the chapter tries to identify the relative contributions of the Production effect, Structural effect and Intensity effect of the change in electricity consumption by the major18 states (Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal) and then we try to compare the results for the period 1990-91 to 1995-96 and 1995-96 to 2000-01. Further, it attempts to rank the states according to their performances of relative contribution (ratio) of said three effects (production effect, structural effect and intensity effect) with respect to change (five year change) in total electricity consumption of the corresponding States for the respective periods.

It is a state wise sectoral analysis. Constrained by the availability of relevant data, our study is based on following assumptions:

- There are four Sectors –
    1. Commercial sector which is mainly referred to communication, hotel and trade services, banking and insurance and public administration.
    2. Agriculture sector.
    3. Industry sector which is referred to mining, manufacturing and construction.
    4. Transport sector, which is, here, only referred to railway traction.
- This is two-period analysis – early 1990s and late 1990s.
    1. In early 1990s we took 1995-96 as benchmark year and calculated 5 year change taking 1990-91 as base year.
    2. Similarly, in late 1990s, we took 2000-01 as benchmark year taking 1995-96 as base year.

Since it is demand side analysis, we have to leave domestic sector because it is generally used in the expenditure side estimation. So, we firstly, deduct the domestic sector's share in the total consumption for the adjustment of demand side analysis. As electricity is non-storable commodity, consumer category wise sale of electricity data originally published in the Annual Report of Working Group of SEB for three periods are readjusted and used as consumption data as shown in tables 2, 3 and 4.

Table 3.1: Consumption of Electricity in MKwh Unit for the Year 1990-91

States	Domestic E_{0d}	Commercial E_{0c}	Agriculture E_{0a}	Industry E_{0i}	Railway Traction E_{0r}	Total E_0	Total-Domestic $E_0 - E_{0d}$
Andhra Pradesh	2217	467	5237	7275	305	16144	13927
Assam	175	117	15	894	NA	1554	1379
Bihar	464	277	1544	2787	388	5716	5252
Gujarat	1519	NA	5069	6588	249	15857	14338
Haryana	982	165	2749	1700	NA	6772	5790
Himachal Pradesh	225	93	26	604	NA	1767	1542
Jammu Kashmir	378	236	147	360	NA	1490	1112
Karnataka	1741	228	3241	5829	NA	11355	9614
Kerala	1620	585	226	3003	NA	5739	4119
Madhya Pradesh	2592	476	1428	8177	613	15036	12444
Maharashtra	2852	677	5874	10790	345	28583	25731
Meghalaya	34	32	1	69	NA	361	327
Orissa	670	138	230	2839	222	4475	3805
Punjab	1591	380	5616	5165	NA	14050	12459
Rajasthan	1043	521	2784	3794	19	9140	8097
Tamil Nadu	2300	1350	3850	7254	295	16235	13935
Uttar Pradesh	2555	1474	7267	7295	842	20185	17630
West Bengal	750	310	520	1725	410	5981	5231

Source: Annual Report of Working Group of SEB, 'Consumer Category wise Sale of Electricity'

Note: '0' signifies the base year in the period early 1990s. $E_0 - E_d$ is final consumption after deducting domestic sector.

d for Domestic Sector, c for Commercial Sector, A for Agricultural Sector, i for Industrial Sector, r for Railway Traction.

Table 3.2: Consumption of Electricity in MKwh Unit for the Year 1995-96

States	Domestic E_{1d}	Commercial E_{1c}	Agriculture E_{1a}	Industry E_{1I}	Railway Traction E_{1r}	Total E_1	Total-Domestic $E_1 - E_{1d}$
Andhra Pradesh	3276	704	11399	6470	632	23562	20286
Assam	429	160	44	506	NA	1804	1375
Bihar	831	339	1268	3381	411	6544	5713
Gujarat	2176	601	10132	9109	331	24695	22519
Haryana	1637	258	3905	2017	90	8745	7108
Himachal Pradesh	387	112	12	968	NA	2647	2260
Jammu Kashmir	439	80	304	216	NA	1728	1289
Karnataka	2654	440	7363	4546	31	15984	13330
Kerala	2777	799	322	532	NA	7415	4638
Madhya Pradesh	3387	655	7982	7902	1083	22957	19570
Maharashtra	4424	979	13332	14870	821	41619	37195
Meghalaya	77	40	2	61	NA	510	433
Orissa	1047	273	175	2866	131	5179	4132
Punjab	2764	581	5868	6512	NA	16412	13648
Rajasthan	1961	685	4343	5127	180	13703	11742
Tamil Nadu	3924	1711	6631	9817	342	24610	20686
Uttar Pradesh	6148	2142	9843	6674	773	27107	20959
West Bengal	1612	691	1232	2124	466	8951	7339

Source: Annual Report of Working Group of SEB, 'Consumer Category wise Sale of Electricity'

Note: '1' signifies the terminal year in the period early 1990s and base year in late 1990s period. $E_1 - E_d$ is final consumption after deducting domestic sector.

d for Domestic Sector, c for Commercial Sector, A for Agricultural Sector, i for Industrial Sector, r for Railway Traction.

Table 3.3: Final Consumption of Electricity in MKwh Unit for the Year 2000-01

States	Domestic E_{2d}	Commercial E_{2c}	Agriculture E_{2a}	Industry E_{2I}	Railway Traction E_{2r}	Total E_2	Total-Domestic E_2- E_{2d}
Andhra Pradesh	6955	1291	11222	6786	937	28418	21463
Assam	648	170	49	287	0	1916	1268
Bihar	1068	428	1549	3759	710	7898	6830
Gujarat	3122	889	14507	9200	394	31435	28313
Hariana	2359	446	5171	2104	99	10958	8599
Himachal Pradesh	657	160	18	1225	0	3268	2611
Jammu Kashmir	1276	166	142	427	0	2812	1536
Karnataka	4120	1184	6457	3842	28	17276	13156
Kerala	4946	895	410	3767	19	10702	5756
Madhya Pradesh	3785	885	10200	6611	1600	25571	21786
Maharashtra	7521	1575	10937	16894	982	41598	34077
Meghalaya	137	47	0	118	0	607	470
Orissa	2166	429	196	2583	201	10822	8656
Punjab	4074	902	8200	8295	0	22385	18311
Rajasthan	3110	942	6967	4980	247	17686	14576
Tamil Nadu	6402	1935	9066	12064	466	33290	26888
Uttar Pradesh	7341	1911	4965	5040	975	25310	17969
West Bengal	2700	1179	1360	2827	530	10000	7300

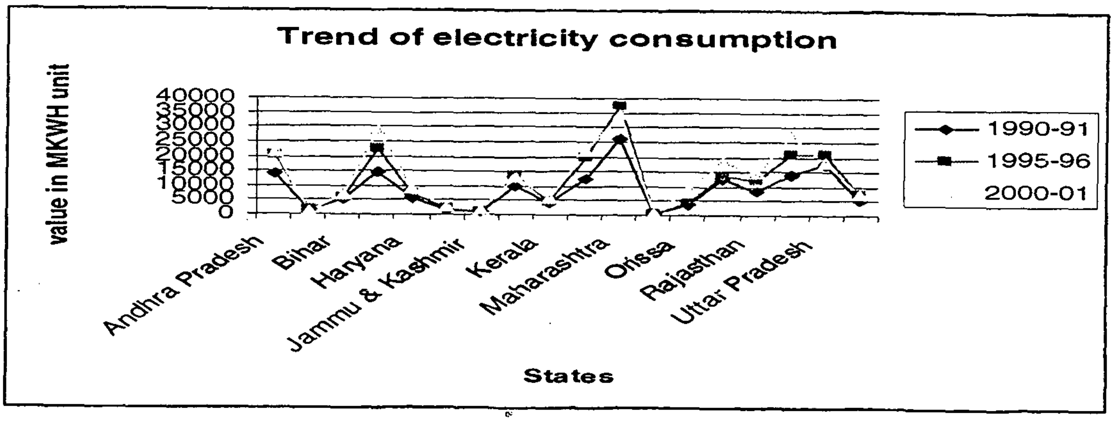
Source: Annual Report of Working Group of SEB, 'Consumer Category wise Sale of Electricity'

Note: '2' signifies the terminal year in the period late 1990s. E_2- E_d is final consumption after deducting domestic sector

d for Domestic Sector, c for Commercial Sector, A for Agricultural Sector, i for Industrial Sector, r for Railway Traction.

The above three tables reflect that most of the States, except few, the total (except Domestic Sector) electricity consumption have increased over ten years. Though there has been an increasing trend, different States have maintained their different levels in electricity consumption (as seen in chart below).

Chart 3.1



If we rank the states according to their power consumption level and divide them by creating three groups (table below), high level, middle level and low level consumption group, we can see most of the states are in the same group over the 10 years.

Table 3.4: Categorization of the States according to level of power consumption

High			Medium			Low		
1990-91	1995-96	2000-01	1990-91	1995-96	2000-01	1990-91	1995-96	2000-01
Maharashtra	Maharashtra	Maharashtra	Madhya Pradesh	Punjab	Uttar Pradesh	Kerala	Kerala	West Bengal
Uttar Pradesh	Gujarat	Gujrat	Karnataka	Karnataka	Rajasthan	Orissa	Orissa	Kerala
Gujarat	Uttar Pradesh	Tamil Nadu	Rajasthan	Rajasthan	Karnataka	Himachal Pradesh	Himachal Pradesh	Himachal Pradesh
Tamil Nadu	Tamil Nadu	Madhya Pradesh	Haryana	West Bengal	Orissa	Assam	Assam	Jummu Kashmir
Andhra Pradesh	Andhra Pradesh	Andra Pradesh	Bihar	Haryana	Hariana	Jammu Kashmir	Jammu Kashmir	Assam
Punjab	Madhya Pradesh	Punjab	West Bengal	Bihar	Bihar	Meghalaya	Meghalaya	Meghalaya

Source: Annual Report of Working Group of SEB, 'Consumer Category wise Sale of Electricity'

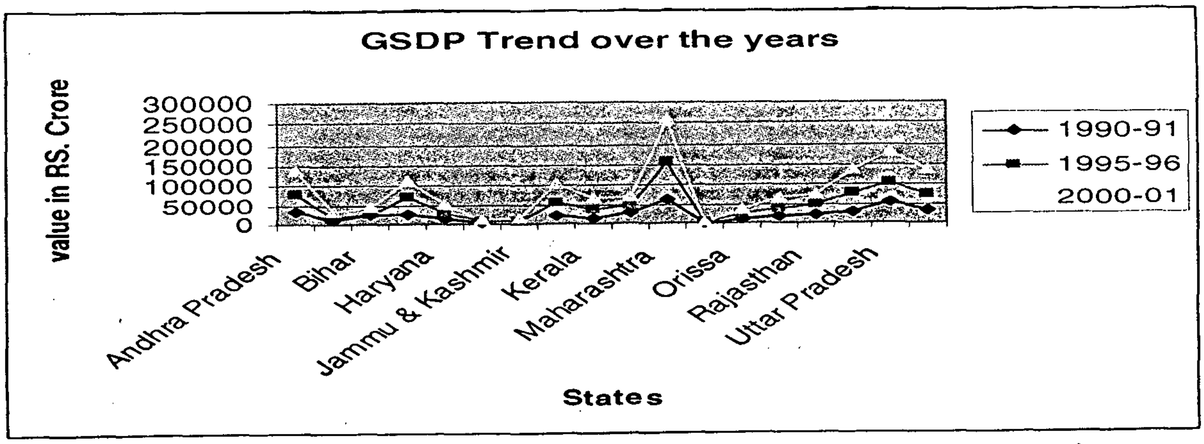
In order to make clear compatibility between electricity consumption and gross output produced, we again made another group of the states according to the Gross State Domestic Product (current account) for the same periods.

3.5: Categorization of the States according to GSDP

High			Medium			Low		
1990-91	**1995-96**	**2000-01**	**1990-91**	**1995-96**	**2000-01**	**1990-91**	**1995-96**	**2000-01**
Maharashtra	Maharashtra	Maharashtra	Gujarat	Karnataka	Karnataka	Haryana	Orissa	Bihar
Uttar Pradesh	Uttar Pradesh	Uttar Pradesh	Bihar	Madhya Pradesh	Rajasthan	Orissa	Bihar	Orissa
West Bengal	Andhra Pradesh	West Bengal	Karnataka	Rajasthan	Madhya Pradesh	Assam	Assam	Assam
Andhra Pradesh	Tamil Nadu	Andhra Pradesh	Rajasthan	Kerala	Kerala	Himachal Pradesh	Jammu Kashmir	Jammu Kashmir
Tamil Nadu	West Bengal	Tamil Nadu	Punjab	Punjab	Punjab	Meghalaya	Himachal Pradesh	Himachal Pradesh
Madhya Pradesh	Gujarat	Gujarat	Kerala	Haryana	Haryana	Jammu Kashmir	Meghalaya	Meghalaya

Source: Data collected from National Account Statistics, CSO, GSDP s are in current prices.

Chart 3.2



Source: Data collected from National Account Statistics, CSO, GSDP s are in current prices.

From the above two set of tables (3.4 & 3.5), we can get the traditional method of comparability (power consumption change and output growth) for each of the state. But, here, we are looking for the individual impact of the indicators (production change, structural composition change and change in intensity in use of electricity) to the final change in electricity demand for actual performance of the states' electricity sector. Therefore, we try to reach the decomposed effects in total electricity demand by the states using said 'consumption approach' and 'intensity approach' in a unified framework. In our analysis, we have applied two methods in each approach. The choice between the two methods would be based on the growth pattern of energy consumption and GSDP of the states. Generally, PDM1 and PDM2 would be preferred in logarithmic trend and linear trend respectively. Since different states have different growth trend in the consumption of electricity and sectoral output, we have calculated the period wise decomposition analysis for all the states in both of PDM1 and PDM2 methods.

D. Empirical results:

Using the said formulae and secondary data we have estimated the effects (scale effect, structural effect, intensity effect) for the major 18 states for said two periods – early 1990s (1990-91 to 1995-96) and late 1990s (1995-96 to 2000-01) as shown by A and B respectively. In each section, there are three tables for three effects (scale effect, structural effect, intensity effect) respectively. Each table contains estimated results by four methods for 18 States.

Production effect or scale effect positive (negative) means the total electricity consumption increases (decreases) due to increase in total production of the economy when other variables remain unchanged. Similarly, structural effect and intensity effect intensity effect positive (negative) means the total electricity consumption increases (decreases) due to change in sectoral composition of the economy and due to increase in technological efficiency of the economy respectively when other variables remain unchanged.

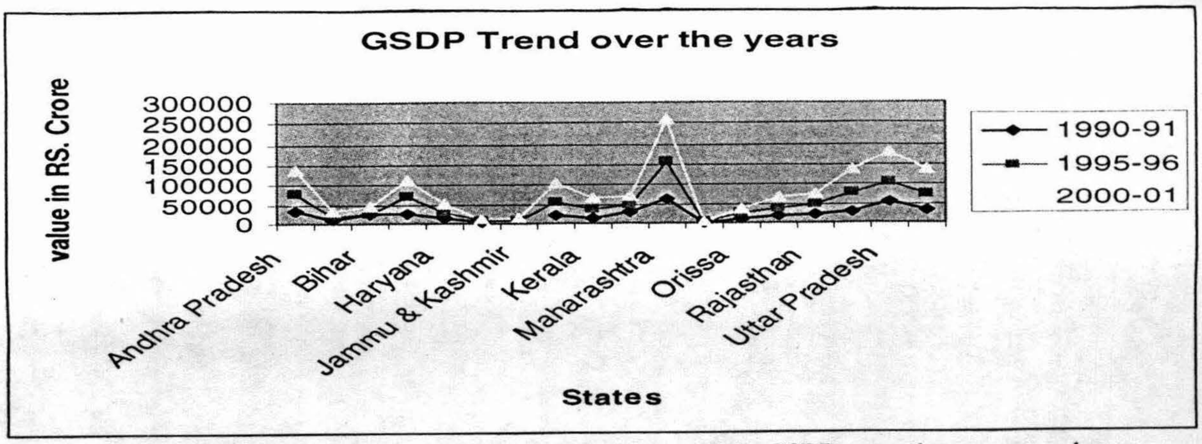
In order to make clear compatibility between electricity consumption and gross output produced, we again made another group of the states according to the Gross State Domestic Product (current account) for the same periods.

3.5: Categorization of the States according to GSDP

High			Medium			Low		
1990-91	1995-96	2000-01	1990-91	1995-96	2000-01	1990-91	1995-96	2000-01
Maharashtra	Maharashtra	Maharashtra	Gujarat	Karnataka	Karnataka	Haryana	Orissa	Bihar
Uttar Pradesh	Uttar Pradesh	Uttar Pradesh	Bihar	Madhya Pradesh	Rajasthan	Orissa	Bihar	Orissa
West Bengal	Andhra Pradesh	West Bengal	Karnataka	Rajasthan	Madhya Pradesh	Assam	Assam	Assam
Andhra Pradesh	Tamil Nadu	Andhra Pradesh	Rajasthan	Kerala	Kerala	Himachal Pradesh	Jammu Kashmir	Jammu Kashmir
Tamil Nadu	West Bengal	Tamil Nadu	Punjab	Punjab	Punjab	Meghalaya	Himachal Pradesh	Himachal Pradesh
Madhya Pradesh	Gujarat	Gujarat	Kerala	Haryana	Haryana	Jammu Kashmir	Meghalaya	Meghalaya

Source: Data collected from National Account Statistics, CSO, GSDP s are in current prices.

Chart 3.2



Source: Data collected from National Account Statistics, CSO, GSDP s are in current prices.

The above table shows that production effect is positive for almost all the states in early 1990s. LAS-PDM 2 shows Scale Effect is negative for Bihar, Jammu Kashmir and Meghalaya. All the methods show production effect negative for only Bihar.

B. For the period of late 1990s

Table 3.7 Production Effect

States	LAS-PDM1	LAS-PDM2	AVE-PDM1	AVE-PDM2
Andhra Pradesh	11039.05	12807.65	11359.30	11838.97
Assam	771.89	-130.31	741.86	790.10
Bihar	3634.95	4487.87	3990.30	4148.12
Gujarat	9995.33	8924.97	11281.20	11365.20
Haryana	4200.03	4213.05	4640.54	4781.35
Himachal Pradesh	1488.49	-150.11	1604.08	1683.13
Jammu Kashmir	728.57	-233.10	798.37	821.31
Karnataka	8378.84	9881.60	8324.15	8900.99
Kerala	2677.36	-1693.74	3000.05	3073.71
Madhya Pradesh	8163.11	7172.97	8625.28	8779.79
Maharashtra	18321.12	11903.75	17553.20	18464.65
Meghalaya	258.64	-245.82	269.69	282.62
Orissa	1298.69	585.24	2009.64	1930.24
Punjab	7812.69	9326.54	9147.34	9262.62
Rajasthan	5632.79	4955.34	6312.55	6391.27
Tamil Nadu	11569.18	11679.74	13303.49	13510.20
Uttar Pradesh	11158.94	12134.57	10362.98	11076.51
West Bengal	4704.79	1228.95	4692.29	5024.50

In late 90s, only LAS PDM 2 method shows negative Production Effect for Assam, Himachal Pradesh, Jammu Kashmir, Kerala and Meghalaya. Comparing Chart 3.3 and 3.4, it is clear that almost all the States follow the same trend for this effect in both the periods.

A. For the period of early 1990s

Table 3.6 Production Effect

States	LAS-PDM1	LAS-PDM2	AVE-PDM1	AVE-PDM2
Andhra Pradesh	12165.93	17893.49	14943.39	15625.50
Assam	831.62	496.22	830.41	882.04
Bihar	-401.54	-623.73	-419.17	-420.25
Gujarat	13520.91	16233.09	17378.30	18113.33
Haryana	4524.26	4289.33	5039.20	5356.25
Himachal Pradesh	1336.64	178.26	1647.83	1718.54
Jammu Kashmir	0.00	-1112.00	0.00	644.50
Karnataka	8467.10	12818.36	10103.45	10692.79
Kerala	4165.99	6367.48	4428.45	5078.60
Madhya Pradesh	5613.39	4345.86	7220.63	7099.32
Maharashtra	23050.17	17587.80	28184.98	29650.92
Meghalaya	264.26	-98.14	307.10	323.36
Orissa	3389.42	4551.58	3535.06	3952.20
Punjab	8913.13	10365.22	9338.43	9996.89
Rajasthan	6689.54	8164.53	8195.24	8501.70
Tamil Nadu	12793.05	17993.67	15891.93	16695.03
Uttar Pradesh	11447.23	14678.00	12527.99	13063.65
West Bengal	3937.37	1062.87	4730.72	4877.31

Note: Laspeyres-based Parametric Divisia Method (LAS-PDM), Simple Average Parametric Divisia Methods (AVE-PDM), 1 signifies 'Absolute Consumption approach', 2 signifies 'Intensity of Sectoral Output approach'.

Chart 3.3

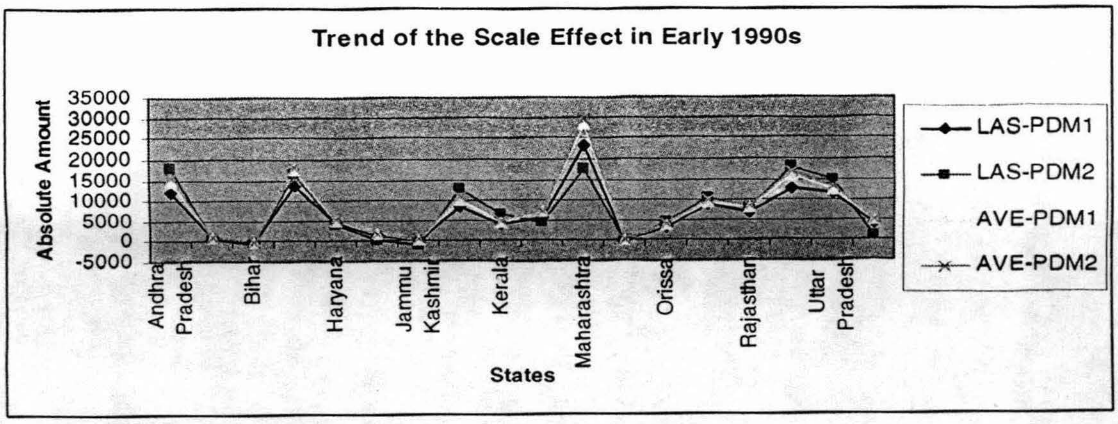
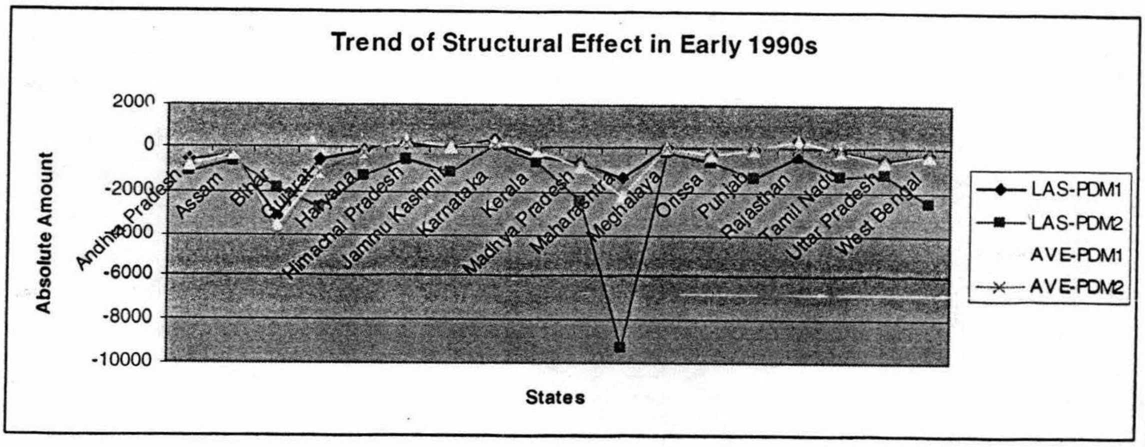


Chart 3.5

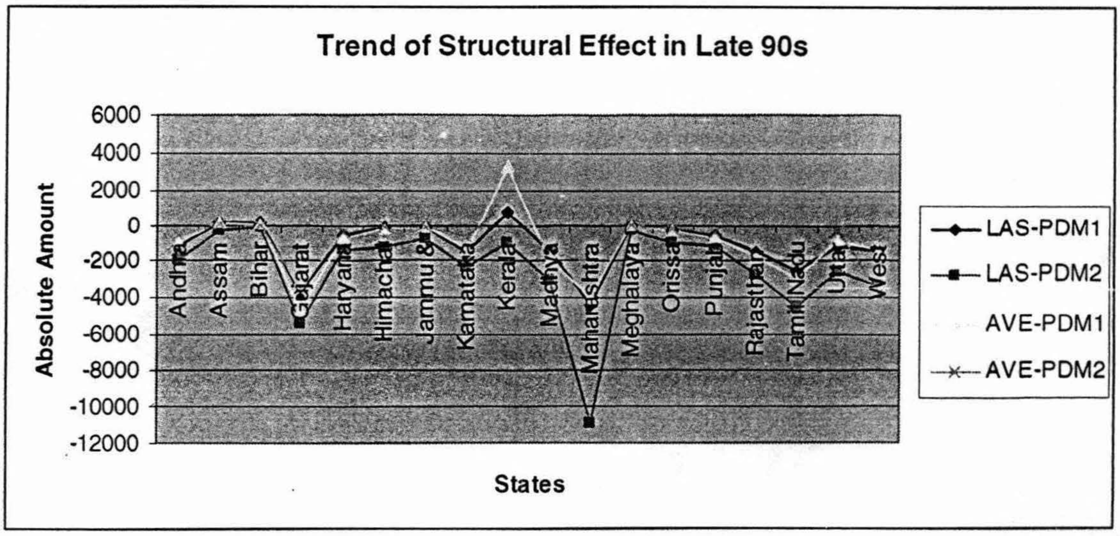


B. For the period of late 1990s

Table 3.9 Structural effect

States	LAS-PDM1	LAS-PDM2	AVE-PDM1	AVE-PDM2
Andhra Pradesh	-1213.37	-1960.79	-1020.47	-603.44
Assam	248.01	-324.23	226.61	75.42
Bihar	180.56	-77.13	148.73	20.36
Gujarat	-3816.99	-5355.49	-4718.22	-3560.59
Haryana	-615.27	-1399.65	-698.28	-429.94
Himachal Pradesh	-146.78	-1304.22	-166.30	-100.30
Jammu Kashmir	-91.79	-769.86	-110.68	-76.17
Karnataka	-1572.35	-2399.19	-1433.28	-709.08
Kerala	831.07	-969.18	3346.75	1470.45
Madhya Pradesh	-1540.97	-3053.98	-2020.07	-1565.53
Maharashtra	-4370.27	-10886.50	-3954.35	-2118.35
Meghalaya	2.20	-327.76	3.25	2.11
Orissa	-312.25	-958.41	-298.54	-172.36
Punjab	-556.64	-1210.68	-669.46	-415.85
Rajasthan	-1490.42	-2766.71	-1762.66	-1125.29
Tamil Nadu	-2620.58	-4520.61	-3046.16	-1954.55
Uttar Pradesh	-1187.40	-2622.69	-884.80	-319.34
West Bengal	-1461.58	-3443.46	-1533.20	-3664.55

Chart 3.6



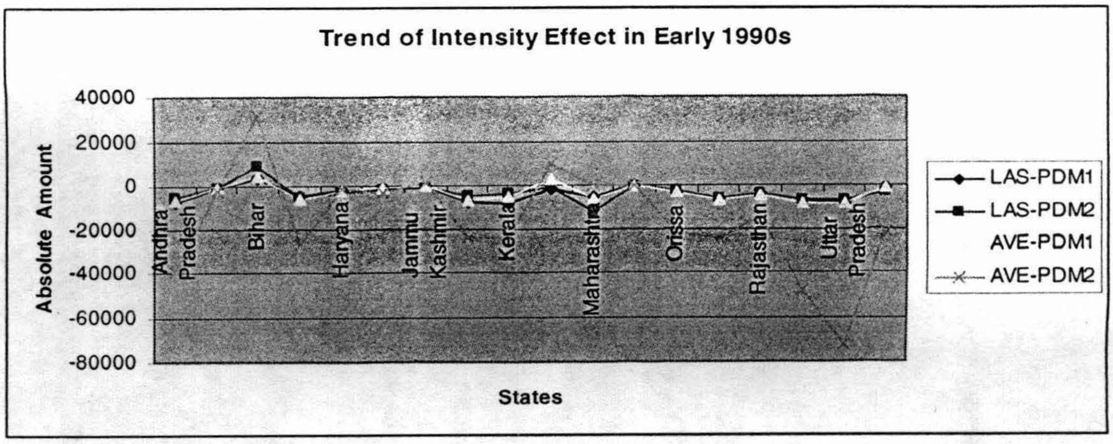
Except for some States, it has been estimated that the Structural Effect is negative. The chart 3.5 and the chart 3.6 reflect the same trend by the three methods, viz., LAS PDM 1, AVE PDM 1, and AVE PDM 2 for all the States. LAS PDM 2 has shown a dramatic result for Maharashtra (huge value with negative sign) in both the periods. In early 90s, LAS-PDM 1, AVE-PDM 1, AVE-PDM 2 shows that Himachal Pradesh and Karnataka have positive Structural Effect but in late 90s, this effect has been positive for Assam and Bihar, Kerala and Meghalaya. In early 90s, LAS PDM1 and AVE PDM1 have shown positive Structural Effect for Rajasthan also.

A. For the period of early 1990s

Table 3.10: Intensity effect

States	LAS-PDM1	LAS-PDM2	AVE-PDM1	AVE-PDM2
Andhra Pradesh	-7413.16	-5412.83	-7149.55	-39209.80
Assam	-661.92	-793.39	-498.04	-2119.70
Bihar	3855.48	9310.84	4324.65	31306.96
Gujarat	-4903.67	-5614.03	-5772.03	-26905.51
Haryana	-2084.95	-2710.03	-2369.33	-1819.16
Himachal Pradesh	-531.19	-1192.10	-656.42	-2704.28
Jammu Kashmir	NA	-1112.00	NA	1191.64
Karnataka	-7174.36	-4523.91	-6487.27	-24334.08
Kerala	-8385.12	-3534.42	-5344.17	-24252.29
Madhya Pradesh	-1413.20	-435.93	3037.70	9641.85
Maharashtra	-5623.40	-12092.75	-6347.37	-81.08
Meghalaya	-68.98	-274.93	-69.61	-327.75
Orissa	-2783.87	-2226.29	-2693.45	-22127.82
Punjab	-6289.91	-6078.37	-6731.46	-24797.26
Rajasthan	-3630.90	-3505.51	-4171.51	-14060.75
Tamil Nadu	-6896.96	-6452.44	-8327.16	-48453.96
Uttar Pradesh	-8358.24	-7028.92	-8534.57	-72307.62
West Bengal	-808.56	-2934.53	-889.29	-22020.94

Chart 3.7



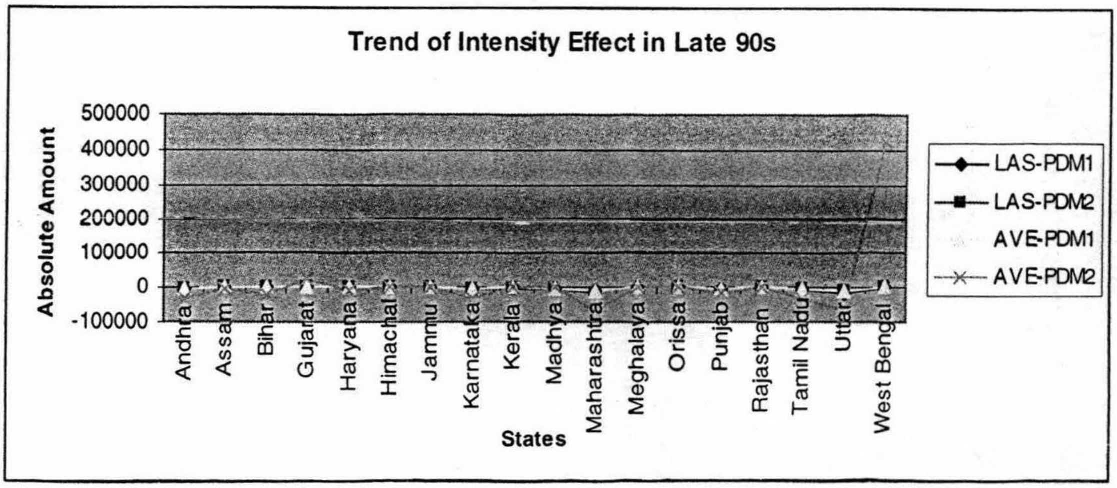
In early 90s, LAS PDM1, LAS PDM2 and AVE PDM1 follow the same trend for Intensity Effect for almost all the States. The said three methods show negative Intensity Effect for most of the States except Bihar. LAS PDM2 reflects different trend for all the States. This Effect is estimated positive for Madhya Pradesh by AVE PDM1 and AVE PDM2 and Jammu & Kashmir by AVE PDM2.

B. For the period of late 1990s:

Table 3.11 Intensity effect

States	LAS-PDM1	LAS-PDM2	AVE-PDM1	AVE-PDM2
Andhra Pradesh	-8431.52	-7842.21	-8657.99	-35966.16
Assam	-919.08	-1172.41	-777.76	-4158.23
Bihar	-2699.87	-2322.89	-2860.87	-26445.51
Gujarat	-1116.82	-1917.95	-437.15	23351.24
Haryana	-1758.07	-2300.77	-1901.52	-9701.72
Himachal Pradesh	-299.70	-1430.04	-342.56	-1264.06
Jammu Kashmir	-273.14	NA	-127.46	-244.55
Karnataka	-7508.62	-6434.18	-6887.48	-34691.77
Kerala	-575.50	-3430.87	-894.98	2092.63
Madhya Pradesh	-4642.19	-4791.93	-3989.66	-742.02
Maharashtra	-10537.63	-16037.43	-10526.24	-71020.04
Meghalaya	-15.93	NA	-16.67	-47.47
Orissa	-869.18	-1390.66	-811.09	141.95
Punjab	-3067.72	NA	-3548.06	-15439.09
Rajasthan	-1288.79	-2218.31	-1014.64	-2895.72
Tamil Nadu	-3312.87	-5000.61	-3648.54	-37784.29
Uttar Pradesh	-17833.69	-13014.60	-14459.84	-67258.93
West Bengal	-273.33	-372.94	-403.70	421198.74

Chart 3.8



Comparing chart 3.7 and 3.8, it is evident that AVE PDM2 shows the absolute value of the Intensity Effect is drastically changed for West Bengal. In late 90s, Intensity Effect is negative for most of the States. AVE PDM2 shows positive Intensity Effect for only Gujarat, Kerala, Orissa and West Bengal.

Being able to disaggregate the total affects into components, we now rank the States by the four specific methods for said two periods (table 3.12 and table 3.13). Since different states have different level of income, size and growth, we rank the states according to their share of the effects in total change of electricity consumption during the corresponding periods. The lower the absolute value of the effects of change in final electricity consumption, the higher is the efficiency in use of scarce resources in an economy. So we rank the states in descending order of the estimated values of the effects.

Early 1990s: 1990-91 to 1995-96

Table 3.12: Ranking of the States Corresponding to Their Decomposition Effects

Methods	LAS_ PDM 1			AVE_PDM 1			LAS_ PDM 2			AVE_PDM 2		
States	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}
Andhra Pradesh	9	9	12	7	9	10	7	4	5	13	4	12
Assam	18	1	1	15	1	1	18	1	1	18	18	1
Bihar	17	18	2	18	11	17	16	17	2	1	2	18
Gujarat	14	7	7	2	15	9	10	6	4	16	15	4
Haryana	5	13	13	11	2	13	6	11	12	6	12	14
Himachal Pradesh	12	2	9	8	5	16	14	10	11	11	6	10
Jammu Kashmir	16	5	3	17	4	18	17	18	16	5	14	9
Karnataka	7	3	14	6	16	11	5	2	9	9	8	15
Kerala	2	16	18	1	10	14	2	14	18	3	1	3
Madhya Pradesh	15	10	4	16	13	7	12	7	3	17	9	6
Maharashtra	8	11	6	4	8	6	11	9	8	15	7	13
Meghalaya	6	12	8	10	17	15	15	16	14	8	3	7
Orissa	1	17	17	5	7	12	1	15	17	4	16	5
Punjab	3	8	16	13	3	8	3	12	15	2	13	16
Rajasthan	13	4	10	9	6	5	9	3	7	14	11	8
Tamil Nadu	10	6	11	3	14	4	8	5	6	12	10	11
Uttar Pradesh	4	15	15	14	12	3	4	8	13	7	5	17
West Bengal	11	14	5	12	18	2	13	13	10	10	17	2

Note: DE_{pt}, DE_{st}, DE_{it} are said Scale Effect, Structural Effect and Intensity Effect respectively.

Laspeyres-based Parametric Divisia Method (LAS-PDM), Simple Average Parametric Divisia Methods (AVE-PDM),

1 signifies 'Absolute Consumption approach', 2 signifies 'Intensity of Sectoral Output approach'

Late 1990s: 1995-96 to 2000-01

Table 3.13: Ranking of the States Corresponding to Their Decomposition Effects

Methods	LAS_ PDM 1			AVE_PDM 1			LAS_ PDM 2			AVE_PDM 2		
States	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}
Andhra Pradesh	1	17	18	12	16	18	1	15	18	1	15	17
Assam	16	18	2	10	18	3	2	4	2	16	17	2
Bihar	5	6	17	3	6	17	2	6	14	5	7	16
Gujarat	11	15	7	16	15	6	8	11	10	12	16	5
Haryana	7	11	15	6	11	15	4	12	13	7	11	15
Himachal Prad	3	12	13	1	12	14	11	17	17	3	10	13
Jammu Kashmir	6	10	14	9	10	10	12	16	8	6	12	9
Karnataka	17	2	1	4	2	1	18	2	1	17	2	1
Kerala	8	4	10	7	3	13	13	10	16	8	3	6
Madhya Pradesh	4	16	16	17	17	16	3	14	15	4	18	8
Maharashtra	15	3	5	14	4	5	14	3	4	15	4	3
Meghalaya	2	7	8	5	7	9	16	18	7	2	6	11
Orissa	13	8	6	18	8	7	10	7	9	13	8	7
Punjab	12	9	12	8	9	12	5	8	6	11	9	12
Rajasthan	9	14	9	15	14	8	7	13	11	9	14	10
Tamil Nadu	10	13	11	11	13	11	6	9	12	10	13	14
Uttar Pradesh	14	5	4	13	5	4	15	5	5	14	5	4
West Bengal	18	1	3	2	1	2	17	1	3	18	1	18

Note: DE_{pt}, DE_{st}, DE_{it} are said Scale Effect, Structural Effect and Intensity Effect respectively.

Laspeyres-based Parametric Divisia Method (LAS-PDM), Simple Average Parametric Divisia Methods (AVE-PDM),

1 signifies 'Absolute Consumption approach', 2 signifies 'Intensity of Sectoral Output approach'

From the difference in ranks (table 3.14) of the States between two periods we can analyze the status (efficiency in use of electricity in early 1990s and late 1990s) of the States by each method and also can determine which indicator is more responsible among three (production volume, structural composition of the Sectors and technical efficiency in use of electricity) for the increase in electricity demand by the States. The most important thing that we can well understand from the rank difference of the states is the impact of power sector reforms on state specific disaggregated effects.

Table: 3.14 Rank Differences between the Early 90s and Late 90s

Methods	LAS_ PDM 1			AVE_PDM 1			LAS_ PDM 2			AVE_PDM 2		
States	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}	DE_{pt}	DE_{st}	DE_{it}
Andhra Pradesh	-8	8	6	5	7	8	-6	11	13	-12	11	5
Assam	-2	17	1	-5	17	2	-16	3	1	-2	-1	1
Bihar	-12	-12	15	-15	-5	0	-14	-11	12	4	5	-2
Gujarat	-3	8	0	14	0	-3	-2	5	6	-4	1	1
Haryana	2	-2	2	-5	9	2	-2	1	1	1	-1	1
Himachal Pradesh	-9	10	4	-7	7	-2	-3	7	6	-8	4	3
Jammu Kashmir	-10	5	11	-8	6	-8	-5	-2	-8	1	-2	0
Karnataka	10	-1	-13	-2	-14	-10	13	0	-8	8	-6	-14
Kerala	6	-12	-8	6	-7	-1	11	-4	-2	5	2	3
Madhya Pradesh	-11	6	12	1	4	9	-9	7	12	-13	9	2
Maharashtra	7	-8	-1	10	-4	-1	3	-6	-4	0	-3	-10
Meghalaya	-4	-5	0	-5	-10	-6	1	2	-7	-6	3	4
Orissa	12	-9	-11	13	1	-5	9	-8	-8	9	-8	2
Punjab	9	1	-4	-5	6	4	2	-4	-9	9	-4	-4
Rajasthan	-4	10	-1	6	8	3	-2	10	4	-5	3	2
Tamil Nadu	0	7	0	8	-1	7	-2	4	6	-2	3	3
Uttar Pradesh	10	-10	-11	-1	-7	1	11	-3	-8	7	0	-13
West Bengal	7	-13	-2	-10	-17	0	4	-12	-7	8	-16	16

There are large variations in the position of the states in early 1990s and late 1990s. The variations are due to change in production level, change in demand, change in share of sectoral output in total GSDP, change in per unit average tariff, change in technical efficiency in transmission, distribution and final use of power by the states over the years from 1990 to 2001. Now for each state and for each method we can get the performance status according to their production level, structural composition of the sectors and intensity of power use, which is more compatible with their relative position in the total developmental ranking. Now we can easily assess the power sector quality of the states in a disaggregated form.

E. Conclusion:

To ensure the best use of scarce resources, which is an important policy for energy sustainability, the information about the disaggregated effects (scale effect, structural composition effect and power intensity of GSDP effect) is essential. From the above data and econometric analysis, it follows that there are significant variations in performances between the states. The consumer category wise sale of electricity has increased over the years not only due to change in production volume but also change, in structural composition of the sectors, increasing technological efficiency and other changes in the economy. All these changes are different for different states. That means the need for electricity arises unequally for different factors in different states. The decomposition analysis traced the disaggregated effects, separately, in the ov 'rall change in electricity demand by the states. The choice between the four parametric divisia methods should be based on the growth patterns of the output and electricity consumption and also the choice of the parameter values depends on whether or not the assumptions associated with the chosen values can best meet the objective of the study. After deciding which effect should be considered as inherent in the efficiency measurement of the states' electricity sector, we can compare the states according to that effect separately. Therefore, the development and the application of the decomposition analysis are crucially important to recognize the limitations of the states to meet the successful and sustainable integrated policy for regional development of power sector in India.

Chapter IV

Ranking of the Major Indian States on the basis of Efficiency in use of Electricity

A. Introduction:

There is considerable wastage of electricity in India due to inefficient transmission and distribution (T&D) system, uneconomic unit size and obsolete technology. This wastage can be reduced with careful energy planning. There are technical losses, theft (by State Electricity Boards) where meters are installed unofficially, off the records theft (by the consumer) either by hooking or making the meter run slow by using magnet. India experiences a high level of T& D losses, for example, 24.53% in 1996-97 to 26.5% in 1998-99 and 27.8% during 2001-02 of total availability[19]. T& D losses are under-reported by S E Bs, i.e. 34% in2000-01 to 38.3% in 2002-03[20]. Due to unreliability of data we need proper estimation of efficiency in use of electricity for the states.

The critical problem today lies in increasing inefficiency in use of electricity. Keeping the view of the operational inefficiency of State Electricity Boards, our attempt is to make an alternative approach of estimating efficiency in the use of electricity of the major states in India. The vast size and complexity of the Indian economy makes consistent, meaningful and understandable measurement of any board based characteristic a daunting task. Efficiency in the use of electricity is no exception. It is often debated how the efficiency in use of energy in a nation or a region should be measured. In the past studies, the efficiency in the use of electricity is used in conjunction with the other term 'intensity in the use of electricity' in describing mathematical relationship between energy use and service output. Energy intensity is generally defined as the ratio of energy consumption to Gross Domestic Product of the country. As per capita national income is inadequate to measure economic development of a country, intensity in use of electricity is not a sufficient measure for the state of electricity consumption of a country or a region. The distinction between electricity intensity and electricity efficiency in use is important. These distinctions may be structural, they may be behavioral, or they may be due to factors over which we have no control. These are sometimes collectively referred to as structural elements and they give rise to a change in electricity use per unit measure of output, but do not reflect improvements in the underlying efficiency of electricity use.

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[19] **Annual Report, State Electricity Board (S E Bs), May 2002, p. XVI.**
[20] **TEDDY, 2003-04.**

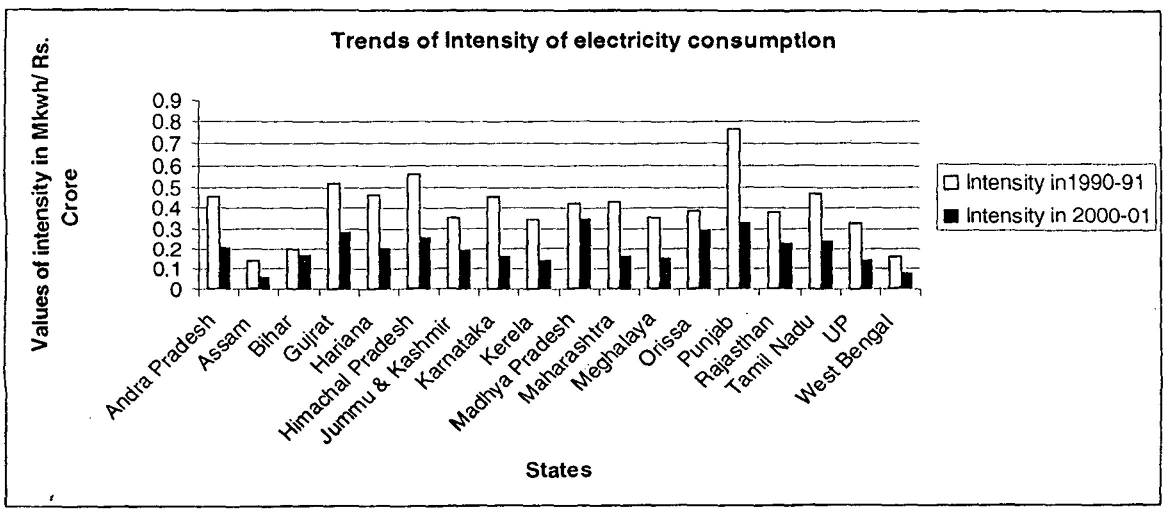
Structural changes in the economy are major movements in the composition of the economy and in any of the end-use sectors that can affect intensity of electricity but are not related to efficiency improvements.

In this chapter we try to estimate the efficiency in the use of electricity within a boarder structure (composite index of 13 indicators) for 18 major States in India. This study is based on secondary cross section data for two benchmark periods 1990-91 (Early Reform Period) and 2000-01 (Post Reforms Periods).

B. Data:

In the discussion of State wise efficiency in use of electricity in India, we have to take a look, firstly, on the intensity in use of electricity (ratio of electricity consumption to gross state domestic product) of the States. Efficiency improvements in processes and equipment and other explanatory factors can contribute to observed changes in electricity intensity. Intensity measured in 2000-01 is lower than intensity calculated in 1990-91 for every States (See Chart 4.1). That means, apparently, efficiency in use of electricity increased after reforms in Power Sector for almost every State.

Chart 1



Source: Annual Report Working Group of State Electricity Boards 1992, 2002, Planning Commission, India. Values are taken as five decimal points.

Intensity in the use of electricity is measured as Electricity Consumption in MKWH / State Domestic Product in Rs. Crore. According to Intensity measurement, in 1990-91, Punjab was the most inefficient State in use of electricity but afterwards it recovered. In 2000-01, Madhya Pradesh was the most inefficient State in use of electricity.

In present study, we treat this 'electricity intensity' status of the state postulated by the S E Bs as unobservable or abstract, something which is not directly measurable. Our study attempts to make a composite index of many latent variables that are measured with a reasonable degree of accuracy. These variables are mutually inter-correlated and they may themselves be determined by several other variables. The causal variables are mainly related to the macro economic variables of agriculture, industry, transport and residential sectors of the States. The per capita Gross State Domestic Product has been treated in almost all models as proxy variables to represent the state of development of the States which would have an impact on the technological level of development in the concerned sector. The percentage of households electrified of the States in total electrified households would be an indicator of state's position in electricity consumption in the domestic sector. The share of irrigated area in the States may be considered to be a significant measure of electrical power use in agricultural sector. In the context of industrial sector, the share of electricity consumption by most of the electricity intensive industries would have significant impact in the electricity demand of the sector. Railway is the most electricity intensive industry in the transport sector. For that reason we have taken the share of route length of railway of the States in India as the proxy measure of electricity use in Transport Sector. Among all these macro variables the price structure of electrical power shows the wide discrimination across the consuming sectors. In order to capture the inter state variations of electricity use per unit average tariff would be the most important causal variable in the analysis. But, the relationship between the consumption of electricity and the variables used should be uni-directional.

In our analysis we postulate the causal variables as follows:

1. **Inverse Real Tariff of Per Unit of Electricity Consumption** (i.e. inverse of per unit consumer category wise average tariff with respect to the GSDP deflator), **IRT:** Data generated from the source 'Annual Report Working Group of State Electricity Board', Planning Commission, 1993 and 2002. There are 5 sectors, viz. Commercial, Agriculture, Domestic, Industry, and Railway Traction. Since all the variables should be uni-directional for the factor analysis by Principal Component method we have used inverse of real average tariff because the functional relationship between tariff rate and electricity demand is negative.

2. **Per Capita GSDP** (ratio of GSDP at Current Prices and Population of the corresponding State), **PSDP** in unit Rs. Crore: Data is collected from 'National Account Statistics', CSO, India.

3. **Share of Gross Irrigated Area by the States in Total Irrigated Area in India, SGIA,** (Proportional). Source of the data is Statistical Abstract, India for various years. It is used to capture the proportion of total electricity consumption in agricultural sector by the States.

4. **Share of Consumption of Electricity in the Industry Sector** by the states in total consumption in the industrial sector in India, **SIEC**. Data are collected from 'Annual Survey of Industries, Factory sector', 1990-91 and 2000-01. It is to measure industrial use of electricity by the States.

5. **Number of Households Electrified, NHE:** Source, TEDDY (TERI Energy Data and Directory Yearbook), various years. In domestic sector, electricity is mainly used for lighting. Number of household electrified may be an account for electricity consumption in the domestic sector by the States.

6. **Share of Route Length of Railways by the States in Total Route Length in India, SRLR**: Source, 'Infrastructure, Centre for Monitoring Indian Economy, 2004 and 2001. It is used to measure the electricity consumption for railway traction (Transport Sector) by the States.

7. **Sectoral Share of Gross State Domestic Product** (ratio of output of the sector and total GSDP) in current account, **SSSP:** data source, 'Domestic Product of States of India, 1960-61 to 2000-01', EPW Research Foundation, 2003. There are 3 sectors, agriculture, industry, service or commercial.

Here our analysis is concerned with 18 major Indian states viz. Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal for which the data are collected for the two time periods 1990-91 and 2000-01. There are 13 variables in the final data set for both the periods. We show data for all the 13 variables in the following few tables: Table 4.1, 4.2, 4.3 for the period 1990-91.

Table 4.1: Inverse Real Tariff Per Unit of Electricity for 1990-91

Variables	Inverse Real Tariff (KWh/ Paise)				
Sector	Domestic	Commercial	Agriculture	Industry	Railway Traction.
States	DIRT (1)	CIRT (2)	AIRT (3)	IIRT (4)	RIRT (5)
Andhra Pradesh	0.0110	0.0052	0.1570	0.0021	0.0054
Assam	0.0133	0.0074	0.0159	0.0050	NA
Bihar	0.0124	0.0071	0.0722	0.0021	0.0042
Gujarat	0.0106	0.0106	0.0340	0.0030	0.0064
Haryana	0.0128	0.0058	0.0239	0.0023	NA
Himachal Pradesh	0.0169	0.0089	0.0368	0.0034	NA
Jammu & Kashmir	0.0248	0.0112	0.0744	0.0186	NA
Karnataka	0.0109	0.0041	0.0776	0.0034	NA
Kerala	0.0154	0.0096	0.0341	0.0043	NA
Madhya Pradesh	0.0378	0.0067	0.0294	0.0023	0.0048
Maharashtra	0.0136	0.0072	0.0829	0.0034	0.0065
Meghalaya	0.0164	0.0106	0.0344	0.0066	NA
Orissa	0.0137	0.0072	0.0230	0.0036	0.0072
Punjab	0.0094	0.0066	0.0936	0.0030	NA
Rajasthan	0.0013	0.0007	0.0025	0.0004	0.0007
Tamil Nadu	0.0125	0.0065	0.0800	0.0023	0.0066
Uttar Pradesh	0.0113	0.0076	0.0347	0.0029	0.0057
West Bengal	0.0143	0.0083	0.0342	0.0035	0.0093

Source: Annual Report Working Group of State Electricity Board, Planning Commission, there are four Sectors. Unit of average tariff is Paise/ Kwh.

Note: Real Tariff is calculated from consumer category wise average tariff (average tariff / GSDP deflator for each State).

The values are taken as four decimal points. The four sectors are individually behaved as four different variables as DIRT, CIRT, AIRT, IIRT in final data set.

The values are taken in inverse form for making it positively related with the demand or use of electricity.

Data are not available for Railway Traction Sector of Punjab, Orissa, Kerala, Karnataka, Himachal Pradesh, Jammu & Kashmir, Haryana and Assam

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Table 4.2 : Five variables with different charecterestics for 1990-91

Variables	Percentage of Household Electrified	Share of Length of Railway	Share of Irrigated Area	Share of use of Electricity in Industry India	Per capita SDP at current in Rs Cr.
States	PHE (6)	SLR (7)	SIA (8)	SEI (9)	PSDP (10)
Andhra Pradesh	46.30	0.0805	0.0849	0.0729	0.0005
Assam	18.74	0.0395	0.0090	0.0057	0.0005
Bihar	12.57	0.0851	0.0663	0.0373	0.0003
Gujarat	65.93	0.0847	0.0460	0.0958	0.0007
Haryana	70.35	0.0240	0.0670	0.0206	0.0008
Himachal Pradesh	87.01	0.0042	0.0026	0.0046	0.0005
Jammu& Kashmir	NA	0.0012	0.0068	0.0011	0.0005
Karnataka	52.47	0.0491	0.0411	0.0605	0.0005
Kerala	48.43	0.0157	0.0060	0.0252	0.0005
Madhya Pradesh	43.30	0.0941	0.0701	0.0884	0.0005
Maharashtra	69.40	0.0871	0.0525	0.1651	0.0008
Meghalaya	29.16	0.0000	0.0007	0.0019	0.0005
Orissa	23.54	0.3207	0.0464	0.0659	0.0003
Punjab	82.31	0.0346	0.1116	0.0450	0.0009
Rajasthan	35.03	0.0934	0.0736	0.0436	0.0005
Tamil Nadu	54.74	0.0643	0.0458	0.0944	0.0006
Uttar Pradesh	21.91	0.1431	0.2337	0.1195	0.0004
West Bengal	32.90	0.0612	0.0302	0.0518	0.0005

Source: TEDDY (TERI Energy Data and Directory Yearbook), various years, Infrastructure, Centre for Monitoring Indian Economy, 2004 and 2001, Statistical Abstract, India for various years, Annual Survey of Industries, Factory sector', 1990-91 and 2000-01, 'National Account Statistics', CSO, India.

Note: There are four variables from four different sectors, viz. PHE for Household Sector, SLR for Railway or Transport Sector, SIA for Agricultural Sector, SEI for Industry Sector. PHE is taken as two decimal points. SLR, SIA, SEI, PSDP are as four decimal points.

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Table 4.3: Sectoral Share in GSDP for 1990-91

Variables	Sectoral Share of Agriculture	Sectoral Share of Industry	Sectoral Share of Service
States	SSA (11)	SSI (12)	SSS (13)
Andhra Pradesh	35.62	23.85	40.53
Assam	37.53	30	32.47
Bihar	40.48	29.66	29.86
Gujarat	27.85	36.37	35.78
Haryana	43.84	25.08	31.08
Himachal Pradesh	33.88	27.69	38.43
Jammu & Kashmir	NA	NA	NA
Karnataka	34.19	25.71	40:09
Kerala	30.1	26.28	43.61
Madhya Pradesh	38.67	29.77	31.57
Maharashtra	22.04	34.9	43.06
Meghalaya	25.09	24.04	50.88
Orissa	35.56	28.28	35.16
Punjab	44.00	23.82	32.18
Rajasthan	44.45	22.3	33.24
Tamil Nadu	18.82	36.66	44.52
Uttar Pradesh	40.75	22.86	36.39
West Bengal	30.56	28.42	41.02

Source: Domestic Product of States of India, 1960-61 to 2000-01.

EPW Research Foundation, Mumbai, June 2003.

Note: 1.Data collected from Sectoral Share of GSDP of 1980-81 series in Current Prices.

2. Data are in percentage value and two decimal points.

3. Data for Jammu & Kashmir are not available.

Similarly, the same 13 variables for 2000-01 are as follows by the tables 4.4, 4.5, and 4.6.

Table 4.4: Inverse Real Tariff Per Unit of Electricity for 2000-01 (Kwh/ Paise)

Variables	Domestic	Commercial	Agriculture	Industry	Railway Traction.
States	DIRT (1)	CIRT (2)	AIRT (3)	IIRT (4)	RIRT (5)
Andhra Pradesh	0.0093	0.0038	0.1159	0.0037	0.0035
Assam	0.0089	0.0037	0.0062	0.004	NA
Bihar	0.014	0.0055	0.1144	0.0042	0.0041
Gujarat	0.0104	0.0037	0.0314	0.0037	0.0029
Haryana	0.0055	0.0029	0.0236	0.0031	0.0038
Himachal Pradesh	0.0058	0.0036	0.0342	0.0034	NA
Jammu & Kashmir	0.0156	0.0063	0.0339	0.0062	NA
Karnataka	0.0193	0.0103	0.0075	0.0122	0.0036
Kerala	0.0053	0.0026	0.0388	0.0031	0.0095
Madhya Pradesh	0.0233	0.0043	0.0281	0.0083	0.003
Maharashtra	0.0096	0.0036	0.2129	0.0035	0.0037
Meghalaya	0.0062	0.0034	0.0188	0.0074	NA
Orissa	0.0121	0.0085	0.0317	0.0078	0.0043
Punjab	NA	NA	NA	NA	NA
Rajasthan	0.0074	0.0043	NA	0.0053	0.0037
Tamil Nadu	0.0079	0.0035	0.0326	0.0038	0.004
Uttar Pradesh	0.0085	0.0036	1.1499	0.0039	0.004
Wes. Bengal	0.0092	0.0036	0.014	0.0034	0.0044

Source: Annual Report Working Group of State Electricity Board, Planning Commission, there are four Sectors.

Note: 1.Real Tariff is calculated from consumer category wise average tariff (average tariff / GSDP deflator for each State).

2. The values are taken as four decimal points. The four sectors are individually behaved as four different variables as DIRT, CIRT, AIRT, IIRT in final data set.

3. The values are taken in inverse form for making it positively related with the demand or use of electricity.

4. Data are not available for Punjab for all sectors and for railway traction data are not available for Jammu & Kashmir, Assam, Himachal Pradesh.

Continued.....

Table 4.5 : Five variables with different charecterestics for 2000-01

Variables	Percentage of household electrified	share of length of Railway	share of irrigated area	Share of use of electricity in industry India	per capita SDP at current in Rs Cr.
States	PHE (6)	SLR (7)	SIA (8)	SEI (9)	PSDP (10)
Andhra Pradesh	67.20	0.0823	0.0999	0.0649	0.0018
Assam	24.90	0.0398	0.0363	0.0061	0.0013
Bihar	10.30	0.0543	0.0865	0.0046	0.0006
Gujarat	80.40	0.0841	0.0689	0.0993	0.0023
Haryana	82.90	0.0245	0.0347	0.019	0.0027
Himachal Pradesh	94.10	0.0043	0.0054	0.0126	0.0021
Jammu & Kashmir	80.60	0.0015	0.0059	0.002	0.0014
Karnataka	78.50	0.0471	0.0634	0.0323	0.002
Kerala	70.20	0.0166	0.0062	0.0328	0.0021
Madhya Pradesh	70.00	0.0767	0.107	0.0359	0.0012
Maharashtra	77.50	0.0817	0.1168	0.1533	0.0027
Meghalaya	42.70	NA	0.0011	NA	0.0016
Orissa	26.90	0.0367	0.0361	0.0398	0.001
Punjab	91.90	0.0333	0.0437	0.0638	0.0028
Rajasthan	54.70	0.0933	0.101	0.0375	0.0014
Tamil Nadu	78.20	0.0663	0.148	0.1248	0.0022
Uttar Pradesh	31.90	0.1359	0.1463	0.0967	0.0011
West Bengal	37.50	0.0583	0.052	0.0558	0.0018

Source: TEDDY (TE?I Energy Data and Directory Yearbook), various years, Infrastructure, Centre for Monitoring Indian Economy, 2004 and 2001, Statistical Abstract, India for various years, Annual Survey of Industries, Factory sector', 1990-91 and 2000-01, 'National Account Statistics', CSO, India.

Note: There are four variables from four different sectors, viz. PHE for Household Sector, SLR for Railway or Transport Sector, SIA for Agricultural Sector, SEI for Industry Sector. PHE is taken as two decimal points. SLR, SIA, SEI, PSDP are as four decimal points.

1. PHE is taken as two decimal points. SLR, SIA, SEI, PSDP are as four decimal points.
2. Data are not available for Meghalaya for SIA and SEI.

Continued...

Table 4.6: Sectoral Share in GSDP for 2000-01

Variables	Sectoral Share in GSDP		
Sector	Agriculture	Industry	Service
States	SSA (11)	SSI (12)	SSS (13)
Andhra Pradesh	29.63	25.12	45.25
Assam	35.63	24.74	39.62
Bihar	38.64	11.3	50.06
Gujarat	13.84	43.18	42.99
Haryana	31.35	29.94	38.71
Himachal Pradesh	26.67	33.2	40.13
Jammu & Kashmir	29.42	18.42	52.16
Karnataka	27.52	25.52	46.96
Kerala	23.64	21.89	54.47
Madhya Pradesh	27.43	30.79	41.79
Maharashtra	12.85	33.29	53.86
Meghalaya	24.06	20.31	55.63
Orissa	33.59	24.18	42.23
Punjab	39.1	24.51	36.39
Rajasthan	27.3	30.34	42.36
Tamil Nadu	15.67	32.82	31.51
Uttar Pradesh	32.35	23.79	43.86
West Bengal	27.65	22.65	49.7

Source: Domestic Product of States of India, 1960-61 to 2000-01. EPW Research Foundation, Mumbai, June 2003.

Note: 1.Data collected from Sectoral Share of GSDP of 1980-81 series in Current Price.

2. Data are in percentage value and two decimal points.

3. Data for Jammu & Kashmir are not available.

The analysis is based on information available in various published reports. In both the periods, we have carefully normalized the indicators. The data are missing in some cases. We have replaced the data by the means of the corresponding columns for fulfillment of the condition of Principal Component Analysis method.

C. Methodology:

Now we propose to construct the composite index of the above causal variables for the periods 1990-91 and 2000-01. The explicit analytical solution may be obtained by 'Principal Component Analysis' (PCA). Despite having some limitations, it is a very scientific method. By the estimation of the composite index of electrical power use efficiency, we shall get 13 principal components from 13 numbers of causal variables. Principal Components are normalized linear functions of the causal variables such that the sum of squares of the coefficients is unity.

The Composite Index of the indicators is the weighted average of the Principal Components-

$E = (\tau_1 p_1 + \tau_2 p_2 + \ldots + \tau_{14} p_{13}) / \tau_1 + \tau_2 + \ldots + \tau_{13},$

$\tau_1 = \text{var}(P_1), \tau_2 = \text{var}(P_2), \ldots\ldots, \tau_{13} = \text{var}(P_{13}).$

Where τ_i $i = 1$ to 13 represents the Eigen values or the characteristic roots of determinantal equation. Eigan values are a special set of scalars associated with a linear system of equations (i.e a matrix equation) that are sometimes also known as characteristic roots, characteristic values[21], proper values, or latent roots[22].

$| R - \tau_1 I. | = 0$, R is the 13 × 13 correlation matrix (a correlation matrix is a table of all possible correlation coefficients between a set of variables). Corresponding to each value of τ, we have to solve the matrix equation $(R - \tau_1 I)\, \alpha = 0$. For the characteri tic vector α, subject to the condition that $\alpha' \alpha = 1$.

The Principal Components are obtained as

$P_1 = \alpha_{11} V_1 + \alpha_{12} V_2 + \ldots\ldots + \alpha_{1\,13} V_{13}$

$P_2 = \alpha_{21} V_1 + \alpha_{22} V_2 + \ldots\ldots + \alpha_{2\,13} V_{13}$

. .

$P_{13} = \alpha_{13\,1} V_1 + \alpha_{13\,2} V_2 + \ldots\ldots + \alpha_{13\,13} V_{13},$

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21 **Hoffman and Kunze 1971**

22 **Marcus and Minc, 1988, p. 144**

Where V_1, V_2, ..., V_{13} represent the causal variables or indicators of efficiency in use of electricity by the States. If P_1,... ...P_{13} are the principal components, their weighted average is the actual composite index of the causal variables.

"Although, in practice, it is adequate to replace the whole set of causal variables by the first few Principal Components, which accounts for a substantial proportion of total variation in all causal variables, we compute as many principal components as the number of causal variables 100 % of the total variation is accounted for by them" [23]. Therefore we propose to compute as many Principal Components as the number of causal variables. Using this method we will get the efficiency index of the use of electricity and then we can rank the states according to the value of the index for the periods 1990-91 and 2000-01. On the other hand, from the data published by the State Electricity Board, we can rank the states according to the estimated 'intensity in use of electricity' (ratio of absolute electricity consumption and GSDP). Now in the present study we will compare the ranks and analyze the accuracy of the data reported by the State Electricity Board for each state.

A convenient way of summarizing a large number of correlation coefficients is correlation coefficient matrix which is able to detect functional dependency or mutual information among the variables. In statistics, it is a measure of the strength of the relationship between two variables. It is used to predict the value of one variable given the value of the other. The correlation matrix is symmetrical (the correlation between X_i and X_j is the same as the correlation between X_j and X_i). Therefore, in order to get a measure for general dependencies in the data we have calculated the correlation matrix of the causal variables for both the periods, 1990-91 (table 4.7) and 2000-01 (table 4.8).

[23] **Nagar 1999**

Table 4.7: Correlation Matrix of the Causal Variables for 1990-91

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1												
2	0.44	1											
3	-0.06	-0.06	1										
4	0.40	0.58	0.09	1									
5	0.21	0.57	0.13	0.17	1								
6	0.00	0.05	0.25	-0.05	0.11	1							
7	-0.11	-0.23	-0.14	-0.29	0.10	-0.40	1						
8	-0.22	-0.33	0.13	-0.35	-0.16	-0.13	0.36	1					
9	-0.05	-0.19	0.25	-0.39	0.17	0.09	0.46	0.53	1				
10	-0.17	-0.03	0.20	-0.12	0.15	0.80	-0.36	0.04	0.19	1			
11	-0.10	-0.45	-0.18	-0.15	-0.50	-0.14	0.12	0.44	-0.31	-0.06	1		
12	0.20	0.32	0.04	0.01	0.38	0.17	0.08	-0.32	0.43	0.13	-0.66	1	
13	-0.02	0.34	0.22	0.19	0.35	0.07	-0.25	-0.34	0.08	-0.01	-0.81	0.1	1

Table 4.8: Correlation Matrix of the Causal Variables for 2000-01

Vs	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1												
2	0.63	1											
3	-0.12	-0.15	1										
4	0.70	0.81	-0.18	1									
5	-0.37	-0.21	-0.06	-0.24	1								
6	0.00	-0.10	-0.26	0.00	-0.03	1							
7	0.05	-0.18	0.65	-0.06	-0.40	-0.30	1						
8	0.19	-0.09	0.51	-0.10	-0.41	-0.11	0.83	1					
9	-0.12	-0.22	0.36	-0.29	-0.18	0.25	0.59	0.71	1				
10	-0.35	-0.30	-0.22	-0.26	0.07	0.79	-0.20	-0.10	0.44	1			
11	0.16	0.27	0.13	0.13	0.01	-0.43	-0.23	-0.24	-0.61	-0.45	1		
12	-0.12	-0.25	-0.09	-0.16	-0.34	0.57	0.24	0.26	0.55	0.55	-0.67	1	
13	0.05	0.05	0.00	0.11	0.37	-0.23	-0.06	-0.31	-0.18	-0.19	-0.15	-0.45	1

Note: DIRT (1), CIRT (2), AIRT (3), IIRT (4), RIRT (5), PHE (6), SLR (7), SIA (8), SEI (9), PSDP (10), SSA (11), SSI (12), SSS (13).

According to the process we, now, compute the Eigen values and the principal components of the data matrices. Though we have taken all the components in our analysis, it is better to cover the information that how much variance is actually explained by the single principal component. The initial Eigen values and the percentage of explained variance by the principal components are shown by following two tables 4.9 and 4.10 for 1990-91 and 2000-01 respectively.

Table 4.9: Total Variance Explained for the period 1990-91

Component	Initial Eigen values	Explained Variance by Principal Components	Explained Variance by Principal Components
	Total	% of Variance	Cumulative %
1	3.5101547	27.0011898	27.0011898
2	2.4005665	18.4658958	45.4670856
3	2.0490481	15.7619087	61.2289943
4	1.2708158	9.7755062	71.0045006
5	1.1116469	8.5511298	79.5556304
6	0.7961955	6.1245807	85.6802111
7	0.5909963	4.5461255	90.2263366
8	0.4826904	3.7130031	93.9393397
9	0.3819159	2.9378148	96.8771545
10	0.2338072	1.7985169	98.6756714
11	0.1257633	0.9674103	99.6430816
12	0.0463930	0.3568692	99.9999508
13	0.0000064	0.0000492	100.0000000

Extraction Method: Principal Component Analysis.

Table 4.10: Total Variance Explained for the period 2000-01

	Initial Eigen values		
Component	Total	% of Variance	Cumulative %
1	3.86644215	29.7418627	29.7418627
2	2.959738056	22.7672158	52.50907851
3	2.381868864	18.3220682	70.8311467
4	1.281313752	9.85625963	80.68740633
5	0.737535713	5.67335164	86.36075796
6	0.485317549	3.73321191	90.09396987
7	0.428492788	3.29609837	93.39006824
8	0.365318298	2.81014076	96.200209
9	0.21888652	1.68374246	97.88395146
10	0.14522127	1.11708669	99.00103815
11	0.083404459	0.64157276	99.64261091
12	0.033677669	0.25905899	99.9016699
13	0.012782913	0.0983301	100

In general, the first principal component accounts for the largest proportion of variations in all latent variables; the second accounts the second largest proportion and so on. Since the single Principal Component explained very little percentage of total variance for both the periods we have taken 13 Principal Components as many as the number of causal variables in our analysis.

Following the steps of the method we have to estimate the principal components or the factors of the transformed data matrix. The following tables (4.11 and 4.12) have shown the values of the principal components for the periods 1990-91 and 2000-01 respectively.

Table 4.11: Principal Components of the Factor Analysis for 1990-91

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
-0.35	0.29	-0.95	0.01	-0.72	-0.13	-0.17	2.97	0.27	-0.14	-0.09	0.33	1.37
-1.08	-1.10	0.71	-0.96	0.17	-0.47	0.46	-0.72	-0.94	-0.28	1.18	-0.12	-0.30
-1.85	-1.55	0.80	-0.30	-0.77	-0.43	-0.69	1.10	-0.51	0.99	0.21	0.06	-1.04
0.82	-0.33	1.86	0.23	-0.20	-0.85	-0.14	-0.56	0.23	1.82	-0.31	0.67	1.64
1.52	-1.19	-0.70	-0.18	-0.25	-0.07	0.54	-0.87	-0.51	-0.57	0.79	-0.75	-0.61
1.08	0.05	-0.32	-1.08	-0.59	0.35	-0.14	-0.39	-0.38	0.83	-2.75	-0.38	0.13
-0.13	-0.33	0.06	-0.41	3.75	0.71	-0.27	0.54	-0.37	0.18	-0.42	-0.05	0.30
-0.04	0.38	-0.43	-0.28	0.03	-0.28	0.38	0.57	-0.35	-1.79	-1.01	0.84	-1.19
-0.13	0.98	-0.59	-0.72	-0.42	0.09	-0.24	-0.46	-0.49	1.08	-0.44	0.90	-1.92
-0.16	-0.69	0.31	0.47	-0.89	3.57	-0.64	-0.42	0.14	-0.51	0.29	0.18	0.54
1.33	1.15	1.46	0.82	0.21	-0.01	-0.20	0.39	0.56	-0.41	1.06	2.04	-0.96
-0.50	2.32	-1.21	-0.69	0.00	0.26	-0.51	-0.54	-0.47	1.21	1.70	-0.76	0.56
-0.64	-0.21	-0.25	-0.79	0.16	-0.12	0.77	-0.45	3.69	0.09	0.00	-0.51	-0.43
2.05	-1.15	-1.05	0.42	-0.07	-0.49	0.22	0.97	-0.03	0.44	1.06	-0.85	-0.15
-0.25	-0.24	-0.61	-0.08	-0.13	-1.36	-2.57	-1.26	0.22	-1.71	-0.12	0.41	1.17
-0.01	1.37	2.04	0.36	-0.27	-0.22	0.12	0.47	-0.29	-1.12	-0.38	-2.69	-0.24
-1.00	-0.03	-0.96	3.41	0.28	-0.35	0.32	-0.72	-0.06	0.63	-0.74	-0.30	-0.40
-0.66	0.26	-0.18	-0.24	-0.30	-0.20	2.76	-0.60	-0.72	-0.72	-0.04	0.97	1.54

Method: Soft ware package of SPSS version 0.9. Process is Factor Analysis of data reduction. The above table is appearing as final score matrix in output page.

Table 4.12: Principal Components of the Factor Analysis for 2000-01

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
1.17	-0.52	0.44	-1.00	0.46	-0.54	-0.75	-0.42	-0.34	0.41	-0.38	-1.69	0.72
-0.85	-0.68	-1.43	-0.35	-1.04	-0.12	-0.39	0.05	0.26	0.57	0.38	1.27	-0.39
0.45	-0.34	-1.68	-1.55	0.73	-0.20	-0.73	0.64	-0.33	-0.83	-1.53	0.48	-0.39
-0.06	-0.45	0.26	2.17	-0.17	-0.87	-0.02	0.42	0.34	1.21	-0.96	0.49	2.34
-0.80	-0.88	1.21	-0.62	-0.69	-0.65	-0.02	-0.61	-1.11	0.07	-0.50	1.74	-0.82
-1.87	-0.63	0.59	0.71	-0.81	-0.43	0.66	-0.38	-0.49	0.20	-0.60	-1.11	-1.33
-1.60	0.37	0.27	-0.11	0.98	-0.44	0.52	1.23	0.23	-1.65	-1.00	-1.48	0.42
0.22	3.22	0.95	0.00	0.29	0.14	-0.03	-0.04	-0.98	-0.13	-0.64	1.32	0.14
-0.51	-0.68	0.35	0.31	0.84	3.71	-0.12	0.09	-0.44	0.43	-0.04	0.01	0.21
0.48	0.22	-0.26	0.36	-0.51	-0.25	-0.32	3.12	-0.86	0.65	1.74	-0.28	-0.66
1.30	-0.39	1.08	1.02	1.80	-0.47	-0.06	-0.10	1.62	0.40	-0.07	0.32	-2.24
-0.91	0.13	-0.59	0.42	1.57	-0.70	-0.11	-1.43	-0.61	-0.98	2.67	0.11	0.55
-0.66	1.70	-1.57	0.10	-0.82	0.36	-0.16	-0.78	1.97	0.96	-0.09	-0.77	-0.55
-0.07	0.03	1.94	-2.15	-0.96	0.07	0.03	0.05	1.43	0.37	1.08	-0.25	0.88
1.02	0.13	-0.46	0.04	-0.27	-0.16	-0.57	-1.26	-1.82	1.25	-0.16	-1.33	-0.17
1.36	-0.22	0.18	1.26	-2.00	0.56	-0.84	-0.44	0.32	-2.68	0.12	-0.14	-0.05
1.28	-0.27	-0.76	-0.32	-0.18	0.13	3.65	-0.15	-0.10	-0.17	0.10	0.24	0.29
0.06	-0.75	-0.52	-0.26	0.77	-0.15	-0.73	0.02	0.90	-0.07	-0.13	1.07	1.05

Method: Soft ware package of SPSS version 0.9. Process is Factor Analysis of data reduction. The above table is appearing as the score matrix in output page.

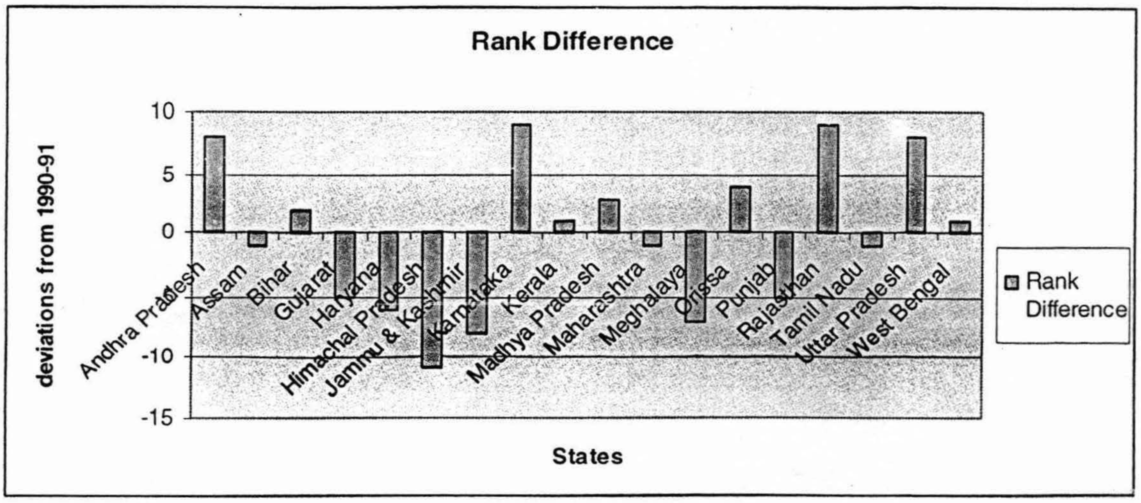
In order construct the efficiency index in the use of electricity we should multiply the initial Eigen values with corresponding Principal Components and then divided it by the sum of all Eigen values. Here Eigen values are the weights attached to the corresponding Principal Components. The required Composite Indices of the Indicators for both the periods are obtained by this method. We can rank all the 18 States for the years 1990-1991and 2000-01 by this estimator as follows –

Table 4.13: Rank of the States according to the Composite Index of Causal Variables

States	1990-91	2000-01
Andhra Pradesh	5	13
Assam	2	1
Bihar	1	3
Gujarat	16	11
Haryana	10	4
Himachal Pradesh	13	2
Jammu & Kashmir	14	6
Karnataka	9	18
Kerala	8	9
Madhya Pradesh	11	14
Maharashtra	18	17
Meghalaya	12	5
Orissa	4	8
Punjab	15	10
Rajasthan	3	12
Tamil Nadu	17	16
Uttar Pradesh	7	15
West Bengal	6	7

The table 4.13 above shows that Andhra Pradesh, Rajasthan, Karnataka and Uttar Pradesh ranked higher in 2000-01. It means that after Power Sector Reforms these States have deteriorated their efficiency in the use of electricity. The impact of Power Sector Reforms has been expected for only Jammu & Kashmir, Himachal Pradesh and Meghalaya (See Chart 4.2 also).

Chart 4.2



D. Empirical Results

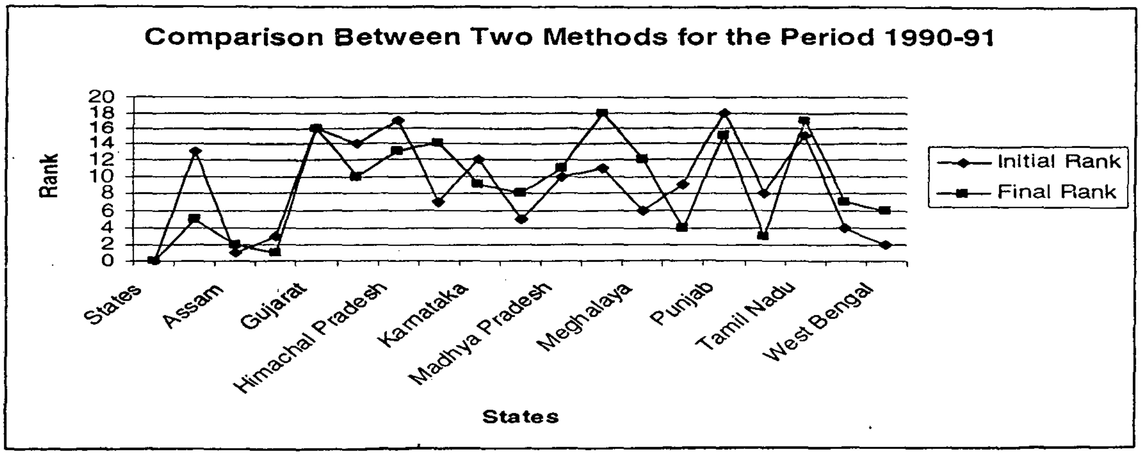
In order to check the reliability of the data reported by the State Electricity boards, we have compared the estimated 'electricity intensity' rank and the rank by the composite index of efficiency in the use of electricity of the States. Thereby, we can analyze the actual performances of the states in the light of the above analysis. Firstly, we have to rank the States by the traditional measurement scale of efficiency i.e. intensity of electricity use (Electricity consumption with respect to Gross State Domestic Product) using total consumption of electricity data reported by the SEBs in the annual reports.

Table 4.14 : Rank of the States according to the Intensity in use of Electricity

States	1990-91	2000-01
Andhra Pradesh	13	11
Assam	1	1
Bihar	3	8
Gujarat	16	15
Haryana	14	10
Himachal Pradesh	17	14
Jammu & Kashmir	7	9
Karnataka	12	7
Kerala	5	4
Madhya Pradesh	10	18
Maharashtra	11	6
Meghalaya	6	5
Orissa	9	16
Punjab	18	17
Rajasthan	8	12
Tamil Nadu	15	13
Uttar Pradesh	4	3
West Bengal	2	2

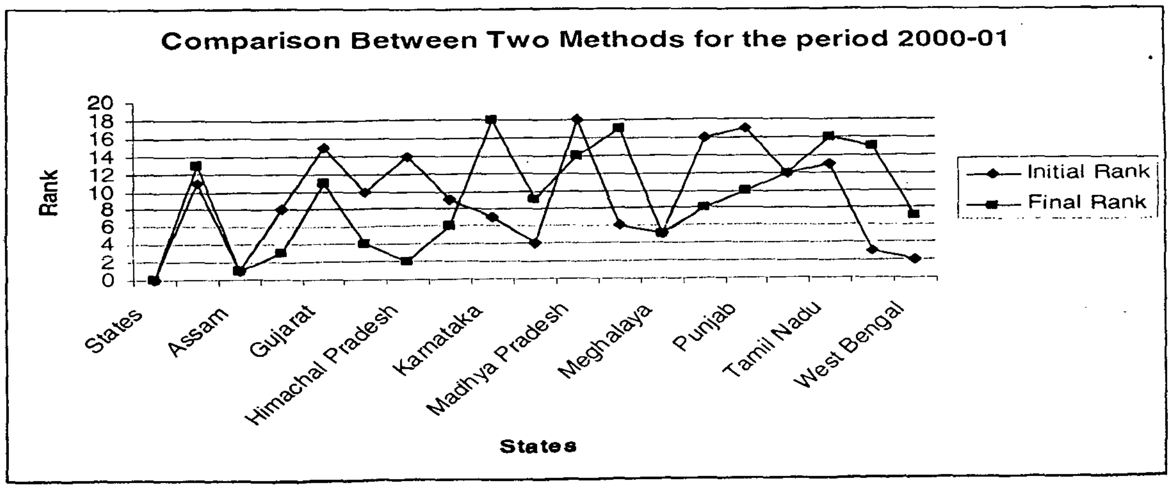
Now, we have to consider the outcome of PCA method (table 4.13) to get robustness of the data in a boarder structure. The following two charts 2 and 3 have shown the difference in the ranks or outcomes of two methods for two periods 1990-91 and 2000-01 respectively.

Chart 4.3: Period 1990-91



Initial Rank: Intensity per unit of GSDP, Final Rank: Composite Index of Efficiency in use of Electricity

Chart 4.4: Period 2000-01



From the above charts 4.3 & 4.4, it is clear that there is wide variation in the outcome of intensity method and the outcome of PCA for both the periods 1990-91 and 2000-01. The PCA scores has shown the same rank with intensity rank only for the State Gujarat in 1990-91 and for Assam, Meghalaya and Rajasthan in 2000-01. The study revealed huge difference in the position of the States by the traditional and proposed method for both the periods. Specifically after the Power sector Reforms (here only for the period 2000-01) there are drastic difference in the rank of the States.

E. Conclusion :

This chapter discussed the rationale behind capturing of all indicators which can influence the demand for electricity rather than taking only intensity of electricity use in the process of mesuring the quality of electricity use by the final consumers of the States in India. At the same time it examine the reliability of the data provided by the State Electricity Boards (SEBs) for major 18 States. From the traditional consensus, state wise assessment of efficiency in use of electricity, we ranked the States according to their intensity in use of electricity (ratio of absolute electricity consumption to GSDP) for two periods 1990-91 (before Power Sector Reforms) and 2000-01 (post Reforms) using the data reported by State Electricity Board. Then the chapter proposed a composite index of indicators that influnce the use of electricity. Using Principal Component Analysis of Factor Analysis method composite index has been computed for 18 major State. The study provides a detailed account of major five sub-sectors (domestic, agriculture, industry, commercial and railway) of Electricity Sector in India. The indicators used are the proxy variables of the demand for electricity by the corresponding sector and the States. Original data provided by the SEBs is taken as unobserved for the testing of reliability of the Consumer Category Wise Sale of Electricity data.

Empirical results revealed that there is very few match in the ranks by the final and initial mesurement of the States in both the periods. The results supported that at the level of the aggregate economy (or even at the level of an end-use sector) electricity intensity is not a sufficient measure because of the heterogeneous nature of the output of the States. It is very obvious that the variations in the position of the States would be more wide after the Power sector Reforms (here, we have taken only 2000-01 as a representative year). It is, basically, for the different timing of restructuring of the genarating units, unequal tariff structure of the diffrent Sectors of the economy, private investment in production units, technologicsl improvement in transmission & distribution of electricity of the States. In short, the outcomes of the two measures, intensity of electricity consumption and composite index of indicators estimated Principal Component Analysis method did not match either because of short widen of intensity measure, or because of the nonreliable data reported by SEBs, or the both. But, single cause might affect the estimation of power sector quality of the States. It would encompass information assymetry about the demand structure and efficiency of electricity use by the States.

Moreover, it can be safely asserted that even after several years of initiating power sector reforms, the outcome has not been very satisfactory. Despite calls to restructuring the SEBs, many states, in practice, lost their position in the ranks of index of efficiency in the use of electricity in the post reform periods. Therefore, it is seen that power sector reform is woefully short of expectation.

Chapter V

Conclusion

The demand for electricity has out-paced the supply resulting chronic electricity shortage in India. The dismal performance and negative rate of return for long periods of the Indian State Electricity Boards (SEBs) has led to reduced access to market borrowings and their inability to utilize multilateral and bilateral assistance. They are not even able to earn a minimum Rate of Return of 3% on their net fixed assets in service after providing for depreciation and interest charges in accordance with Section 59 of the Electricity (Supply) Act, 1948. It was realized by the Government that the modifications and private participations was essential. To turn around the financial health of the power sector, the Government has taken up reforms.

The South Asian countries have made significant progress in term of creating an independent regulatory authority over the years, particularly in the electricity sector. In our country economic reforms started since July 1991. Power sector reforms were expected to focus on two areas- viz. the rationalization of tariff structure through independent Electricity Regulatory Commissions (*ERCs*) and the restructuring of Electricity Board, separating generation from transmission and distribution and to bring about greater efficiency in each area. Thereafter, State Electricity Commissions (*SECs*) have been set up in several states of India. Orissa was the first state to initiate major reforms in the power sector through enacted of Orissa Reforms Act, 1995. Haryana, Andhra Pradesh, Uttar Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Delhi and Gujarat have enacted their State Electricity Reforms Acts, which provide, interlaid, for unbundling of SEBs, setting up of State Electricity Regulatory Commissions, etc. The SEBs of Orissa, Haryana, Andhra Pradesh, Karnataka, Uttar Pradesh, Uttaranchal Rajasthan, Delhi and Madhya Pradesh have been unbundled. Distribution has been privatized in Orissa and Delhi.

There is currently a debate on deregulation of the electricity market in many states. There are two major factors for encouraging private sector participation:

1. to bridge the wide gap between demand for and supply of the power,
2. mobilizing private capital for power sector development.

But, most interesting thing is that private players are reluctant to invest in this sector[24]. The expenditure on power sector has been increasing since the beginning of the power sector reforms. The commercial losses of the utilities have been rising significantly[25]. Orissa SEB was earning commercial profit up to 1995-96. Since then it has incurring losses. The commercial loss steadily increased from 363 Crore in 1996-97 to Rs. 538 Cr in 1999-2000. It has been able to reduce the losses to Rs. 230 Cr in 2001-01. After reforms, the financial position instead of improving has been deteriorating in Orissa. Bihar has been incurring losses since 1991. The commercial losses increased from Rs. 357 Cr in 1990-91 to Rs. 753 Cr in 2001-02. In Gujarat, during 1998-99, the magnitude of the commercial losses was Rs. 366 Cr and it has increased Rs. 2260 Cr in 2001-02. the commercial losses in Tamil Nadu was Rs. 1192 Cr in 1999-2000 and it would increase to Rs. 2260 Cr in 2000-01 (AP). There are nine States viz. Assam, Bihar, Delhi, Kerala, Jammu & Kashmir, Madhya Pradesh except (1993-94), Meghalaya (except 1993-94), Punjab and West Bengal have been showing commercial losses in each year during the period 1990-91 to 2001-02. Maharashtra SEB started showing losses since 2000-01. Karnataka is the only state is earning commercial profits in each year during 1990-91 to 2001-02(AP)[26]. The major causes for this increasing commercial loss are the large imbalances in tariff rate for agricultural sector and the improper cost of power supply per unit in several States. Utilities have in the process to recover these losses by the way of cross subsidization mainly from the industrial and commercial sectors. Sectoral disaggregation in the demand analysis is, therefore, needed to promote efficiency, and safety in the allocation of electricity to the states.

The important task before the regulators were to bring the tariff rebalancing, promote efficiency and competitive in the purely governmental sector. Currently, regulators expect detailed information to develop indicators for judging performance and quality of services provided by the utilities. Keeping this view in mind we attempted to provide the necessary information about the status and performance of States' Electricity Sector in India.

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[24] **TERI Regulatory, 2005.**
[25] **Planning Commission, New Delhi, 2002.**
[26] **Gupta, Gupta, 2005.**

The present study has been divided into five chapters, including the present one. The second chapter is descriptive. It provided the information about the trends and progress of Indian Electricity Sector over the years. According to the characteristics of the important parameters of the performance has been divided into two parts, viz., Physical Performance and Financial Performance. In Physical Performance part, we described India's condition in Installed Generating Capacity of Electricity in Utilities and Non-utilities, Power Sector Plan Outlay and Expenditure, Plant Load Factor, Transmission and Distribution Losses, Consumption of Electricity by Sectors. Similarly, in the second part, we described about Average Cost, Average Tariff, Consumer Loss, Rate of Return, Subsidy and State Electricity Duty of the Indian Electricity Sector.

The inter state disparities in consumer category wise sale of electricity arise mainly due to three factors, viz. change in total production of the economy (Scale effect), structural composition of the sectors (Structural effect), technical efficiency (Intensity effect). In the third chapter, the relative contributions of the Scale effect, Structural effect and Intensity effect in the total change of electricity consumption have been estimated individually in the major 18 states in India using Period wise Decomposition analysis. We have applied the decomposition method for estimating the scale effect, structural effect and intensity effect separately for two bench mark periods, early 1990s and late 1990s. Decomposition method is, basically, an important statistical tool for disaggregation of the energy demand. The Sectoral disaggregation in the demand analysis is necessary to promote efficiency, and safety in the allocation of electricity to the states. Our empirical work considers two specific decomposition methods as follows –*Laspeyres based Parametric Divisia Method (LAS-PDM), Simple Average Parametric Divisia Methods (AVE-PDM)*. From the data and econometric analysis, it concluded that there are significant variations in performances between the states. The consumer category wise sale of electricity has increased over the years not only due to changes in production volume but also due to changes in structural composition of the sectors, increasing technological efficiency and other changes in the economy. All these changes are different for different states. it also showed the reform effects on the state specific disaggregated effects of the change in total consumption of electricity.

There are some limitations in our study and we list them below-

1. It is period wise decomposition analysis which is less informative and hence may not always give a good representation of the real situation.[27]
2. The residual term (D) is also high for most of the States. That means there are some exogenous effects also, which influenced the electricity demand of the States [28].

Chapter four examines the efficiency in use of electricity as multi dimentional quality index of electricity use (proposed composite index of indicators which influnce the consumption of electricity) for the periods 1990-91 and 2000-01. This study also examines the reliability of State wise sectoral consumption of electricity data provided by the States Electricity Boards. In the past studies, the efficiency in use of electricity is used in conjunction with the other term 'intensity in use of electricity' in describing mathematical relationship between energy use and service output. Greater efficiency in use of electricity means that less electricity is required in performing a given tash. Our attempt is to make an alternative approach of estimating efficiency in use of electricity of the major states in India. This chapter discussed the rationale behind capturing of all indicators which can influence the demand for electricity rather than taking only intensity of electricity use in the process of mesuring the quality of electricity use by the final consumers of the States in India. The explicit analytical solution obtained by 'Principal Component Analysis' (PCA). In the estimation of the composite index of electrical power use efficiency, we have used 13 numbers of causal variables (Inverse Real Tariff of Per Unit of Electricity Consumption, Per Capita GSDP, Share of Gross Irrigated Area by the States in Total Irrigated Area in India, Share of Consumption of Electricity in the Industry Sector by the states in total consumption in the industrial sector in India, Number of Households Electrified, Share of Route Length of Railways by the States in Total Route Length in India, Sectoral Share of Gross State Domestic Product).

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[27] *B. W. Ang and S. Y .Lee, 'Decomposition of Industrial Energy Consumption: some methodological and application issues', Energy Economics, 1994 16(2) pp 83-92.*

[28] **The author is thankful to the participants in The Indian Econometric Society Conference, 2006.**

Empirical results revealed that there is very few match in the ranks by the final and initial mesurement of the States in both the periods. The results supported that at the level of the aggregate economy (or even at the level of an end-use sector) electricity intensity is not a sufficient measure because of the heterogeneous nature of the output of the States. It also concluded that even after several years of initiating power sector reforms, the outcome has not been very satisfactory for the States in India. This sector has not been able to attract the investment capital needed and the bulk of the investment guaranteed by the Government.

Some unavoidable limitations in our study are listed below.

1. The causal variables might not be sufficient as indicators of overall electricity consumption by the States. The study might be an underestimation of the actual fact.
2. Since the data were not available for integrated time path our study has to be confined in period wise analysis.

Despite such limitations, the accountability framework clarified the conditions under which the regulator will be effective in supporting sector reforms. An independent regulator is needed to enforce, the separation between policy maker and provider, but if the separation is not initiated with the complete information (state wise and sector wise) about the physical and financial conditions of electricity boards of a country, the regulation may be ineffective. More importantly, our study also brought out the shortcomings of 'all India' uniform reform model. This implies that for power sector reforms each state should be treated differently, depending upon the state specific problems. Experience so far suggests that regulation and information, two interlinked parts of overall power sector reforms, are important in successfully implementing private sector participation in the electricity sector and in promoting greater voice in service delivery.

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Annexure:

1. State Sectoral Share in GSDP in Fractional Form

1990-91	S_{0c}	S_{0a}	S_{0i}	S_{0r}	Y_0
States	**Commercial**	**agriculture**	**Industry**	**Railway traction**	**Total**
Andhra Pradesh	0.254174	0.311273	0.223041	0.016077	33336.22
Assam	0.20294	0.334889	0.284273	0.009405	10620.66
Bihar	0.187255	0.377089	0.286008	0.024092	26428.78
Gujarat	0.2192	0.251568	0.336362	0.015734	27996.06
Haryana	0.214413	0.433996	0.235705	0.010954	13636.43
Himachal Pradesh	0.245912	0.265066	0.22953	0.000803	2815.19
J & K					
Karnataka	0.280817	0.312344	0.227116	0.004009	23300.4
Kerala	0.263863	0.26568	0.247379	0.004556	14098.1
Madhya Pradesh	0.197824	0.348313	0.258575	0.036162	30471.98
Maharashtra	0.258168	0.193977	0.32466	0.01105	64433.26
Meghalaya	0.327798	0.231476	0.218435	0	889.51
Orissa	0.233299	0.297369	0.257201	0.026659	10903.75
Punjab	0.233631	0.43593	0.205427	0	18882.59
Rajasthan	0.232475	0.427495	0.197974	0.018455	20710.07
Tamil Nadu	0.295332	0.178305	0.336761	0.009098	31339.38
Uttar Pradesh	0.241994	0.400681	0.202697	0.017438	55505.71
West Bengal	0.269823	0.26087	0.267945	0.01345	34797.1

2. State Sectoral Share in GSDP in Fractional Form

1995-96	S_{1c}	S_{1a}	S_{1i}	S_{1r}	Y_1
States	**Commercial**	**Agriculture**	**Industry**	**Railway traction**	**Total**
Andhra Pradesh	0.14400	0.29488	0.22304	0.01564	79853.58
Assam	0.11450	0.36216	0.19280	0.00799	19411.37
Bihar	0.29937	0.40269	0.08224	0.02972	24483.47
Gujarat	0.25926	0.18768	0.38622	0.01376	71885.61
Haryana	0.20718	0.36263	0.28261	0.00935	29788.93
Himachal Pradesh	0.24354	0.23272	0.31481	0.00073	6698.28
J & K	0.31863	0.28556	0.20232		8096.79
Karnataka	0.28594	0.30286	0.24499	0.00307	56214.56
Kerala	0.33070	0.25540	0.20732	0.00318	38762.32
Madhya Pradesh	0.24448	0.32999	0.24022	0.02813	47841.80
Maharashtra	0.35019	0.16007	0.31417	0.00782	157818.14
Meghalaya	0.39813	0.23408	0.16264	0.00000	1995.84
Orissa	0.20394	0.37092	0.22530	0.02842	26572.79
Punjab	0.24132	0.42736	0.20580	0.00000	38614.86
Rajasthan	0.25273	0.31981	0.26332	0.01665	47313.48
Tamil Nadu	0.30578	0.17741	0.33445	0.00579	78486.53
Uttar Pradesh	0.27417	0.35793	0.20491	0.01725	106249.46
West Bengal	0.29620	0.28178	0.22029	0.01202	73864.61

3. State Sectoral Share in GSDP in Fractional Form

2000-01	S_{2c}	S_{2a}	S_{2i}	S_{2r}	Y_2
States	**Commercial**	**Agriculture**	**industry**	**Railway traction**	**total in Rs Crore**
Andhra Pradesh	0.291154	0.257209	0.221362	0.013309	137602.02
Assam	0.267238	0.324625	0.243066	0.012153	34029.80
Bihar	0.327253	0.351142	0.093576	0.022599	46259.05
Gujarat	0.287311	0.124258	0.406697	0.008209	112049.23
Haryana	0.251512	0.309871	0.278468	0.007357	53786.61
Himachal Pradesh	0.243838	0.224567	0.270604	0.000682	12941.96
J & K	0.347271	0.255403	0.149914	0.000000	14249.00
Karnataka	0.31437	0.253119	0.229991	0.002554	105398.21
Kerala	0.371061	0.192933	0.985561	0.003492	69041.93
Madhya Pradesh	0.275121	0.247302	0.274327	0.020085	72604.24
Maharashtra	0.378023	0.114785	0.316917	0.006584	258271.87
Meghalaya	0.400077	0.223234	0.168337	0.000000	3626.95
Orissa	0.263131	0.28479	0.204861	0.017559	36386.15
Punjab	0.248082	0.38395	0.207572	0.000000	68448.33
Rajasthan	0.271555	0.258501	0.236068	0.012259	76440.19
Tamil Nadu	0.341253	0.1366	0.298205	0.006722	137304.73
Uttar Pradesh	0.30985	0.316721	0.198879	0.016250	180947.60
West Bengal	0.353276	0.232081	0.209951	0.000836	140232.34

Source: National Account Statistics, CSO

4. Sectoral Intensity of Power Consumption in Mwh /Rs.Crore

1990-91	I_{0c}	I_{0a}	I_{0i}	I_{0r}	I_0
States	commercial	Agriculture	industry	Railway traction	Total
Andhra Pradesh	0.06	0.50	0.98	0.57	0.48
Assam	0.05	0.00	0.30	0.00	0.15
Bihar	0.06	0.15	0.37	0.61	0.22
Gujarat	0.00	0.72	0.70	0.57	0.57
Haryana	0.06	0.46	0.53	0.00	0.50
Himachal Pradesh	0.13	0.03	0.93	0.00	0.63
J & K					
Karnataka	0.03	0.45	1.10	0.00	0.49
Kerala	0.16	0.06	0.86	0.00	0.41
Madhya Pradesh	0.08	0.13	1.04	0.56	0.49
Maharashtra	0.04	0.47	0.52	0.48	0.44
Meghalaya	0.11	0.00	0.36		0.41
Orissa	0.05	0.07	1.01	0.76	0.41
Punjab	0.09	0.68	1.33		0.74
Rajasthan	0.11	0.31	0.93	0.05	0.44
Tamil Nadu	0.15	0.69	0.69	1.03	0.52
Uttar Pradesh	0.11	0.33	0.65	0.87	0.36
West Bengal	0.03	0.06	0.19	0.88	0.17

5. Sectoral Intensity of Power Consumption in Mwh /Rs.Crore

1995-96	I_{1c}	I_{1a}	I_{1i}	I_{1r}	I_{1}
States	**Commercial**	**Agriculture**	**industry**	**Railway traction**	**Total**
Andhra Pradesh	0.06	0.48	0.36	0.51	0.30
Assam	0.07	0.01	0.14	0.00	0.09
Bihar	0.05	0.13	1.68	0.56	0.27
Gujarat	0.03	0.75	0.33	0.33	0.34
Haryana	0.04	0.36	0.24	0.32	0.29
Himachal Pradesh	0.07	0.01	0.46	0.00	0.40
J & K	0.03	0.13	0.13		0.21
Karnataka	0.03	0.43	0.33	0.18	0.28
Kerala	0.06	0.03	0.07	0.00	0.19
Madhya Pradesh	0.06	0.51	0.69	0.80	0.48
Maharashtra	0.02	0.53	0.30	0.66	0.26
Meghalaya	0.05	0.00	0.19		0.26
Orissa	0.05	0.02	0.48	0.17	0.19
Punjab	0.06	0.36	0.82		0.43
Rajasthan	0.06	0.29	0.41	0.23	0.29
Tamil Nadu	0.07	0.48	0.37	0.75	0.31
Uttar Pradesh	0.07	0.26	0.31	0.42	0.26
West Bengal	0.03	0.06	0.13	0.52	0.12

6. Sectoral Intensity of Power Consumption in Mwh /Rs.Crore

2000-01	I_{2C}	I_{2a}	I_{2i}	I_{2r}	I_2
States	Commercial	Agriculture	industry	Railway traction	Total
Andhra Pradesh	0.03	0.32	0.22	0.51	0.21
Assam	0.02	0.00	0.03	0.00	0.06
Bihar	0.03	0.10	0.87	0.68	0.17
Gujarat	0.03	1.04	0.20	0.43	0.28
Haryana	0.03	0.31	0.14	0.25	0.20
Himachal Pradesh	0.05	0.01	0.35	0.00	0.25
J & K	0.03	0.04	0.20		0.20
Karnataka	0.04	0.24	0.16	0.10	0.16
Kerala	0.03	0.03	0.06	0.08	0.16
Madhya Pradesh	0.04	0.57	0.33	1.10	0.35
Maharashtra	0.02	0.37	0.21	0.58	0.16
Meghalaya	0.03	0.00	0.19		0.17
Orissa	0.04	0.02	0.35	0.31	0.30
Punjab	0.05	0.31	0.58		0.33
Rajasthan	0.05	0.35	0.28	0.26	0.23
Tamil Nadu	0.04	0.48	0.29	0.50	0.24
Uttar Pradesh	0.03	0.09	0.14	0.33	0.14
West Bengal	0.02	0.04	0.10	4.52	0.07

Sectoral Intensity = Sectoral power Consumption / Sectoral output in GSDP

7. Consumer Category wise Average Tariff in Paise/ Kwh in 1990-91

States	domestic	commercial	agriculture/irr	industry	Rly trac.
Andhra Pradesh	64.2	135	4.5	336	131.3
Assam	60	108.1	50	159.6	
Bihar	54.6	95	9.4	319.8	161.5
Gujarat	69.1	69.1	21.5	247.7	114.1
Haryana	56	123	30	311	NA
Himachal Pradesh	43.5	82.5	20	214.8	NA
Jammu & Kashmir	30	66.7	10	40	NA
Karnataka	69.1	183	9.7	221.3	NA
Kerala	48.7	78	22	172.6	NA
Madhya Pradesh	20.1	112.7	25.9	325.6	158.3
Maharashtra	55	103	9	219	115
Meghalaya	44	68	21	110	NA
Orissa	54	102	32.1	203.5	103
Punjab	74.5	106.5	7.5	236	NA
Rajasthan	57.6	110.4	29.5	199.9	108.7
Tamil Nadu	57	110.3	8.9	306.2	108
Uttar Pradesh	65.3	97.2	21.3	251.3	129
West Bengal	58.7	100.4	24.5	237	89.6

8. Consumer Category wise Average Tariff in Paise/ Kwh in 2000-01

States	domestic	commercial	agriculture/irr	industry	Raly trac.
Andhra Pradesh	174	426	14	441	468
Assam	199.81	485.68	287.15	447.56	0
Bihar	109.5	276.6	13.37	362.26	376.24
Gujarat	265	501	62	476.67	506.00
Haryana	280.51	451.14	47.71	477.94	432.24
Himachal Pradesh	109	270	50	275	0
Jammu & Kashmir	85	160	220	135	0
Karnataka	282	572.12	38.8	480.73	413.93
Kerala	81.02	436.4	67.21	226.69	198.26
Madhya Pradesh	159.58	430.64	7.2	437.84	506.12
Maharashtra	248.02	456.39	82.28	208.84	419.93
Meghalaya	135.27	192.13	51.61	208.84	0
Orissa	0	0	0	0	375.71
Punjab	216.86	374.81	0	306.48	0.00
Rajasthan	190.93	432	46.33	395.13	405.88
Tamil Nadu	181.1	430.77	1.34	395.35	385.11
Uttar Pradesh	181.09	466.72	119	482	412.18
West Bengal	182.87	271.31	91.86	352.82	369.96