DEMAND FOR ELECTRICITY IN ASSAM

With Special Reference to Urban Areas

Dissertation

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CHAPTER I

INTRODUCTION

In this dissertation we have made an effort to study the demand for electricity in Assam with special reference to urban areas. Since it is a very vast subject and also data on all items regarding energy are not adequate, we have tried to estimate some of them which are not up-to date. Conventional as well as non-conventional sources of energy have been discussed in this dissertation. The non-conventional sources of energy are yet to be utilised in a large scale though they are important in view of overall scarcity of fossil fuels in our country.

Electricity in India is barely hundred years old. The first Power supply was commissioned in 1897 in Darjeeling. In pre-independence days the generation and distribution of power was only in the private sector and confined to urban areas. The total power installation capacity in 1947 was as low as 1400 MW. With the advent of the five year plans, Power generation programme made phenomenal progress in our country. The increase in energy production between 1950-51 and 1991-92 is of order of 42 fold, Six fold in crease in the production of coal and 130 fold increase in the production of oil. The total requirement of energy in the economy is likely to double between 1986 and

2004. Studies also show that while the demand for electricity in the entire economy has risen at the rate of about ten percent during 1980-87 the demand for household and agricultural sectors increased at the rate of 14.03 percent and 14.58 percent respectively per year. Therefore, the growth of demand for electricity in India appears to be very much faster than the general pattern for developed countries and there is a high probability that this high rate will continue for some more time to come.

The sources of power production are thermal, hydel, nuclear and non-conventional. Thermal energy generation is based on coal, furnance oil and natural gas and hydro-power is mainly based on canal net work knitted by dams. India is a varitable fountain head of hydro-power which represents a renewable sources of energy and enjoys many intrinsic advantages as compared to thermal power. To-day power production in India is in private as well as central and state sectors.

During 1990-91, a target of 4,212 MW was envisaged comprising 2970.5 MW thermal, 1006 MW hydro and 235 MW nuclear. The achievements were 2776.5 MW comprising 2331 MW thermal and 445.5 MW hydel. For 1991-92 the capacity addition programme has been of 3810.8 MW comprising 2586.5 MW thermal, 754.3 hydro and 470 MW nuclear. Against this capacity of 3026.5 MW was added comprising 2370.5 MW thermal, 436 MW hydro and 220 MW nuclear. In short, the installed power generation capacity in the country increased from a meagre 1400 MW in 1947 to about 69,000 MW at the end of 1991-92. (S.K. Nayyar, 93).

As is known, electricity is one of the most infrastructure for development. To-day, a world without electric power ean hardly be conceived. The use of electricity for human beings commences at the cradle and ends at the crematorium with innumerable uses in between. The sources of electricity in Assam which are known as conventional have been described in details. The other non-conventional sources could not detail due to non-availability of requisite data.

The actual picture of energy consumption is yet to be determined with caution. First the energy consumption in manufacturing and mining is not up-to-date. The trend of consumption in agriculture sector is sluggish, since the majority of the farmers are small or marginal. In the transport sector one can estimate with near accuracy. But so far the domestic fuel consumption is concerned, hardly any information is available. All data are estimated. Nearly 200 million households of India use variety of fuels for different purposes. The major portion of energy consumed goes for cooking. None takes seriously how many kilograms of firewood or dry leaves a rural household burns every day and what percentage of it is actually wasted. The people living in the urban slumps collect torn papers, sticks any thing, they could burn. But we know the wood equivalent when we estimate the demand. Knowing the demand alone is not sufficient, the supply source is also to be studied carefully. (K.Bez,'90)

The use of electricity has limitation both in urban and rural households. As we have seen during the course of investigation a rural family uses electricity mainly for lighting purpose. Supply of electricity in rural areas frequently disrupts for which people remain in darkness hours together. In urban areas, however, supply continues for more time as compared to rural areas. An urban household uses electricity other than lighting purpose. The income of the households and family size determine the consumption of electricity. A family with higher income uses electricity for heating, cooking and for other purposes besides lighting. A big family uses more electricity in different rooms for lighting purpose. But the amount of electricity used by the household can not be discerned as it appeared from the electricity bill that the number of units consumed are not given but the bills contain small amount of money. In certain cases the amount shown in the bill is many more times than the actual consumption.

Now we shall give a brief account of chapters in this dissertation.

The Second chapter of this dissertation deals with the review of literature of the energy use pattern in some of the developing countries of the world.

Chapter Three has been devoted to deal with the energy situation in India. At the begining we have discussed about the sources of energy both commercial and non commercial in our country. Energy cousumption pattern in industry, transport, agriculture and domestic sector of India has been detailed in this chapter. A brief description of energy sources both conventional and non-conventional and also the development of power industry have been given here. Some important tables in connection with various sources of energy in our country are presented in this chapter.

In the Fourth chapter, we have discussed about power potential and its development in Assam. At the out set socio-economic characteristics of Assam including population size and growth pattern, urbanisation, percapita income and educational status have been given. Land use pattern, waste land and agricultural wastes, land covered by forests and fallow land of Assam are also accounted here. Energy from agricultural wastes and animal wastes, has been estimated and presented in this chapter. Sources of energy, Power situation in Assam, functioning of Assam State Electricity Board (ASEB), progress of rural electrification in Assam and.tariff policy of ASEB have been discussed here. A few tables in connection with power supply and energy consumption in Assam are presented in this chapter.

In chapter Five, we have analysed survey data of our study. Socio-economic composition of sample population is given at the begining of the chapter. Energy consumption for cooking and lighting in domestic sector and energy used for transportation have been analysed here. Some important tables relating to energy consumption and family size, income of the household of survey data have been presented in this chapter.

Chapter Six deals with econometric analysis of survey data. Data base including sources of data and sampling frame and also data arrangement have been given here. The chapter contains the methodology of study and models adopted for empirical analysis of survey data. Linear regression equations applied for calculating each type of fuel and combined fuel expenditure of sample households have been shown and described in this chapter.

Finally in chapter Seven, we have concluded on the basis of entire findings. The demand as well as supply of fuel is a newly brance of economics. In some countries e.g. West Germany, they have seperate department of Energy Economics. We have still to go far ahead.

In this dissertation, we only could begin with the problem and for a real analysis of demand for power is very difficult to make due to non-availability of data, we have mentioned some of these facts in these chapters.

CHAPTER-II

PATTERNS OF ENERGY CONSUMPTION IN DEVELOPING COUNTRIES : AN OVERVIEW

Energy is the name given to the ability or capacity to do work. It provides the power to progress. All energy available to men can be classified into animate energy forms. Animate energy forms are those which function through living organism such as plants, animals, bacteria and fungi. Inanimate energy forms include fossil fuels like coal, oil and natural gas which are especially derived from non-living matter. Coal, oil and natural gas are the exhaustible forms of energy sources and once used, they can not be replaced or renewed. These are called fund resources. On the other hand, solar energy, wind power, tidal power, geothermal energy etc. are self renewable sources of energy. They are called flow resources. (Bhaskar Moni, 1988)

The principal energy needs that correspond to the human needs are-1) for agriculture, irrigation, draft power, fertilizers, manufacture of implements, crop processing, food transport, food storage; 2) for cooking ; 3) for providing clean domestic water which in some places includes energy for boiling drinking water; 4) for heating house and worming water for bathing in cold climates; 5) for washing clothes; 6) for personal transport; 8) for processing and fabricating materials needs for house construction, pots and pans, cloths, tools, bycicles, etc; 9) for transport of good; 10) to run local health services, schools and other educational institutions, Government offices, and other community uses. (A. Makhijani, 1977)

Researchers in the field of economic development recognised the special role of energy inputs in furthering economic growth. Considering the strategy for development in the general framework of unbalanced growth for a developing economy, Hirschaman distinguished between Social Overhead Capital (SOC) and Direct Productive Activities (DPA). Power supply was an important element in the SOC category. Provision of adequate supply of power at reasonable prices only could ensure expansion of power intensive activities on which the growth of the economy depended. A number of analysis observed correlation between energy use and economic development. Darmstadter (1971) obtained a high degree of correlation between per capita income and commercial energy consumption per capita for countries having per capita income of at least $300 in 1965. Reddy and Prasad (1977) took a selected number of countries of both advanced and less developed economics, for a similar analysis. They also found a strong correlation between consumption of energy and economic growth indicated by the level of GNP. (D.K.Bose, 1989).

The demand upon energy are almost unlimited and growing space. For the last few decades, coal, oil and natural gas occupy the first position in providing energy to the mankind. The question as to whether world energy resources will be adequate enough to meet the expected demand can not be answered in definite terms. No one really knows what the potential resources of coal, oil and natural gas are. There has been a shift in the relative importance of various resources of energy. Solid fuels like wood, coal etc. supplied about 80 percent of the total commercial energy of the world for the last four decades. But during 1978 and 1980 the production of fossil fuels has been fallen to 37 percent. Experts thought that if this trend is continued further the world will soon suffer from energy crisis.

Normally, in most countries, growth of demand for electricity is an integral part of the process of economic development. As national income increases there is a greater demand for electricity from all sectors. Indeed, the per capita consumption of electricity is an accepted indicator of the relative level of per capita electricity consumption and per capita national product of a country.

As development proceeds, there is a major shift in the structure of energy demand from household uses to transport and industrial uses, including electricity generation. At low levels of income, the household sector is the predominant energy user, often accounting for 50 percent or more of total energy consumption. At higher levels of GNP per head, the share of the household sector falls (to about 20 percent of the total energy in some middle income and industrial countries), and the share of industry and transport rises. This structural change is more noticeable in the move from low to middle income countries. There is less variation between middle and high income countries. The shares of the different sectors in total energy consumption in Argentina and Brazil do not differ greatly from consumption patterns in west European countries.

On the other hand, there is considerable variation with in groups of countries. Within the industrial countries, for example, the U.S.A. and Japan differ from Western European countries, an exceptionally large share of total energy used in the U.S.A. is consumed by the transport sector; whereas in Japan an un usually large portion of the total energy used is consumed by industry. Among the middle income countries, Korea devotes a relatively small proportion of its total energy use to transport and a relatively large proportion to household use.

Energy consumption patterns in the household and commercial sector accounts for a larger share of total energy use in poor countries. What is more surprising is the high per capita consumption and energy intensities in this sector in developing countries. The reason for high per capita household consumption in the poorer countries lies in the fuel mix in this sector. Most of the countries with high per capita household energy consumption (colombia, Gabon, Kenya, Malaysia,,Zimbabwe) also derive a high share of total household fuels from traditional fuels.

Empirical studies of household energy consumption in developing countries indicate that energy consumption in households rises very little as household income increases, and may even decline. At low levels of income, cooking is the main household energy using function; and the amount of cooking fuel used bears little relation to income level. This is illustrated in a recent study of household energy use in Hyderabad, India where total consumption of fuel for cooking hardly varied among households, regardless of the level of household income (Alam et al, 1985; Cecelski et al, 1979). On the other hand, the relationship between household income and individual cooking fuels showed dramatic variation. A 10 percent increase in household income was associated with an 8 percent decline in fire wood consumption. Consumption of LPG, the preferred cooking fuel in Hyderabad, roses at about the same rate as household income. Kerosene plays, in Hyderabad at least, a transitional role, it is used in place of wood at low income levels, then is in turn replaced by LPG at higher income. (J. Dunkerleg'80).

As household modernizes, demand for new services arise, and there are changes in the manner in which old services are performed. The transition from traditional to modern ways of performing household services some times results in new demands such as refrigeration of food. On the other hand, a traditional service such as lighting or space cooling may be better performed by a modern device fuel combination. The replacement of human labour by non-human machines is also a characteristic of the transition. Convenience is a major motivating force in the transition to modern methods, as is the desire for more services; more cooling than ventilation provides, more entertainment than radio provides. Of course, considerations of style and image are at work in the development of new demands.

The majority of Third World urban households makes use of a combination of traditional and modern methods. The mix varies widly among cities. The desire for convenience and more services has led to the growing use of appliances in urban homes. At the same time, the devices and fules used for cooking and lighting are also changing. The move from traditional fuels and devices to Kerosene, gas or electricity depends very much on household income. These changes generally lead to the more efficient use of energy.

Modernization alters the fuel device combinations used for cooking; it means a move from Kerosene to electricity allowing much more lighting and increased services. In other activities, modernizing some times means providing a service previously met with human energy or creating a new services. Within households the three activities that have a major impact on residential 'electricity demand are refrigeration, water heating and air conditioning.

A refrigerator is usually the first electricity intensive appliance to be acquired by urban families when they have sufficient income. It is generally not found in traditional settings. The percentage of urban homes with refrigerators varies from almost zero in China to over 75 in the wealthier cities of Asia.

Changes in the manner of suppporting other activities also involve the acquisition of electricity using appliances. For the most part these appliances do not use much electricity. In places where household electricity use is very low, however, increasing use of such appliances could have a significant effect on electricity demand.

Growth in enregy demand in Third World's urban homes is mainly in the use of electricity. Room for growth in its use exists at nearly all income levels. The level of electricity consumption depends largely on ownership of appliances. Data from the phillipines suggest that the location of the household affects appliance ownership and electricity use. Among households in the same general socio-economic class, those living in the primary city, manila, had more appliances and consumed more electricity than did households living in more provincial urban areas. This may be a result of the greater availability of appliances or the more modern life style of manila. (Sathaye and Meyers'90).

Electricity consumption is closely related to income level. The disparity among countries is greatly reduced when electricity consumption is expressed in terms of GNF. None the less, majopr disparities remain, electricity consumption relative to GNP, which is highest in Jamaica, is 10 times higher than in Nigeria, where electricity consumption relative to GNP is the lowest. The exceptionally high Jamaican electricity intensity is due to the disproportionate size of the Aluminium industry in its economy but other countries, such as India and Korea, which have no such obvious cause, have almost as high an intensity. These countries demonstrate the importance of electricity pricing and supply policies as well as industrial structure in determining electricity intensities. India, for example, has a strong policy commitment to electricity, which stems both from extensive rural electrification and the decision to use low quality coal in the form of electricity.

From the point of view of fuel substitution, electricity is particularly interesting because of the high degree of substitutability among fossil fuels. Estimates of elasticities of interfuel substitution in thermal electricity generation invariably are quite high, for example, a 10 percent increase in oil prices would increase the demand for coal by as much or even a little more (Choe, 1984).

The share of thermal electricity generation in the total differs markedly among countries. Only a few countries Argentina, India, South Korea have nuclear generation, which, at present accounts for a small part of the total. Brazil and several African countries rely heavily on hydro-electricity. It accounts for 92 percent of Brazils capacity. For the countries that rely largely on thermal electricity, however, oil and in the case of South Korea, Thailand, and Jamaica, imported oil, is invariably the major fuel.

The reasons behind these differences in structure of generating capacity are related domestic energy endowments. Countries that rely heavily on hydro-generation are those with cheap, accessible hydro resources. The importance of resource endowment is also evident in the structure of thermal generation. Thus 85 percent of Indias thermal generation is based on domestic coal, Gas is also widely used where it is available domestically, as in Mexico, Venezuela, Nigeria and Gabon.

The intensity of industrial energy use varies considerably among countries. The differences when corrected for exchange rate basis, can be attributed to three factors the size of the industrial sector, the composition of the industrial sector in terms of energy intensive and less energy intensive industries and the energy intensiveness of the individual manufacturing process.

Traditional fuels continue to play a major part in the supply of industrial fuel of developing countries. Much of this fuel is used in agro-processing industries such as sugar processing and tobacco drying. However, commercial fuels are the main source of energy for the industrial sector in almost all countries. Among commercial fuels, petroleum is generally the most widely used, though, its share in total industrial energy consumption varies widely. This variation is related to domestic endowments of energy resources. India and Zimbabwe, for example, rely heavily on domestic coal, oil accounts for under 20 percent of their total industrial energy supplies. The share of oil in Pakistan, Mexico and Venezuela, which use domestic gas in industry is also low. Countries without domestic resource, such as Jamaica, depend strongly on petroleum, as do oil producing countries such as Indonesia and Nigeria.

There is wide variation in the share of electricity in total industrial fuel supplies. It tends to be low in the poorer countries, although there is little difference between the middle income and industrial countries. The influence of domestic resource endowment is reflected in the high share of electricity in countries such as Argentina, Brazil, Chile and Zimbabwe that have extensive hydro resources.

The wide variation in share of different fuels in the industrial sector suggests the existence of considerable substitutability among fuels.

Per capita energy consumption in the transport sector among the developing countries ranged from 27 Kilo grams oil equivalent in India to 670 kgoe in Venezuela. The variation among countries is explained by income level which is much reduced when transport energy consumption is related to GNP.

The variations can be attributed also to differences in passenger and freight tonne Kilometres travelled in the transport mode, and to differences in the fuel efficiency of each type of transport. In a study that compared west European countries with the USA, these three factors were found to contribute to the higher US energy transport - GNP ratio in almost equal parts (Darmstadter et al, 1977). The experience in some developing countries suggests that the number of passenger and freight kilometres rises rapidly as development proceeds, at a rate well in excess of the growth of GNP. In Brazil, freight transport grew at an average of over 10 percent a year between 1968 and 1979 (poole, 1983). In India between 1960 and 1977, freight transport rose by over 5 percent and passenger transport by over 7 percent annually.

In all countries, road transport dominates the sector accounting typically for about 80 percent of the total fuel consumed in transport. Empirical studies of the demand for gasoline and diesel fuels for road transport indicate an income elasticity substantially greater than unity for the developing countries (Choe, 1984). Industrial and agricultural development leads to increased movement of passengers and freight, and higher incomes give rise to increased demand for leisure - related transport, specially in middle income countries.

The consumption of transport fuels is also affected by other factors. Geography and land use can affect the number of freight and passenger kilometres travelled. Transportation policies with regard to infrastructure investment, taxes on transport equipment, regulation and traffic management also affect energy consumption by the transport sector. (Dunkerley '90).

The mix of energy sources to meet the high energy demands for the Asian countries depends on relative prices; industrial structure, technology and the individual country's natural energy resources.

The aggregate primary energy consumption since 1986 has been higher than at any time prior to the first oil crisis in 1973. The increase in demand is only partially attributed to growth in income or industrialisation. The main phenomenon being the lower oil prices since 1986.

The per capita energy consumption varies with per capita income and degree of industrial development. The per capita consumption of energy in Phillipines is lower than expected in relation to its income and industrial development. In 1987, the per capita energy consumption in Philipines, Malaysia, Thailand and Indonesia was lower than the average of their middle income economics. As incomes grow in Asia, there would be a trend towards higher energy consumption. Recent data on gasoline and electricity consumptions indicate this trend.

The changes in oil prices have brought about changes in the structure of demand for the various sources of energy. The second oil shock of 1979-80 forced the Asian countries to increase the efforts to diversify their energy sources. Strong efforts were made to develop indigenous sources like coal, natural gas, geo-thermal, nuclear or hydro-electric power.

It is found that price changes sustained overling period lead to a change in the structure and growth of energy demands. Another factor contributing to structural changes is income growth and urbanization. In several Asian countries there has been a high growth in the demand for electricity. Consumers are increasingly turning to electrical appliances.

There has also been a spurt in the demand for scooters and cars.

By 1985 considerable structural changes were made as indicated in Table 2.1. Dependence on oil fell to 51 percent in Korea and the substitutes were nuclear power and coal. In Thailand oil consumption came down to 65 percent. In Thailand, Malaysia and Indonesia the natural shifts were towards natural gas and coal. After 1985, the efforts of these countries to substitute oil slowed down. In fact, in Phillipines oil consumption shot up to over 72 percent from 66 percent in 1985.

TABLE 2.1

STRUCTURE OF ENERGY DEMAND (PERCENTAGE SHARES)

COUNTRY		1980	1985	1987	1989
1		2	3	4	5
India -	Oil	30.2	29.8	30.2	30.6 *
	Gas	1.3	3.1	4.5	6.5 *
	Coal	52.3	53.1	53.9	54.7 *
	Primary electricity	16.2	14.0	11.1	8.80 *
Indonesia-	Oil	79.7	66.8	64.3	61.9 *
	Gas	17.4	25.6	26.0	26.4 *
	coal	0.6	2.5	4.6	8.4 *
	Primary electricity	2.3	5.1	5.1	5.1 *
korea-	Oil	65.1	51.1	45.5	45.7
	Gas	0.0	0.0	3.1	3.3
	coal	31.7	39.7	34.7	35.4
	primary electricity	3.3	9.3	16.7	15.7
Malaysia-	Oil	87.8	77.2	63.12	51.0 *
	Gas	7.4	11.8	26.2	38.0 *
	Coal	0.6	2.9	2.3	1.8 *
	Primary electricity	4.2	8.1	8.5	8.9 *
Pakistan-	Oil	36.7	38.8	39.0	39.2 *
	Gas	41.0	37.4	35.0	32.7 *
	Coal	5.2	7.2	10.2	14.0 *
	Primary electricity	17.2	16.7	18.2	19.8 *
Phillipines	Oil	86.8	65.7	72.3	78.0 *
	Gas	0.0	0.0	0.0	n.a
	Coal	2.1	10.6	8.0	6.0 *
	Primary electri-	11.1	23.7	19.8	16.0 *
Thailand-	Oil	93.6	64.7	62.0	60.6
	Gas	0.0	20.1	22.6	24.5
	Coal	3.6	9.7	10.6	10.8
	Primary electricity	2.8	5.4	4.8	4.1

Note :- Data with asterisks are estimated.

Source:- Asian Development Bank,Energy Indicators of Developing member countries of ADB,May 1989

Price changes, income growth and environmental concerns are all influential factors in determining energy demand patterns. Of the various alternatives, nuclear power is not considered available option. Its safety and environmental impacts are not likely to make it totally acceptable. For similar reasons coal too would experience difficulties in being accepted as a positive alternative to oil. Besides, there is also the problem of infrastructure and finding suitable sites for thermal stations near urban centres. Thus, natural gas will continue to be a major source of energy whose price and supply are closely linked to the oil markets.

With the present trends in energy consumption it is felt that Asian countries will be competing with the U.S. and Europe for the supply of the persian gulf oil. In fact, their dependence will be greater than the developed nations. Oil supply and oil prices are beyond the control of these countries. Therefore, it is imperative for them to employ mechanisms of conservation and explore alternative sources of energy (Asia Energy Digest '90).

CHAPTER III

A BRIEF SURVEY OF INDIAN ENERGY SITUATION

3.1. INTRODUCTION.

The need for energy in a developing society can hardly be over-emphasised. It is a basic input required to sustain economic growth and to provide basic amenities of life to the entire population of a Country. In the Indian Context, fulfilment of the national objectives of removing unemployment and poverty are going to require a very significant input of energy.

It is an undisputed fact that economic progress is crucially dependent on and intimately linked to steady and reliable supply of energy. To a developing nation, the growth process from the low economic base is dependent upon adequate supplies of energy and defficiencies in energy supplies effect the very growth.

The phenomenon of modern society with its Computer run factories and skyscraper-studded cities and more comfortable facilities for an average citizen to-day could also be explained by the advent of energy as the maker of Complex industrial Culture. Energy is at the heart of modern industrial society.

While importance of power in the industrial field has long been recognised in our country, it is only recently that its importance in the agricultural field also has become to be acknowledged. Agricultural output is the single most important of the gross domestic product of India. Here the choice must be a balance, modest but appropriate development model which places greater emphasis on labour intensive, small-scale technologies with rural orientation.

Per capita consumption of Power is now universally accepted as one of the major indicators of economic growth. The requirement of Power and the Position of its availability provide the surest index of a Country's over all economic scene as Power is the basic input for industrial and agricultural activities. Energy has thus emerged as a strategic factor in the process of economic development. An accelerated development programme is, therefore, needed for increased harnessing of energy resources and, thereby, improve the living standard and quality of life, reduce social inequalities and regional imbalances.

India is one of the foremost developing nations in all spheres. The growth of economy, income, Population and urbanisation necessitate higher energy demand. The energy consumption and per capita availability is very low compared to most of the industrialised countries in the world even after likely attainments of gross energy generation of around 275 billion KWH by the end of Seventh Five Year Plan against which the availability through utilities would be of the order of 252 billion KWH.

Both energy production and energy utillisation are the indicators of a country's progress. No industrial development or even large scale food production, water supply or construction of buildings are possible without adequate supply of energy. Therefore, one of the most important tasks of the planning process is to ensure that there is a Sharp increase in the production of energy and its effective utilisation. The development of energy source is highly Capital intensive and large investment are required for meeting the demand of energy for the different consuming sectors. As a result, the energy sector outlays in the Seventh and Eighth Plans are about 30 percent or approximately. One-third of the total plan outlays. Inspite of such large investments there is a growing shortage of energy in all sectors of our economy.

3.2 SOURCES OF ENERGY IN INDIA:

In the present state of scientific and technical knowledge the main energy sources in India can be listed under five headings which come under commercial and non-commercial sources of energy. These are coal, oil and natural gas, hydro-electric power, nuclear fuels and forests (fire wood and char coal). The former four can be categorised under the general description of "Commercial energy" and the latter can be included in the category of "non-commercial energy" because much of it is not ordinarily bought and sold at any rate of recorded transaction. Dried cow dung and vegetable wastes are also come under the category of non-commercial sources of energy.

In India, the other possible sources of energy such as - solar energy, tidal power, wind power and geothermal energy are yet largely untapped because limitations of existing knowledge and techniques of these possible new sources. Solar energy which seems to have greatest potential in India in the long run. conversion of solar energy into electricity can be achieved with the Present techinques at a very high cost and will remain extremely limited in our country untill further research work is developed in this field. Potentiality with regard to other new possible sources are also limited and to generate electric power from these sources will be a costly method in comparision to other maeans of generation. Inspite of high costs and limited technology, a great deal of research and development work is now being undertaken in many countries including India. (Henderson, 1975).

The present energy system in India is more or less based on non--commercial sources (such as fuelwood, agricultural wastes and animal dung), and on commercial sources such as coal, oil and electricity. So far as domestic cooking and heating, non-commercial sources of energy play a very significant role. The domestic needs are largely met, by what are referred to as non-commercial sources of energy.

In India before the advent of coal and other commercial fuels, all the thermal energy used to come from non-commercial fuels. In the aggregate, India consumes almost 50 percent of its total energy through use of non-commercial fuels. But commercial fuels surpassed non-commercial fuels in energy generation only as late as 1968. As a result the share of non-commercial energy sources is falling rapidly. In 1970, the contribution was around 52 percent (350 m.t.c.r*) by commercial energy and 34 percent (178 m.t.c.r.*) by non-commercial energy. The ratio of non-commercial to commercial sources has fallen from 2:1 in 1953-54 to 0.77:1 in 1975-76. The increasing importance of commercial energy is the result of the increse in the aggregate energy consumption and also of the shift of energy consmption away from the non-commercial sources.

Statistics pertaining to non-commercial energy in India is subject to serious limitation. First, figures pertain only to household sector and ignore industrial sector. Second, they are essentially estimates and are derived from certain 'assumptions' regarding per capita household consumption. Third, the interse shares of fire wood, agricultural wastes and animal dungs are again assumed to be constant at 65, 15 and 20 percent respectively. Fourth, animate energy is not taken in to account at all.

Among the various commercial sources of energy, coal is loosing to both oil and electricity. Electricity will continue to be the most preferred source of energy at least during the next 10 years. The share of electricity is, thus, expected to gain further. Coal is also likely to make up a part of what is lost during the last 25 years. In consequence, the share of oil is unlikely to improve further in the next decade or so. Consumption trend in both commercial and non-commercial sources is shown in table 3.1 below. It is more or less evenly based on non-commercial energy sources like fuel wood, agricultural wastes and animal dung and on commercial sources such as coal, oil and electricity. The table shows that the consumption of electricity is increasing rapidly. It has been increased by 91.5 in metric tonne coal replacement values in 1980-81 as compared with 7.6 m.t.c.r. in 1953-54.

TABLE 3.1

CONSUMPTION OF ENERGY (SOURCE WISE)

CATEGORY	1953-54	1965-66	1975-76	1978-79	1979-80	1980-81	1985-86	1990-91
1. Non-commercial	125.9	159.6	194.6	NA	NA	215.9	237.3	263.3
	(67.6)	(52.1)	(423.5)			(40.8)	(26.1)	(31.79)
Total of which-								
1.a.Firewood	82.2	103.8	126.5	NA	NA	140.37	154.2	170.5
1.b.Agricultural wastes	25.1	31.9	38.9	NA	NA	43.27	47.3	52.9
1.c.Cow dung	18.6	23.9	29.2	NA	NA	32.4	35.8	39.9
2. Commercial-	60.4	147.0	232.7	294.3	303.7	312.9	420.7	564.4
	(32.4)	(47.9)	(56.5)	---	---	(59.2)	(63.9)	(68.21)
Total of which-								
2.a.Coal	28.7	51.8	71.0	68.8	71.4	71.3	99.5	138.8
2.b.Oil	24.1	64.6	115.7	141.1	145.6	150.1	194.4	245.7
2.c.Electricity	7.6	30.6	66.0	84.4	86.1	91.5	126.8	179.9
3. Total (1+2)	186.3	306.6	447.3	-	-	528.8	658.0	827.7

Note: (i) Figures in brackets indicate the share of non-commercial and commercial energy.

(ii) Asterisks data are estimated.

Source : Economic and Political weekly, March 13, 1984. vol. XIX. No.13.

3.3 PATTERNS OF ENERGY CONSUMPTION IN INDIA:

Economists have studied several issues including the level of economic development, relative energy consumption level in the various economic sectors and subsectors, major energy consuming activities in a particular sector, type, cost/ other characteritics of energy consuming equipment in use, energy price and so on, in trying to identify the diterminants of energy demand.

To get a clear idea of the energy demand aspects of a country obviously entails very large data base requirement. In a developing country, like India, such data are not usually compiled systematically. However, we shall try to make an attempt to present energy and related data for major energy consuming activities in the following sections.

There are four main energy consuming sectors namely, industry, transport, household and agriculture. Of these, industry is the maximum energy consuming sector followed by transport, household and agricultural sectors. The share of each of these sectors for the years from 1953-54 to 1990-91 is given bellow in table 3.2.

TABLE 3.2

SECTORWISE AND SOURCEWISE CONSUMPTION OF COMMERCIAL ENERGY IN INDIA.

SECTORS/PERIOD	PERCENTAGE SHARE OF DIFFERENT SOURCES OF ENERGY			
	COAL	OIL/GAS	ELECTRICITY	TOTAL
Household				
1953-54	17.3	77.2	5.5	100.0
1965-66	15.5	75.6	8.9	100.0
1978-79	10.0	71.2	18.8	100.0
1990-91	3.9	77.1	19.0	100.0
Agriculture				
1953-54	--	89.0	11.0	100.0
1965-66	--	70.0	30.0	100.0
1978-79	--	61.8	38.2	100.0
1990-91	--	57.1	42.9	100.0
Industries				
1953-54	61.5	16.2	22.3	100.0
1965-66	49.5	13.3	37.2	100.0
1978-79	44.5	7.9	47.6	100.0
1990-91	69.96	13.1	17.3	100.0
Transport				
1953-54	56.4	40.8	2.8	100.0
1965-66	34.8	62.9	2.3	100.0
1978-79	13.3	83.9	83.9	100.0
1990-91	9.6	88.9	88.9	100.0
Others				
1953-54	35.3	--	64.7	100.0
1965-66	8.2	23.1	68.9	100.0
1978-79	11.9	36.2	51.9	100.0
1990-91	--	29.2	70.8	100.0

Source : (i) Economic and Political weekly, March 13, 1984.

(ii) Yojana, Republic Day Special , 1993.

In table 3.2 it has been found that coal is consumed in large quantity by the industrial sector, while oil is used maximum in the transport sector. Utilisation of electricity in agricultural sector recorded a rising trend.

The table shows from a mere 0.198 MTRC in 1953-54 (11.0%) the consumption of electricity rose to 11.958 MTRC in 1978-79 (38.2%) in agricultural sector. Electricity is increasingly preferred in agriculture becasue of the fact that this sector has been accorded a high priority in India's national planning and the government provides inputs including energy at subsidised prices. The number of pumpsets being energised every year is also increasing and the Rural Electrification Corporation looks after that task. But it must also be noted that agricultural sector consumes only 17 percent of electricity although it contributes 35 percent of the country's Gross Domestic Product. Whereas industry contributes only 19 percent of the gross domestic Product but consumes 60 percent of electricity. Compulsions of industrialization lead to increased consumption of energy, particularly from the commercial source. An EIR special report (1979) emphasises that the key to India becoming a major industrial power of 2020 A.D. is nuclear power.

The share of each of these sectors for the years 1990-91 and 1996-97 is given below :

TABLE 3.3.

SHARES OF FOUR MAIN SECTORS IN COMMERCIAL ENERGY CONSUMPTION DURING TWO YEARS :

Sector	1990-91 (%)	1996-97(%)
Industry	51.0	46.3
Transport	23.3	25.4
Household	13.8	15.8
Agriculture	9.6	8.8
Others	2.3	3.7
Total	100.0	100.0

Source:Yojana, Republic day special ,93.

It can be seen from the table that during the last year of the plan, industry and agriculture are expected to record a fall in the Power Consumption whereas transport and household sectors will record an increase.

From the year 1990-91 till the end of the Eighth Plan (1996-97) the relative shares of the four sectors in energy consumption are indicated in table 3.4.

TABLE 3.4

RELATIVE SHARES OF DIFFERENT FORMS OF COMMERCIAL ENERGY IN VARIOUS SECTORS (%).

Sector	Years	Coal	Oil/Gas	Electricity
Industry	1990-91	69.96	13.1	17.3
	1996-97	69.02	11.6	19.2
Transport	1990-91	9.6	88.9	1.5
	1996-97	4.0	94.7	1.3
Household	1990-91	3.9	77.1	19.0
	1996-97	7.3	68.9	23.8
Agriculture	1990-91	-	57.1	42.9
	1996-97	-	50.2	49.8
Others	1990-91	-	29.2	70.8
	1996-97	-	48.2	51.3

Source : Yojana, January 26, 1993.

It is evident that all sectors will record a substantial increase in electricity and oil and gas consumption. The transport and household sector will record a substantial increase in oil and gas consumption whereas agriculture will record a decrease in oil and gas consumption while electricity consumption will increase in agriculture sector.

From the energy scenario presented above, it is clear that from the First Plan to the Seventh Plan, there has been a phenomenal increase in energy consumption. Despite such an increase in the commercial energy, the percapita energy consumption in India is still one of the lowest in the world. It recorded 123.5 KGOE during 1990-91. However, if non-commercial energy consumption is also included, the per capita consumption goes up to 265.4 KGOE. The per capita electricity consumption in India is presently around 253 Kwh (Qasim,93).

3.3.1 ENERGY CONSUMPTION IN INDUSTRIES:

Industry is a major energy consuming sector in India. But the data availability is quite inadeqate and out-of-date. The most recent period for which data on Industrial output and energy are available in physical units, is 1978/79. As energy prices vary from state to state, it becames difficult to use such data meaningfully for analytical work.

Where time series data are available in physical units, the classification of industries for which coal consumption data are available, is not consistent with that for petroleum products or/and electrical power consumption data. This makes it difficult to estimate energy consumption in various categories of Industries. Furthermore, consumption of fuelwood and charcoal-which are used particularly in the unregistered manufacturing sector-is not documented.

A simple analysis shows that the following manufacturing industries spend a very high portion of their value added on energy purchases :(i) non-metalic mineral products,(ii) basic metals and alloys;(iii) chemicals and chemical products, (iv) paper and paper products, and (v) cotton textiles. These industrial categories are likely to be more energy intensive than other manufacturing industries. Table 3.5 shows the consumption of energy by industries in India for the period from 1970-71 to 1986-87 (TEDDY 1988).

TABLE 3.5

ENERGY CONSUMPTION IN INDUSTRY.

	1970-71	1976-77	1982-83	1984-85	1985-86	1986-87(a)
Electricity purchased from utilities(GWH)	29579.1	41605.6	53063.8	63019.3	66980.1	71495.9
Self generated electricity(GWH)	5347.2	7240.3	9989.0	12303.0	12997.3	N.A.
Total Electricity Consumpteions(GWH)	34926.3	48845.9	63052.8	75322.3	79977.4	N.A.
Fuel oilscons(b) ('ooot)	N.A.	3641.0(c)	4304.(d)	4458.0(d)	4639.0(d)	4887.0
Naphtha cons.('ooot)	N.A.	2183.0	2958.0	3125.0	3101.0	3231.0
H.S.D. cons ('ooot)	N.A.	610.0	876.0	1857.0	2006.0	1974.0
L.D.O. cons.('ooot)	N.A.	877.0	302.0	1103.0	1037.0	1055.0
L.P.G.cons. ('ooot)	N.A.	52.0	70.0	99.0	140.0	121.0
Coal cons. (K) (milliont)	N.A.	55.8	67.3	72.2	75.02	70.02

Note:- a. Provisional

b. Furnaceoil, LSHS, and HHS.

c. Includes censumphen of DGS2D.

d. Excludes consumption of DGS2D.

Source:- Teri Energy Data Directory and year Book.1988.

Data on some particular energy intensive manufactaring in dustries are presented in the following sections.

FERTILIZER INDUSTRY :

The fertilizer industry of India accounted for about 75 percent of all naphtha consumption in 1986-87 along with about 47 percent of natural gas, 21 percent of furnace oil and 28 percent of LSHS/HHS. Relatively small quantities of HSD/LDO and electricity were also consumed. In terms of calorific content natural gas has the largest share of energy consumption in the fertilizer industry.

The production of nitrogenous fertilizers in India is more than that of the other times of fertilizer. Nitrogeneous fertilizers are also relatively more energy intensive. However, the energy consumption intensity of urea manufacture has some what reduced during the past two decades or so. It may be related to the type of feedstock, technology employed, unit capacity and capacity utilisation. Trend of energy consumption in the fertiliser industry in India can be seen from the table 3.6 below.

TABLE 3.6

ENERGY CONSUMPTION IN THE FERTILIZER INDUSTRY.

Energy Form	1982/83	1983/84	1984/85	1985/86	1986/87
Nephtha ('ooot)	2282	2134	2365	2360	2437
Furnaceoil ('ooot)	670	574	553	500	787
LSHS/HHS ('ooot)	883	913	911	1032	1203
Natural Gas (million cm)	1155	1283	1603	2500	3335(P)
HSD/LDO ('ooot)	21	28	37	46	26
Coal(MMT)	4.15	4.21	3.92	3.98	4.43
Electricity* (Gwh)	4120	4464	3638	4161	NA

The total electrical energy consumed by the fertilizer industry of electrical energy purchased and generated internally. The consumption of coal, fuel oil etc. for internal generation of electricity is included in the consumption figures for the respective energy forms. Electricity consumption figures in the table are for purchased electrical energy only.

P: Provisional

Source : Teri Energy Data Directory and year Book - 1988

ALUMINIUM INDUSTRY:

The installed capacity and production of the aluminium industry in India has grown steadily over the last ten years or so. The two major energy consuming steps are :

(i) bauxite ore conversion to alumina and (ii) Production of aluminium from alumina.

In the production of alumina, fuel oil is used for firing calcining kilns. Besides calcination, some units also use fuel oil to generate the steam required for digestion and evaporation. Coal is used only for steam generation while electricity is used largely for bauxite grinding. Using about 110 litres of fuel oil per tonne of alumina, the calcination process at the INDAL's Muri and Belgaum plants is least energy intensive. This due largely to better operation and improved heat recovery. The fuel oil consumption in calciners of other units is around 135 litres/ tonnes.

Electricity is the major source of energy utilized in smelters for aluminium production. Petroleum coke, coal tar pitch and coke, which may also be used as an energy fuel, are used for anode making. Besides, fossil fuels are also required for steam generation. Electricity intensity at the Bharat Aluminium Company Ltd. (BALCO) and the Madras Aluminium Company Ltd. (MALCO) is relatively high, mainly because of unavailability of adequate and steady power supplies - which lead to frequent shut-downs and low capacity utilization (TEDDY- 1988). Requirements of energy in Aluminium Production are given in the table 3.7 below.

TABLE 3.7

ENERGY REQUIREMENTS IN ALUMINIUM PRODUCTION
(PER TONNE OF ALUMINIUM) (a)

Plant/Energy form	BALCO	HINALCO	INDAL (Belgaum)	INDAL (Hirakud)	INDAL	MALCO
Semlter						
Electricity (Kwh)	18107	16565	18016(b) 167733(c)	17060	16920	19620
Anode Plant						
Electricity (Kwh)	N.A.	112	N.A.	N.A.	N.A.	N.A.
Coal for steam (Kg)	N.A.	68	N.A.	-(d)	N.A.	--
Fuel oil for backing (Litres)	--	110	N.A.	--	N.A.	--

a. The figures are based on data for the following periods : BALCO 1977-78 to 1983-84; HINDALCO 1977-78, INDAL 1979-83, MALCO 1980-82

b. For 23 KA Pot line

c. For 49 KA Pot line

d. Not applicable

Source : N. Thangarju and V.S. Kothari, "Energy Use in Aluminium Industry", TERI discussion paper DP/02/86, New Delhi, 1986.

<u>TEXTILE INDUSTRY</u>:

The textile industry comprises : (i) Cotton textiles (ii) Wool, silk and synthetic fibre textiles; and

(iii) Jute textiles. Cotton textile manufacture, which is the predominant sub-sector in the textile industry, consists of : (i) the organized sector, and (ii) the decentralized sector, which has both Power-loom and Hand-loom mills.

The textile industry consumes around 9 percent of the total commercial energy consumed in the country, about 80-85 percent of its energy needs are thermal, and the rest electrical. Coal and furnace oil meet the process heat requirements. All textile mills, except for those around Bombay, use coal in boilers. An estimated 80-90 percent of the electricity used is for motive power for driving Pums, motors drives etc. The energy bills of most textile mills accounts for 10-15 percent of the total input costs. The consumption of energy in the textile industry of India is shown in the table 3.8 for the period from 1970-71 to 1986-87.

TABLE 3.8

ENERGY CONSUMPTION IN THE TEXTILE INDUSTRY.

Years	Electricity (GWH)			Coal (MMT)			Fuel oils*
	Textile	Jute	Total	Jute	Cotton	Total	('ooot)
1970-71	3950.5	659.8	4610.3	--	--	--	--
1973-74	4055.6	651.5	4707.1	0.14	1.78	1.92	--
1976-77	5123.9	880.4	6004.3	0.18	2.41	2.59	570
1979-80	5743.2	700.2	6443.4	0.14	1.99	2.13	430
1982-83	5909.4	761.3	6670.7	0.17	2.94	3.11	334
1984-85	7448.0	794.1	8242.1	0.12	2.57	2.69	430
1985-86	8348.7	820.2	9168.9	0.12	2.36	2.48	435
1986-87	**9249.4	**846.2	**10095.6	**0.11	**2.15	**2.26	**389
1991-92	**14477.2	**940.5	**15417.7	**0.07	**1.58	**1.65	**453

* Includes Furnace Oil, LSHS and HHS.

** Estimated.

Source : CEA, Dept. of Petroleum, Coal controller's organisation.

There is a substantial scope for energy conservation in the textile industry. Low efficiency boilers, with efficiency levels of 50-60 percent are in operation in a large number of mills. These boilers may easily be retrofitted with suitable heat recovery equipments.

CEMENT INDUSTRY:

The Indian cement industry recorded a significant growth during the sixth five year plan period. Production increased by 10 percent per annum and installed capacity by 13 percent. At present, the Indian Cement Industry produces thirteen varieties of cement of which three comprises more than 95 percent of the total production.

During the past three to four decades, the technology for cement manufacture has changed substantially in India. Wet process based plants were established in the 1950s and early 1960s and there after dry process have been set-up with those plants. Dry process cement plants are comparatively less energy intensive and now account for over 60 percent of the installed capacity. The precalcinator technology has also been introduced in India at present.

Electric Power and coal are the major energy forms used in the cement industry, also some plants use furnace oil and lignite also. The cement industry accounts for over 10 percent of the industrial sectors coal consumption, and over 6 percent of the sectors electricity consumption. Although the over all energy intensity of the cement industry has declined during the Past decade or more due largely to an increasing share of Production from dry process based cement plants, the energy consumption norms in India are significantly higher than what has been achieved internationally. A picture of energy consumption in cement industry in India is given in table 3.9 below.

TABLE 3.9

ENERGY CONSUMPTION IN THE CEMENT INDUSTRY

Energy type	1973-74	1976-77	1979-80	1982-83	1985-86	1991-92
Electricity (GWH)	1283.8	2340.1	2035.7	2516.9	3467.3	*5902.6
Coal ('ooo tonnes)	3650	4970	3870	6100	7900	*16126.6
Fuel oils ('ooo tonnes)	N.A.	42	154	41	54	19.0

Note : Data with asterisks are estimated.

Source : Tata Energy Research Institute data files, New Delhi.

3.3.2 ENERGY CONSUMPTION IN TRANSPORT SECTOR:

The share contribution of the transport sector to total GDP was just over 16 percent in 1970-71; and increased to nearly 20 percent by 1985-86. The gross value added by the transport sector grew by nearly 5.4 percent per annum during the sixteen year period. Since the mid 1960s, the transport sector has accounted for 12-16 percent of total Public sector investments; while it accounted for as much as 22-23 of Public investments during the First, Second and Third Five Year Plan Periods. Of the total public sector investments on transport, over 75 percent has always been reserved for the rail and road sub-sectors. Consequently, these two modes are the major forms of transport in the country.

The transport sector is a major energy consuming and oil consuming sector. It is therefore important to analyze the *implications on energy consumption of any* transport planning /policy-formulation excercise.

RAILWAY:

Railway system in India has completed more than a hundred years. The first railway line ws introduced in 1853 from Bombay to Thane. The system has a route network of nearly 62,000 km and a running track of over 106,000 km. It developed as a multi-gauge system with tracks in the broadgauge, the metregauge and the narrow gauge.

In 1950s, the government of India initiated track electrification Programme. However, recognizing that electrification is capital intensive and economical only if traffic density exceeds a certain threshold level, dieselization of railways was considered a viable alternative in the interim period. Consequently diesel traction, as traffic carried by the railways did not expand as anticipated thus making electrification viable only on rather small portions of the track network. Furthermore, a concerted effort to phase out steam engines also led to an increase in diesel traction.

Energy consumption data disaggregated for freight and passenger traffic are not available, except for electricity consumption data for suburban Passenger traffic. Energy consumption per gross tonne-km equivalents of freight and passenger traffic may be estimated at an aggregate level. Available data indicate that there has been steady decline in the overall energy consumption intensity of the rail transport system since 1970-71, but only due to a major switch in locomotive Power, from energy intensive coal to diesel and electricity intensity of steam locomotion in fact, increased as steam engines began to be used increasingly for short haul movements, with several halts. The number of coal using steam locomotives reduced substantially, while the stock of diesel and electric locomotives increased. Energy consumption in railways for the Period from 1970-71 to 1990-91 can be seen from the following table.

TABLE 3.10

ENERGY CONSUMPTION IN RAILWAYS

	1970-71	1973-74	1976-77	1979-80	1982-83	1985-86	1986-87	1990-91
a. Freight & non-subrban passenger traffic								
- coal (MMT)	14.3	12.7	12.2	11.4	9.4	8.6	7.9	*6.64
- Furnaceoil ('000 t)	N.A.	63	76	68	51	44	39	*30.0
- Diesel oils ('000t)	569	681	847	981	1227	1224	1317	*1413.0
- Electricity (Gwh)	N.A.	977	1447	1574	1876	3134	325	*4254.8
b. Electricity for suburban passenger traffic (Gwh)	372	407	492	578	608			

Note : Data with asterisks are estimated.

Source : (i) Railway Board (GOI) (ii) Coal controllers organisation, coal statistics, various issues, (iii) Department of petroleum and Natural Gas Statistics, various issues, and (iv) CEA.

ROAD TRANSPORT:

Unlike the railways, this sector is not organized. Perhaps because of the dual ownership pattern, and the data base is therefore rather weak. Firm and up-to-date information on ownership Pattern for trucks which are predominantly in the Private sector is lacking. The information based on passenger-km and freight tonne- km travelled is not too reliable. And the consumption of Petroleum products is known only at an aggregate level - no break-up of Petrol and diesel use by types of vehicles are available. Furthermore, atleast for diesel, a certain unknown fraction may actually be consumed for agriculture.

Data on energy consumption intensity by various types of motorized vehicles are available; but these intensity figures relate only to test condition. It is known that Petrol/ diesel consumption intensity of vehicles is minimum only at a certain speed, and that too, on a smooth, flat, wide road. To the extent vehicles are driven at speed below or above the optimal speed, and roads are undulating and rough, the Petrol/diesel consumption intensity may be higher. Following table will show the consumption of Petroleum Products in road transport from 1970-71 to 1991-92.

TABLE 3.11

CONSUMPTION OF PETROLEUM PRODUCTS IN ROAD TRANSPORT

Year	Petrol ('000 t)	Diesel oils ('000 t)
1970-71	1452	N.A.
1975-76	1275	5093.25
1976-77	1316	5182.25
1977-78	1391	5304.0
1978-79	1499	5421.25
1979-80	1490	5622.5
1980-81	1522	6252.5
1981-82	1599	6580.0
1982-83	1722	6914.0
1983-84	1891	7295.0
1984-85	2084	N.A.
1985-86	2275	N.A.
1986-87	2508	N.A.
1991-92	*3933	N.A.

*Estimated.

Source : (i) Department of Petroleum, Indian Petroleum and Natural Gas Statistics, various Issues; and (ii) Engineering Consultants Pvt. Ltd.

3.3.3 ENERGY CONSUMPTION IN RESIDENTIAL SECTOR:

The residential sector is the largest consumer of energy which accounts for approximately 50 percent of the total energy consumption of the country. A major protion of the energy used in domestic sector comprises traditional fuels *such as, firewood, animal dung and crop residues. The* data base in this sector is quite inadequate. The data presented in the survey reports are based solely on the impression of the quantity used and not based on actual measurement. Therefore, considered to be only of a qualitative nature. But it helps to give some knowledge regarding the energy consumption Pattern in household sector. Field surveys data have indicated broadly that :- (i) Per capita energy consumption increases with a rise in income and expendiure level and (ii) the share of commercial energy in the total consumption increases with income and expenditure levels, as also with the size of town and city. However the rise in Per capita energy consumption with expenditures levels is shown to be relatively more in urban areas. The may reflect the fact that a significant higher Proportion of energy used in rural areas may be collected at zero cost, a practice which is normally not posible in urban areas. The urban-rural differences in regard to per capita consumption of commercial and non-commercial energy are given in table 3.12 and 3.13 for the years from 1963-64 to 1988-89.

TABLE 3.12

ESTIMATES OF ANNUAL PER CAPITA ENERGY CONSUMPTION IN RURAL AREAS.

	Unit	1963-64	1973-74	1978-79	*1983-84	*1988-89
A. <u>Commercial Fuels</u> :-						
Coal/Soft coke	Kg	5.2	6.8	2.3	0.8	0.5
Kerosine	litre	4.4	8.8	5.1	3.0	1.8
L.P.G.	Kg	--	--	0.1	0.5	1.0
Electricity	Kwh	0.3	2.2	4.9	10.9	24.2
B. <u>Traditional Fuels</u> :-						
Fuel wood	Kg	270.1	251.9	40.9	8.0	2.0
Charcoal	Kg	0.7	0.1	0.1	0.4	0.8
Dungcakes	Kg	100.8	72.7	133.1	243.5	445.3
Other Solid fuels (a)	Kg	9.8	12.4	176.9	2346.0	2874.8

(a) includes corp wastes, saw dust, wood shaving, twigs, leaves etc.

Note : Data for 1983-84 and 1988-89 are estimated.

Source: Teri Energy Data Directory and year Book, 1988.

TABLE 3.13

ESTIMATES OF ANNUAL PER CAPITA ENERGY CONSUMPTION IN URBAN AREAS.

	Unit	1963-64	1973-74	1978-79	*1983-84	*1988-89
A. Commercial Fuels :-						
Coal/Soft coke	Kg	29.8	33.4	31.3	29.3	27.5
Kerosine	litre	10.2	14.0	11.6	9.6	8.0
L.P.G.	Kg	--	--	2.2	4.4	8.8
Electricity	Kwh	9.0	18.2	35.0	67.3	129.4
B. Traditional Fuels :-						
Fuel wood	Kg	270.1	251.9	40.9	8.0	2.0
Charcoal	Kg	0.7	0.1	0.1	0.4	0.8
Dungcakes	Kg	100.8	72.7	133.1	243.5	445.3
Other Solid fuels (a)	Kg	9.8	12.4	176.9	2346.0	2874.8

(a) includes cropwastes, saw dust, wood slaving, twigs, leaves etc.

* Data for 1983-84 and 1988-89 are estimated.

Source : Teri Energy Data Directory and Year Book, 1988.

In domestic sector, energy consumption is related to the Purchasing Power of consumers and partly related to distribution inadequacy. The level of per capita domestic energy requirement was around 3,000 K coal per day in rual areas and around 10,500 K coal per day in urban areas in 1977. Although there is no exact assesment of energy consumed by the domestic sector in India, yet the commercial and non-Commercial fuel usage per day in the domestic sector may be roughly taken as- Urban domestic sector: commercial fuels 30 (m.t.c.r.) Non commercial fuels 70 (m.t.c.r.). Rural sector : Commercial fuel 10 (m.t.c.r.), Non commercial fuels 130 (m.t.c.r.)

From the above figures, it has found that the urban domestic sector consumes 100 m.t.c.r. and rural domestic sector consumes 140 m.t.c.r. of thermal energy. This represents about 68 percent of the total thermal energy. Although about four times more People live in rural areas than in urban areas, the energy consumption is only 1.4 times higher which indicates that urban people use about three times more energy for domestic purposes. The domestic needs are largely met by non-commercial sources of energy. But in the urban areas, the basic energy consumption of the residential sector, would be expected to change, and grow in proportion to the total population plus any per capita increase due to increasing affluence and changing life style. Taking together the data on commercial and non-commercial per capita energy consumption, the changes which occured in the decades 1963-64 to 1973-74, 1973-74 to 1983-84 & 1983-84 to 1993-94 can be seen from table 3.14.(Bondopadhya,77)

TABLE 3.14

ENERGY CONSUMPTION (PER CAPITA) UNIT; TONNES OF COAL REPLACEMENT.

year	Commercial				Non-commercial				
	Coal	Oil	Electri city	Total	Fire wood	Dung cake	Vegetable waste	Total	Grand Total
1963-64	0.104	0.127	0.054	0.285	0.242	0.036	0.066	0.344	0.629
1973-74	0.097	0.201	0.096	0.394	0.216	0.063	0.025	0.304	0.698
*1983-84	0.096	0.318	0.170	0.584	0.192	0.110	0.015	0.317	0.901
*1993-94	0.095	0.503	0.301	0.899	0.171	0.192	0.009	0.372	1.26

Note : Data for 1983-84 and 1993-94 are estimated.

Source : Commerce, Annual Number 1977.

The above table makes it clear that during the Period 1963-64 -- 1973-74, the annual growth rate of Per capita consumption was under 1 percent only. But the rate of growth in commercial source was more than in the non-commercial sources. The share of Commercial sources in the total energy consumption is increasing steadily. During the period of 1963-64 - 1973-74, the total energy consumption recorded an annual growth rate of 3.3 percent. Commercial energy consumption grew faster at 5.6 percent per annum and th annual growth rate of non-commercial energy consumption was around 1 percent only. Over the 10 years, the share of total energy, consumption by commercial sources went up from 45.3 percent to 56.5 percent.

The non-commercial energy consumption, which is mostly in the domestic sector, is difficult to assess correctly due to the lack of difinatative data. Various assumptions have to be made to estimate in this regard.

With the increase in oil prices since 1973 following the oil price hike in the world market, the consumption trend of Kerosene is expected to go down although during 1973-74 it has shown an increasing trend in domestic sector both in rural and urban areas. Kerosene is going to be substituted by electricity in domestic sector consumption. A probable change in the pattern of household consumption can be illustrated in table 3.15 for the period from 1975-76 to 2000-1 (Indian Institution of Public opinion 1981-82).

TABLE 3.15

PROBABLE OR PROJECTED CHANGE IN THE PATTERN OF HOUSEHOLDS USING DIFFERENT FUELS : 1975 - 2000. (PERCENTAGE)

Fuel	1975-76	1982-83	1987-88	1992-93	2000-01
		A. RURAL			
Electricity	4.4	12.9	19.3	27.6	45.2
Kerosene	91.4	84.0	78.8	71.1	53.9
Others	4.2	3.1	1.9	1.0	0.9
Total	100.0	100.0	100.0	100.0	100.0
Numbers of Households (Million)	90.1	100.9	108.6	116.1	128.3
		B. URBAN			
Electricity	42.1	53.0	62.3	73.8	89.2
Kerosene	53.6	45.2	36.9	25.5	10.4
Others	4.3	1.8	0.8	0.7	0.6
Total	100.0	100.0	100.0	100.0	100.0
Number of Households (Million)	26.1	32.1	36.9	42.0	51.7

Source : Quarterly Economic Report of the Indian Institute of Public opiinion, December 1981- March 1982.

It is seen from the table that a probable sharp change in the domestic electricity consumption both in rural and urban areas would take place in future. As the table shows, the consumption of electricity in domestic sector would increase from 4.4 percent to 45.2 percent during the period of 1975-2000 in rural households and from 42.1 percent to 89.2 percent during the same period in the urban households. But the share of Kerosene and others are expected to go down as the table shows during 1975-2000.

National sample survey data also show that the consumption of electricity for lighting both in rural and urban areas has been increasing as compared with the consumption of Kerosene. Distribution of households per 1000 over primary sources of energy for lighting can be seen from table 3.16 which are taken from 28th, 38th and 45th round of N.S.S. data (1989-90)

TABLE 3.16

PER 1000 DISTRIBUTION OF HOUSEHOLDS OVER PRIMARY SOURCES OF ENERGY FOR LIGHTING.

Round	Rural				Urban			
	Kerosene	Electricity	Others	Total	Kerosene	Electricity	Others	Total
<u>28th Round</u>								
India	917	66	17	1000	464	535	5	1000
Assam	983	14	3	1000	613	364	5	1000
<u>38th Round</u>								
India	836	149	15	1000	347	638	15	1000
Assam	954	29	17	1000	514	466	20	1000
<u>45th Round</u>								
India	746	238	16	1000	269	718	13	1000
Assam	923	70	7	1000	292	691	17	1000

Source : N.S.S. 45th Round (1989-90), 52nd Issue July, Sept. 1992.

Changes in energy consumption over time are determined by several factors including family size, fuel availability, relative prices of various fuels and so on. The NCAER, collected some informations to establish the broad trends in energy consumption during the five year period 1974-75 to 1978-79. The data that are available relate only to the number of households using a particular type of fuel, and to the actual or estimated quantities of fuels used. The available data indicate a distinct shift away from fire wood in both urban and rural areas. While the fraction of households using LPG increased substantially in urban areas, in rural areas the use of bio gas increased. The fraction of house holds using soft coke also is shown to have increased gradually from 1974-75 to 1978-79, in both rural and urban areas.

Further information on fuel shifts in urban households between 1978-79 and 1983-84 is also available. The trend of a decline in the use of fire wood is clearly evident. However, the use of soft-coke is also reported to have declined, but this may be due to its decreasing supplies. The use of Kerosene and LPG is shown to have increased substantially; the latter particularly in the high expenditure category households.

Despite these shifts, there is a little evidence that households now use the fuel they prefer for cooking. High cost or/and inadequate availability are perhaps the most important reasons for using a fuel which may not be preferred. A rise in income however, is revealed to be the most significant reason for shifting to commercial fuels for cooking.

Percentages of households using different categories of cooking fuels of both rural and urban areas for five years 1974 to 1984 are shown in table 3.17 below.

TABLE - 3.17

BREAK-UP OF HOUSEHOLDS AS PER COOKING FUEL

(% of households)

	Coal/ soft coke	Kerosene	Firewood	LPG	Gobar Gas	% of households for which data are not available
Rural Areas :---						
1974	--	6.82	64.19	0.77	--	28.22
1979	4.92	5.13	9.64	0.70	37.3	42.48
*1984	--	3.86	1.64	0.60	--	93.90
Urban Areas :---						
1974	26.57	10.88	47.01	4.04	--	11.50
1979	30.47	16.76	7.86	32.16	0.20	12.55
*1984	34.94	25.81	1.36	--	--	37.89

Source : National council for Applied Economic Research.

* Data for 1984 are estimated.

In residential sector commercial energy forms may be used for lighting, cooking and running other appliances such as refrigerators, television sets etc while traditional energy fuels are normally used for cooking, water-heating and space-heating. At the aggregate, the survey conducted by the NCAER reveals that 1978-79, the share of total energy used for cooking, water heating and space heating decreased with a rise in income levels in both rural and urban areas. For commercial energy sources alone, their respective shares for these same end-uses increased with income levels in rural households; although no such trend was evident in urban households.

3.3.4 ENERGY CONSUMPTION IN AGRICULTURE :

In agricultural sector, direct commercial energy inputs are used largely for two activities -- mechanized land Preparation and mechanized lift irrigation. Commercial energy is also required for harvesting, threshing, drying and winnowing. Direct commercial energy use in agricultural productivity can not correctly be correlated, as the use of commercial energy usually substitutes some form of human and/or animal energy.

Little information is available on the direct and indirect energy use. The only exception is that of electricity sales, annual time series data for which are available at the state level Data on average capacity ratings of electric Pump sets and their annual utilisation patterns are also estimated and published. However, corresponding data for diesel Pumpsets are not available.

The problem in estimating the utilisation of diesel Pumpsets is compounding further, because some are used for standby purposes even by farmers who possess an electric pumpset, while others are used by farmers in non-electrified rural areas. And even the total diesel consumption for ground-water irrigation and land preparation is also not easily determined from published data, because only a faction of diesel sales for agricaltural purposes listed under a seperate heading, while an unknown fraction is clubbed together with transport. However, some norms for diesel consumption in and annual hours of usage of diesel Pumpsets, and various types of tractors, are estimated.

Indirect energy use through fertilizers is also not easy to eatimate, because information on the use of only inorganic fertilizers is documented. The usage of organic manure may at best be estimated on the basis of norms derived from isolated sample surveys. (TEDDY,1988)

Total consumption of both diesel and electircity in agricultural sectore for the period from 1970-71 to 1986-87 can be seen from the following table.

TABLE 3.18

TOTAL DIESEL AND ELECTRICITY CONSUMPTION

	1970-71	1973-74	1976-77	1979-80	1982-83	1983-84	1984-85	1985-86	1986-87
Electricity cons. (Gwh)	4470.23	6310.21	9620.63	13452.0	17816.8	1823.0	21400.0	23532.4	28217.5
Diesel* Cons. (,000t)	N.A	N.A	N.A	N.A	141	145	157	179	185**

* Accounts for consumption of HSD and LDO in the plantation/ Food Processing sector.

** Provisional

Source : (i) CEA, Public Electricity Supply.

(ii) CMIE, Current Energy scene in India, May 1988.

3.4 BRIEF DESCRIPTION OF ENERGY RESOURCES IN INDIA:

The resources of fossil, non-fossil fuel with respectto India and world as of 1987 are shown in table 3.19. The figuresinclude Proven reserves, rcoverable reserves and estimated additional resources.

TABLE 3.19

FOSSIL FUEL, NUCLEAR AND HYDRAULIC RESOURCES-1987

(Quantities in Million metric tonnes except where indicated)

	WORLD	INDIA
I. Bituminous Coal/ Antheracite		
(a) Proved reserves in place	1630886	129154
(b) proved reserves recoverable	402752	-
(c) Estimated additional resource	3625169	110177
II. Sub-bituminous coal/ Lignite		
(a) Proved reserves in place	736241	2100
(b) Proved reserves recoverable	396152	1900
(c) Estimated additional resources	4367678	3932
III. Peat -		
(a) Proved reserves in place	419145	-
(b) Proved reserves recoverable	12108	-
(c) Estimated additional resources	231436	-
IV. Crude oil and NGL Reserves	122848	657
V. Oil shale-(Proved reserves in Place)	9726	-

Contd......

Contd.....

	WORLD	INDIA
VI. Bituminous sands (Proved recoverable reserves)	41360	-
VII. Natural Gas, (Million cubic metre)	480	500
VIII. Uranium (metric Tonnes)		
(a) Reasonally assured	2355945	45540
(b) Estimated additional Resources	1338100	16610
IX. Hydraulic Resources	105046329	2160000
Gross theoritical capability		
(Terajoules)		

Source; 1989, energy statistics year Book, United Nations, New york, 1991.

The Production figures for the primary sources of commercial energy namely coal, oil, natural gas, hydro power and nuclear power in India from 1970-71 to 1991-92 are given in table 3.20. There is a steady growth for all the sources of energy. The share of Primary sources of energy in India from 1970-71 to 1991-92 is given in table 3.21. It reveals that the share of coal is highest around 60 percent followed by oil around 30 percent and hydro by 3-4 percent.

TABLE 3.20

SUPPLY OF PRIMARY SOURCES OF COMMERCIAL ENERGY

Years	Liquid (million) (tonnes)	Coal			Oil			Natural Gas	Hydro Power	Nuclear Power
		Production (Million tonnes)	Net Import	Supply	Production (Milion tonnes)	Net import	Supply	(Men.Cubic Meters)	(Men. Kwh)	
1970-71	3.39	72.95	Neg.	72.95	6.82	11.68	18.51	1445	25248	2417
1975-76	3.03	99.68	Neg.	99.68	8.45	13.63	22.07	2368	33302	2626
1980-81	5.11	113.91	0.31	114.22	10.51	16.25	26.76	2358	46542	3001
1985-86	8.05	145.20	2.45	156.65	30.17	14.62	44.78	8134	50933	4985
1990-91	13.77	211.73	5.88	217.61	33.03	20.70	53.73	1890	71535	6244
1991-92	15.00*	229.28	6.00	235.28	30.34	24.03	54.37	18400*	72557	5585

Source : Current Energy Scene in India, May'92 Centre for Monitoring Indian Economy (CMIE) Bombay 400025

* : CMIE Estimates.

TABLE 3.21

SHARE OF PRIMARY SOURCES OF ENERGY : 1970-71 TO 1991-92 (percent)

Years	Lignite	Coal	Oil	Natural Gas	Hydro	Nuclear
1970-71	2.80	60.10	31.10	2.10	3.50	0.30
1975-76	1.90	63.10	28.50	2.60	3.60	0.30
1980-81	2.70	61.20	29.30	2.20	4.20	0.30
1985-86	2.90	56.00	32.70	5.10	3.10	0.30
1990-91	3.60	56.40	28.40	8.10	3.20	0.30
1991-92	3.70	57.90	27.30	7.90	3.00	0.20

Source : Current Energy scene in India, May 1992, Centre for Monitoring Indian Economy (CMIE) Bombay - 400025.

India is one of the few countries in the world that is blessed with significant Primary energy sources. Coal has been and will continue to be the main contirbutor to the national economy, while oil also has now achieved an important status due to recent discoveries in the offshoreand outshore areas. Crude oil Production in the first half of the financial year of 1984 was 13,878 million tonnes and the total Production meets nearly 70 percent of the country's requirements. According to a World Bank Study (world Bank, 1980) the reserves of commercial sources of energy in India are : Coal - 22467 million tonnes; oil-218 million tonnes, gas - 196 million tonnes; hydro- 70.0 gigawatts. Ratio of reserves to 1978 production : Coal - 450; oil-20; gas - 163. and Hydro ratio is 7.4.

THE RESOURCES :

3.4.1 COAL :

Among fossil fuels, coal is placed as a primary sources of fuel in view of the vast resources possessed by India. The total coal production of India was 56 million tonnes in 1960-61 and 76 million tonnes in 1970-71. The production figure has been increased to 114 million tonnes in 1980-81 and 229.26 million tonnes in 1991-92. Published estimates of coal reserves have varied appreciably and much exploratory works has still to be done. Estimated figure of reserves can be seen from the table 3.22 given below :

TABLE 3.22

ESTIMATED COAL RESERVES IN INDIA (MILLION TONNES)
(AS ON APRIL 1, 1986)

	Reserves (MMT)			
	Proved	Indicated	Inferred	Total
A.Prime Coking Coals	3623.46	1557.78	288.95	5470.19
B. Medium Coking Coals*	9288.17	9535.84	834.73	19658.74
Total coking coals	12911.63	11083.62	1123.68	25128.93
C. Non-coking Coals	32691.41	53830.27	44062.21	130583.89
Total coal reserves	45603.04	64923.89	45185.89	155712.82

* Includes semi and weekly-coking coals.

Source : Teri Energy Data Directory and year Book,1988.
New Delhi.

In the table the total estimated reserves of all types of coal are put at about 156 billion tonnes. Out of the proved reserves about 28 percent consists of coking and 72 percent of non-coking coal. The share of non-coking coal in indicated and inferred reserves exceeds 80 percent. At present level of out put non-coking coal, a reserve of this size would be adequate for 350 years to 400 years. The reserve position with respect to coking coal appears less favourable. The table shows that the total reserves of prime coking coal are put at some 6 billion tonnes of which 1.6 billion tonnes can be changed to coke ovens. This is because of losses arising from wshing process due to the high ash content. The total geological reserve up to a depth of 1200 metres is estimaed as 196 billion tonnes as on 1.1.1992.

The coal deposits in India have two related characteristic which create problems both in working and in marketing. The first is seems to be very thick, sometimes exceeding 45 meters. The second is the high ash content. Average ash content was found to be about 14 percent in earlier years but gradually over times the average ash content has gone up and exceeded over 20 percent at Present. However, this should not be a problem. The ash content of South African coal is not less than that of Indian coal, yet their desulpharisation and eventual production of oil from the coal, the union of South Africa is ahead of any nation in the world. She is prepared for perspective oil blocked.

In India, coal deposits are distributed unevenly. There are no coal fields in the North West region of the country except for the small fields in Maharashtra and non in the South Indian region except for the singarine fields in Andhra Pradesh and Neyveli in Tamil Nadu. Hence a high transport cost is necessary if coal is to be supplied to different regions of the country.

The total number of coal fields in India is more than 82 excluding few small fields in Assam. Of these, the four largest fields are - Ranigange in West Bengal, Jharia and North Karanpura in Bihar and Singrauli in Madhya Pradesh which account for some five-eights of the total coal reserves. Raniganj and Jharia alone Produced about 58 percent of the total output in 1969-70.

To increase the production of coal in the outlying fields, various attempts have been made over the Past years so as to minimise the transport costs from Bengal/ Bihar to long distances of other Parts of the country. In recent past years the rate of increase in coal Product, has been well under 5 percent per annum and output increased at an average rate of about 5 percent per annum. The sharp rise in oil Price after 1973 improved the competitive position of coal and strengthened the reliance on indegeneous fuels.

Considerable indigeneous R&D work has been carried out in the country on coal mining and coal utilisation. The coking coal washeries for the intergrated steel plants in the country were based on the know how developed by the Central Fuel Research Institute, Dhanbad. A low temperature carbonisation plant was set up at Singareni in Andhra Pradesh based on the process developed by the Indian Institute of Chemical Technology, Hyderabad.

The progressive growth of coal will be apparent from the Production figures in table 3.23 for the period from 1954 to 1991-92 which is given in sectorwise. Type of coal and main coal fields are also included in the table. (Henderson, 1975)

TABLE - 3.23

COAL PRODUCTION BY SECTOR, TYPE OF COAL AND MAIN COAL FIELDS. (million tonnes)

Year	Total Production	Share in total production of ---					
		Public sector	Private sector	Coking coal	Non-coking coal	Bengal/ Bihar	Outlying fields
1954	37.5	4.0	33.5	13.8	23.7	30.2	7.2
1960-61	55.7	10.6	45.1	16.1	39.6	41.3	14.4
1965-66	67.6	13.6	54.1	17.0	50.7	51.2	16.2
1968-69	71.4	16.5	54.9	17.2	54.2	52.3	19.1
1969-70	75.7	17.5	58.2	18.1	57.6	55.7	20.0
1970-71	72.9	17.8	55.1	17.8	55.1	52.4	20.5
1971-72	72.4	25.3	47.1	16.7	55.7	49.9	22.5
1972-73	77.2	41.3	35.9	16.6	60.6	53.1	24.1
1973-74	77.9	75.3	2.6	15.8	62.1	52.6	25.2
1983-84	138.2	*133.5	*4.7	35.9	102.3	*93.2	45.0
1991-92	229.3	*221.5	*7.8	59.4	*169.9	*154.6	74.7

Note : Data with asterisks are estimated.

Source : P.D.Henderson, India : The Energy Sector, 1975.

The table shows that total production of coal has been in ereased double over the period as a whole. Production of coal from 1972 in public sector recorded a rapid increase and a decreasing trend is recorded in private sector. This position achieved as a result of the nationalisation measures adopted by the Union Government to the coal industries.

Coal mining in India started as far back as in 1874. There were more than 800 coal mines by 1971 producing about 70 million tonnes per annum. Nationalisation of the mines allowed their amalgamation and reconstruction into a smaller number of viable units and increase the production to touch the 100 million mark by 1976-77. The total number of operating units in public sector is now over 300 whose average out put may be in order of 240,000 tonnes per year. The increase in production from 100 million tonnes to 200 million tonnes in the next decade needs flexible and effective planning on a long term basis and massive investment programme. (Mahendran, 1977).

3.4.2 PETROLEUM:

In India, proved reserves of Oil are not very satisfactory as compared to coal. In the preindependence era the oil industry in India was mostly marketing oriented. There was only one refinery at Digboi in upper Assam with an annual refining capacity of 0.45 million tonnes per annum for processing the crude produced in the nearby Digboi oil fields.

By this time, the total sedementary area of India both onshore and offshore, comprises about more than 27 basins. The basins are grouped in to four main categories of promise. Those with high prospects comprise Combay and a large part of Assam-Arakan basins. The area which falls into this category comes about at some 18 percent of the total sedimentary areas onshore and offshore upto the 200 metres isobath line.

A second category with medium prospect comprises 15 percent of the total sedimentary area while the remaining two-third of the sedimentary area consists of as fair 40 percent or poor about 27 percent of the total area upto 1974, geological and geo-physical studies have been conducted in 14 of the 27 basins, while exploratory drilling has taken place in 9. The oil bearing reserves are still being discovered in these producing areas which suggest that further useful deposits of oil remain to be found.

Production of crude oil in India is at present concentrated in a small number of fields. It was estimated that in 1973 well over 90 percent out put came from the six main producing fields. The prominent two are Ankleshwar in Gujarat which is operated by the public sector Oil and Natural Gas Commission (ONGC) and Nahakatiya in upper Assam, which is operated by Oil India Limited, a joint sector enterprise in which 50 percent shares each are held by the Government of India and Burmah Oil Company (Now taken up by Oil India Limited).

The cost of finding, producing and distributing oil depends on variety of factors including the difficulties of the terrain, the depth and accessibility of Oil deposits and the productivity of producing wells. In most of these respects the Gujarat fields are more favourably placed than those of Assam. The Assam fields are relatively inaccessible and distant from markets. The average depth of wells in the onshore Combaybasins is just under 1,700 metres (5,500 feet), while the corresponding figure for Assam is over 3,300 metres (10,800 feet). Annual production per well is generally higher in Gujarat than in Assam. For India as a whole, productivity average about 270 barrels per day. This is low compared with big Middle Eastern Fields. (Henderson ,1975)

The production of crude oil both from onshore and offshore rose to 14.37 million tonnes in 1981 as against 9.39 million tonnes in 1980. The production during 1979 was 12.84 million tonnes. In 1982, the total production was increased to about 21 million tonnes. The production during 1980 declined as a result of agitation on the foreigners issue in Assam leading to the blockade of Oil pipe lines and installations. (Fresh Momemtum in India's Development, 1980-82).

The indigeneous production of oil during 1982 was expected to meet nearby 60 percent of the demand. The crude oil availability with in the country was expeceted to be 20.5 million tonnes. Petroleum products to be imported during 1982 was expected to be about 4 million tonnes. Fortunately, a rapid development in oil production has taken place during the last few years of 1980s. Against the target of 20.5 million tonnes in 1982, produuction figure went to about 21 million tonnes in 1982-83. Production of oil continues with increasing trend and recorded over 30 million tonnes in 1986-87. This increase was due largely to accelerated production from the Bombay High Offshore Basin. In 1986-87 Oil produced from Bombay High accounted for 68 percent of total crude oil production in the country.

Production of crude oil both form onshore and offshore for the years from 1970-71 to 1986-87 can be seen from the table given below.

Table -3.24

PRODUCTION OF CRUDE OIL (,000 tonnes)

Year	Onshore			Offshore	Total
	Arunachal	Assam	Gujarat	Bombay High	
1970-71	-	3367	3455	-	6822
1971-72	-	3636	3669	-	7299
1972-73	-	3609	3712	-	7321
1973-74	-	3589	3600	-	7189
1974-75	-	3814	3870	-	7684
1975-76	-	4300	4148	-	8448
1976-77	-	4305	4187	406	8898
1977-78	-	4534	4155	2074	10763
1978-79	-	4085	4238	3310	11633
1979-80	-	3578	3766	4422	11766
1980-81	2	1712	3808	4985	10507
1981-82	2	4795	3422	7975	16194
1982-83	1	5000	3185	12877	21063
1983-84	31	5009	3588	17392	26020
1984-85	51	4893	3910	20136	28990
1985-86	60	4966	4319	20823	30168
1986-87*	51	5239	4561	20618	30480

*Provisional

Source: Department of Petroleum; Govt. of India.

The refining capacities of different indigeneous locations in India expanded to about 43.5 million tonnes of throughput. The increase in indigeneous refining capacity led us to greater self reliance in oil supplies.The import of oil products has been decreased since 1976 and particularly in 1980-81 our imports in volumetric terms began to decline. Refining capacities of different indigeneous locations are given in the table 3.25 below.

TABLE 3.25

REFINING CAPACITY (Million Tonnes Per Annum)

Refining Company	Location	Year of Commissioning	Capacity on Date of Commissioning	April	April
BPCL	Bombay	1955	2.2	5.25	6.0
BRPL	Bongaigaon	1979	1.0	--	1.35
CRL	Cochin	1966	2.5	2.5	4.5
HPCL	Bombay	1954	N.A.	3.5	3.5
HPCL	Vizag	1957	N.A	1.5	4.5
IOC	Barauni	1964	2.0	3.0	3.3
IOC	Digboi	1901	0.5	0.5	0.5
IOC	Gauhati	1962	0.75	0.8	0.85
IOC	Haldia	1974	2.5	---	2.5
IOC	Koyali	1965	2.0	4.3	8.1
IOC	Mathura	1982	6.0	---	6.0
MRL	Madras	1969	2.5	2.5	5.6

* Excludes 2 mt-pa of swing Refinery capacity available at HPLC, Bombay.

Source :- Department of Petroleum, Govt. of India.

The indigeneous availablity of crude oil at present is of the order of 30-32 MMT as against an annual demand of 58 million metric tonnes (MMT) of Petroleum products leaving a gap of about 26 million metric tonnes annually. While all efforts are being made to maximise the indigeneous production through emphasis on exploration and development of oil within the country the gap between domestic demand and indigeneous availability is likely to widen in the Coming years. This has serious foreign exchange implication for the economy. The thrust areas in the petroleum sector, are, therefore oil exploration and development on the one hand and containtment of demand for Petroleum products through Conservation and substitution on the other. Development of oil and gas fields, both onshore and offshore, involves heavy investments of foreign exchange and it is important that R&D efforts are directed towards indigenisation of technology in this area. (Qusim. '93)

3.4.3. NATURAL GAS :

Since oil reserves are very limited and very precious, its conservation for limited usage requires serious consideration. In domestic sector consumption of oil can be replaced by gas to be used as fuel. Gas can be used for Power generation and for industrial use like fertilizer production.

While talking of Petroleum, we concentrate more on crude oil and forget natural gas which can be used without expensive processing. Oil was convenient for international traders but gas can be quickly used locally in large countries like USA, China and India. We shall be able to locate quite a number of gas fields and also exploit gas deposits of the North-East. In the North-East, we have a large deposit of Shales which can provide 100 million tonnes of oil for one hundred years.

ONGC's Gandhar field development project alone would yield 18.55 millions of crude and 24 billion cubic metres of gas. Neelam, Mukta and Panna offshore fields will provide a substantial increase in indigeneous production (D.B. Choudhuri, Urja).

Gross production of natural gas both onshore and offshore can be seen from the following table for the period from 1970-71 to 1986-87.

TABLE-3.26

PRODUCATION OF NATURAL GAS (MILLLION CUBIC METRES)

Year	On shore Assam	Off shore Gujarat	Bombay High	Total
1970-71	980	465	----	1445
1971-72	1012	523	----	1535
1972-73	1034	531	----	1565
1973-74	1195	518	----	1713
1974-75	1388	653	----	2041
1975-76	1595	773	----	2368
1976-77	1558	822	48	2428
1977-78	1717	893	229	2839
1978-79	1518	908	386	2812
1979-80	1385	840	542	2767
1980-81	843	842	673	2358
1981-82	1748	758	1345	3851
1982-83	1829	750	2357	4936
1983-84	1954	748	3259	5961
1984-85	2058(a)	775	4408	7241
1985-86	2335(a)	919	5180	8134
1986-87*	2177(a)	971	6705	9853

*Provisional

a. Includes one million cubic metre of natural gas from Arunachal Prodesh in 1984-85 and 6 mcm of natural gas in 1985-86 and 13 mcm in 1986-87.

Source:- Department of petroleum, govt. of India.

Natural gas was either flared or reinjected during 1950s and 1960s. It began to be used as an energy source outside the producing company for power generation or as a feedstock for the fertilizer and petro-chemical industries only during the 1960s. A steady growth of down-stream utilisation of natural gas is evident, although large quantities still continue to be flared.

Steps are being taken to utilise gas in the Eastern region for fertilizer production and power generation. submarine lines are being laid for bringing the off shore gas to the main land. The main achievements in the onshore operations in 1981 was the discovery of natural gas in Kudara in Ankleshwar (Gujarat), Baramura in Tripura. In the offshore operation the discovery was of hydrocarbons in two new areas. Oil and gas were discovered in the first well drilled in the Northern Palk Strait in the offshore Cauvery Basin.

As LPG is a clean fuel that can be used for domestic cooking, the government has plans to increase its supplies considerably. During the 1970s, LPG was obtained entirely from refinery fuel gases with the commissioning of LPG extraction plants in Bombay and Duliajan (Assam) in 1981 and 1982 respectively, LPG is now extracted from natural gas. Other LPG extraction plants at Hagira and Uran have also come on-stream.

In domestic sector to reduce consumption of Kerosene which is used for cooking and lighting should replace by more utilisation of gas. In 1973-75 only 75 percent of the available LPG could be utilised due to a bottle neck in the availability of cylinders for domestic distribution. However, LPG marketing would throw of challenge before the oil companies during the years 1977-78 to 1981-82 when its availability was to be increased three fold.

At present, LPG is distributed through retailers and agents by the marketing divisions of the Indian oil corporation (IOC), Bharat Petroleum corporation Ltd. (BPC). Hindustan Petroleum corporation Ltd.(HPCL), and the Indo-Burma Petroleum (IBP) company Ltd. The supplies are concentrated primarily in four metropolitan areas Bombay, Calcutta, Delhi and Madras- and to some other smaller cities and towns. Production and distribution of LPG for the years from 1981-82 to 1986-87 can be seen from table 3.27 below.

TABLE- 3.27

PRODUCTION AND DISTRIBUTION OF LPG.

Production (,000 tonnes) Total	1980-81	1982-83	1983-84	1984-85	1985-86	1986-87(a)
From refinarie -	483	575	737	873	1230	1489
From natural gas -	410	406	514	596	867	995
No of distributors-	73 1169(b)	169 1565(b)	23 1791(b)	277 2223(c)	363 2742(c)	494 3066(c)

a. Provisional, b. as on Jan.1, c. as on April,1

Source :- Department of Petroleum, Govt. of India.

3.4.4. HYDEL RESOURCE :

India has abundant sources of hydroelectric power. According to the report of Central Water and Power Commission (CWPC), these are economically utilisable hydropower Potential at 25.26 million KW corresponding to annual energy generation to 221 TWh, On the basis of CWPC's hydro electric potential only about 16 percent has so far been developed in the country. It was estimated that by the end of 1983-84 the exploitation of the potential would be increased to over 28 percent (K.S. Subramanium, 77). The latest assessment of the Central Electricity Authority (CEA) has placed the hydro potential of India at 84,000 MW at 60 percent load factor or 1,35,000 MW at 40 percent load factor which is equivalent to 600 billion units of firm energy annually.

With such a large hydel potential, India faces acute energy crisis. There is still a large gap between the demand and supply. Although the total installed generation capacity from hydro and thermal sources has increased from a meagre 1360 MW at the time of Independence to over 70,000 MW to-day, hydro development has not even touched 15 percent of the available potential (G.P. Singh '93).

Hydro-electric power plays a major role in the field of Power development in the country. Its contribution in the total electricity generation to be about more than 40 percent. Electricity is the most preferred form of energy on account of the versality and cleanliness associated with its handling and utilisation. It is the cheapest and continually renewable source as compared to fossil fuels of power which are limited. Hydroelectric stations have a relatively long life and quick set-up and rapid response to change in demand. Of all the methods of Power generation, hydel electricity is the cheapest cleanest and the best from the resource optimisation point of view.

The main Coal producing eastern region is not well endowed with hydro resources. On the other hand, the Northern, Southern and North-Eastern region which have practically no Coal resources are rich in hydel resources. It is important to note that hydro potential in the North-Eastern region remains undeveloped. The primary reason for the slow rate of exploitation is the lack of Power requirements.

Nature has been very generous and bounteous in providing a vast hydroelectric potential to the Indian sub-continent through the great Himalayas and perennial rivers like Indus, Ganges and Brahmaputra etc. Basinwise hydro Power Potential and development in India during 1970s given in table 3.28.

TABLE 3.28.

BASINWISE ABSTRACT OF HYDROPOWER POTENTIAL AND DEVELOPMENT IN INDIA.

Name of river Basin	Power Potential in MW	Installed Capacity in MW
Indus	7,000	3,039
Ganga	5,000	1,899
Brahmaputra	12,000	276
Sabarmati	Nil	Nil
Mahi	100	Nil
Narmada	1,000	Nil
Topi	300	300
Subarnarekha	100	130
Brahmani	1,000	Nil
Mahamani	1,000	270
Godabari	6,000	1,355
Krishna	1,500	1,893
Pennar	Nil	Nil
Cauvery	1,000	940
Medium and Minor Basins	5,000	3,881
Total :-	41,000 or 41 million KW.	13,913 or 14 million KW.

Source: K.S. Murty, "India's PrimaryEnergySources",University Depertment of Geology, Nagpur.

The effective capacity is actually much than the installed capacity, leaving a balance to be exploited in each of the above basins. Further, the Power Economy Committee (1971) suggested that it might be possible to install about 80 to 100 million KW. of hydel Capacity towards the end of the Century.

While projects on major and medium rivers have been built on a multipurpose basis and large amounts have been invested, gestation periods have been too long and some of these projects are yet to be completed. Transmission and distribution losses have also been on the high side. Therefore it is realised that proper attention should also be given to the development of minor micro hydro power projects.

The surveys conducted by the Cenral Electricity Authority (CEA) and Rural Electrification programme (REP) so far indicated about 1,300 potential sites with 1,800 MW for the country. Various efforts are made in this direction and as a result 120 micro/mini/small hydel schemes upto 3 MW capacity totalling about 86 MW have been installed in the country so far. One hundred and seventeen schemes aggregating about 125 MW are presently under construction. The Eighth Plan proposals envisage a capacity addition through such schemes of about 200 MW.

Recently the CEA has carried out detailed generating capacity optimization and other studies for the next 15 years period i.e. upto 2006-7. Based on these studies the CEA has suggested addition of 50,000 MW hydro capacity in the Country over next fifteen year period. This will mean an average annual growth rate of 9.1 percent in hydro capacity addition.

From long term considerations of national economy environment and conservation of limited fossil energy resources the available hydro resources need to be harnessed up to the maximum feasible extent as early as possible. If we can succeed in adding about 50,000 MW of hydro capacity within next 15 years, the country would save a lot in creating an equivalent Peaking capacity through thermal projects besides recurring advantage on saving coal and its transportation costs.

3.4.5. NUCLEAR POWER :

The development of nuclear energy in India has been characterised by a strong commitment to self-reliance and growing the necessary science and technology within the country. India's first nuclear power station at Tarapur has completed twenty years of successful operation in October 1989. It was the first nuclear power station in Asia out side the Soviet Union. It has been producing the lowest cost non hydro electric power in the country.

The second nuclear power station at Rajasthan consists of reactors using natural uranium as fuel and heavy water moderator. While the Tarapur reactor uses enriched uranium which is presently imported from France the Rajasthan reactor use natural uranium available in the country. This project was taken up as a collaborative venture with Canada and incorporates many significant components made in the country specially in its second unit. The experience with the first unit of Rajasthan has not been upto expectation. However, the second unit has been operating in a reliable and satisfactory manner.

The Madras Atomic Power Station in the first fully indigeneous nuclear power station and total responsibility for this project was taken by Indian scientists and engineers when the first unit went into operation in 1983. India joined a small group of countries who have the ability to design and built nuclear power stations on the own. The second unit of the Madras Atomic Power Station went into operation in 1985 confirming our capability to pursue a nuclear power programme on a self reliant basis. The Kalpakkam units operated fairly satisfactorily in the first few years though the turbine generators have been afflicted by blade failures. This Problem has now been brought under control.

Following Kalpakkam, twelve more reactors of 235 MWe each and six reactors of 500 MWe each are constructing all of which are based on the heavy water, natural uranium technology. The first of this series, namely Narora - 1 attained critically in March 1989. We expected to take up work on six more 500 MWe reactors which will also be completed before 2000 A.D. In addition, a decision has been taken to construct two 1000 MWe reactors with Soviet Collaboration, as a supplement to our own national programme.

Capacity and power generation from the three nuclear power stations of India viz. Tarapur Atomic Power Station (TA PS), Rowatbhata Atomic Power Station and Madras Atomic Power Station are shown in table 3.29 for the period from 1980-81 to 1987-88.

TABLE 3.29.

CAPACITY AND GENERATION FROM NUCLEAR POWER STATION.

	TAPS	RAPS	MAPS
A. Capacity (MW)	2x160	2x220	2x235
B. Generation (GWh)			
1980-81	1649	906	--
1981-82	1821	889	--
1982-83	1358	440	--
1983-84	1701	1075	--
1984-85	1757	940	173
1985-86	1781	1189	1133
1986-87	2000	1325	1698
1987-88	1601	1189	2037
C. Plant Load Factor (%)			
1983-84	50.3	30.8	0
1984-85	52.5	28.0	52.0
1985-86	63.4	33.5	60.8
1986-87	71.3	34.4	41.2
1987-88	57.1	36.2	49.5

Source: CMEI, Current Energy scene in India, May, 1988.

At present more than 55 percent of the Coal mined in India goes towards production of electricity. The share of electricity in primary energy in India is about 19 percent. This may be compared with about 30 percent in western Europe, and the projections are that electricity may count for some 40 percent of the primary energy in that part of the world by the year 2000. In India also, electrical energy is expected to account for about 30 percent of the primary energy by the year 2000. Therefore, we have to make available coal and other fossil fuels as an alternative to wood. For increased electricity production we have therefore no option but to develop nuclear power in big way. At present only some 3 percent of our electricity is from nuclear energy. In the world as a whole, nuclear electricity accounts for 16 percent. Some countries have a much larger nuclear share. For instance, France has 70 percent of its, electricity produced from nuclear sources. Even in countries such as Taiwan, South Korea and Bulgaria about 50 percent of the electricity comes from nuclear energy.

Sources of nuclear power in India are uranium and thorium. Uranium is used for generating electric power. It is found mainly in the Singbhum district of Bihar. The latest estimate of the total uranium resources in India is about 52,000 tonnes and about 363,000 tonnes of thorium. The presently available reserves of uranium in thè country when used in the natural uranium fuelled heavy water reactors, is estimated to be capable of supporting a nuclear power generation capacity of 10,000 to 15,000 MWe. Of course we expect more uranium reserves to be found as exploration activities are intensified. Moreover, even the currently available reserves of uranium can support a Power capacity of 350,000 MWe when fast reactors are utilised.

India has also an important nuclear fuel reserve in thorium. While thorium can not be used directly as fuel, when it is irradiated in the blanket of a fast reactor, Uranium-233 is produced. Uranium-233 in turn can then be used as fuel in other reactors along with thorium. Such reactors also have potential of breeding, namely, Producing nuclear fuel in addition to electricity. It is estimated that the currently available reserves of thorium in India can support an ultimate capacity of one million MW of electricity. Thus thorium appears to be one of the largest single source of energy this Country Possesses. (M.R. Srinivasan).

For increasing the available resources of nuclear fuels arises from the development of fast Breeding Reactors. In fast Breeding system, the conversion of the fertile material is extremely efficient where about 1.2 to 1.5 new fissile atoms are produced from the fertile. This implies that Practically all the Uranium can be burnt to produce electricity and can extract as much as $7x10^6$ KWH of electricity from 1 k.g. of urainium. In breeder systems, thorium can also be used efficiently as a fertile material to breed U^{233} which is a good nuclear fuel.

The energy Potential from the Coal deposits and from the Uranium and thorium deposits in India are compared in the table given below. (Ramanna, 1977)

TABLE 3.30

ENERGY POTENTIAL FROM COAL AND NUCLEAR FUELS.

Fuel	Energy HWH (e)
Coal ------	$160x10^{12}$
Uranium in Thermal Reactors --	$7.2x10^{12}$
Uranium in fast Reactors -----	$208x10^{12}$
Thorium in Thermal Reactors --	0
Thorium in fast Reactors -----	$1280x10^{12}$

Source :- Energy in Indian Economy, Commerce, Annual Number 1977

3.5 NON-CONVENTIONAL SOURCES.

In India the domestic needs are largely met by what are referred to as non-Commercial sources of energy. The main sources of non-commercial fuel are fire wood, char coal, dried cowdung and vegetable wastes. Of these fire wood considers to be the main item of domestic fuel consumption. But there is no precise estimate of the fuel wood reserves in India. The Fuel Policy Committee of the Department of Science and Technology has estimated a demand of 132 million tonnes of firewood in 1978-79. The total availability from recorded felling of wood in forests is expected to be 35 million tonnes. This leaves a huge gap of 97 million tonnes. That would probablly be made up by unathorised cutting of trees. Such deforestation will lead to very drastic ecological consequences which is undesirable.

The crisis of fire wood led people to look for an alternative source resulting in increasing use of dung for fuel a very dangerous substitute. Between 300 to 400 million tonnes of wet dung which shrinks to 60 to 80 million tonnes when dried is annually burnt in India, robbing farm land of badly needed nutrients and organic matter. The plant nutrients wasted annually in this fashion equal more than a third of the country's chemical fertiliser use.

The non-commercial energy sector has been given less importance in Indian energy planning. To estimate non-commercial energy consumption in the domestic sector, various assumption have to be made. This is due to non-availability of definitive data.

About two-third of the estimated consumption of non-commercial fuels in terms of coal replacement values consists of fire wood. Cow-dung accounts for 15 Percent and remaining 20 Percent consists of vegetable wastes.

It is worth mentioning that nearly 50 percent of the total requirement of energy in the country, particularly in the entire rural areas, and in significant sectors of the urban areas, is met by wood, agricultural wastes and animal dung, Thus, it is clear that in most of the Indian villages for cooking and for keeping warm during the winter months and for several other domestic needs, woods and agriculture by products continue to remain the largest source of energy in the country (S.Z.Qusim'93).

In view of the above the prominent alternative sources of energy seems to be quite promising are fire wood plantation biogas plants. The cooking needs which mostly rely on wood fuel, dung cake and agriculture wastes can be met by the use of biogas.

3.5.1 BIOGAS :

Biogas is a sustainable source of energy by virtue of its Producation from vastly available cattle dung, simplicity of construction, operation and maintenance of the Production units, and multiple benefits accrued at the natural and the user level.

Estimates indicate a potential of setting up of about 40 million family type biogas units in the country based on ownership of a minimum of four heads of cattle. However, a potential of about 12 million units is considered to be realisable in a time span of 10-15 years. With the likely development of new simple designs based on leafy bio mass, crop residues, garbage, weeds etc. this potential would get enhanced. However, so far over 1.64 million biogas units have been set up in the country, which represent harnessing of about 13 Percent of the realisable potential. The annual rate of construction of biogas units has increased tremendously from the level of 10,000 plants in 1980 to about 1,80,000 plants at present. The state wise data given in table 3.31 show that the growth has been skewed as only the States of Goa, Gujarat, Himachal Pradesh, Kerala, Maharastra, Mizoram and Timil Nadu have hanassed more than 20 percent of their respective potential and rest of the states have lagged behind.

TABLE 3.31

STATE WISE ACHEVEMENT VIS-A-VIS POTENTIAL OF BIOGAS PLANTS UPTO 1992.

State/Union Territory	Estimated Potential (No.)	Plants set up (No.)	% of Potential harnessed
Andhra Pradesh	1065600	111682	10.48
Arunachal Pradesh	7500	89	0.12
Assam	307700	10734	3.48
Bihar	939900	68263	7.26
Goa Daman & Diu	8000	1867	23.33
Gujarat	554000	152531	27.53
Haryana	300000	22074	7.35
Himachal Pradesh	125600	28000	22.29
Jammu & Kashmir	128500	955	0.74
Karnataka	680000	81154	11.93
Kerala	150500	31607	21.00
Madhya Pradesh	1491200	45104	3.02
Maharashtra	897000	472131	55.63
Manipur	38700	532	1.37(1.37)

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State/Union Territory	Estimated Potential (No.)	Plants set up (No.)	% of Potential harnessed
Meghalaya	24000	269	1.12
Mizoram	2200	789	35.86
Nagaland	6700	1214	1.85
Orissa	605500	69815	11.53
Punjab	411600	19392	4.71
Rajasthan	915300	42551	4.64
Sikkim	7300	814	11.15
Tamil Nadu	615800	146263	23.75
Tripura	28500	274	0.96
Uttar Pradesh	2021000	210283	10.40
West Bengal	695000	56297	8.10
Andaman & Nicobar	2200	98	4.45
Chandigarh	1400	82	5.85
Dadra & Nagar Haveli	2000	149	7.45
Delhi	12900	617	4.78
Pondicherry	4000	490	12.25
Lakshadweep	100	---	-----
All India	1,20,50,000	15,75,030	13.07

Source : Yojana, Republic Day, special '93 .

IMPROVED CHULHAS:-

The National Programme on Improved Chulhas was launched in December, 1983. The design of this chulha incorporates an optimum size of combustion chamber air inlet, grate, baffles, dampers ; some also have chimney. The improved cooking stoves have thermal efficiency ranging from 20 % upwards ; some of the models being promoted are fixed, that is, they are construted in the kitchen itself on the lines of traditional chulhas. Some models are made protable, that is, they are handy and are made of metal sheets or cast iron or a combination of the two. Apart from fuel wood, most of these models can use cow dung or coal cakes, Pellets etc. In addition to saving wood, they reduce smoke, thus vastly improving the environment inside and out side the village home and also greatly improved the health of women. They also reduced the drudgergy and time involved in gathering fire wood and in cleaning kitchen and utensils having an efficiency of 20 % and above development by various research institutions and social organisation, these have been identified for propagation, more models will be added to this list and when the results of research and field trials are available, since both efficiency and social acceptability are the guiding criteria, no cooking stove which has not found favour with a community will be Propagated in that community. The cooking stoves vary according to the region, the type of food cooked, the type of fuel used, the size of the beneficiary family as well as its economic status. In some areas, the cooking stoves serve the dual purpose of cooking and heating. The following table gives an idea of the progress made in respect of improved chulhas upto 15-2-86

TABLE 3.32

	States	No. of Chulhas installed.
1.	Andhra Pradesh	43,235
2.	Assam	660
3.	Bihar	16,081
4.	Gujarat	6,868
5.	haryana	37,353
6.	Himachal Pradesh	23,725
7.	Jummu & Kashmir	5,400
8.	Kerala	3,556
9.	Karnataka	30,457
10.	Madhya Pradesh	21,642
11.	Maharastra	7,659
12.	Orissa	16,680
13.	Pondichery	600
14.	Punjab	52,200
15.	Rajasthan	93,880
16.	Sikkim	1,435
17.	Tamil Nadu	68,821
18.	Tripura	9
19.	Uttar Pradesh	61,232
20.	West Bengal	16,345
21.	Chandigarh	3,800
22.	Dadra Nagar Haveli	196
23.	Delhi	3,592
24.	Goa	2,103
25.	Manipur	200
26.	Others	31,120
	TOTAL=	5,48,849

Source:- Augustus S. Suting "Renewable sources of Energy" Planning Departement,Govt. of Meghalaya.

3.5.2 SOLAR ENERGY :-

Large scale demand for heat energy for meeting day to day domestic, institutional and industrial requirements can be met by utilising solar thermal system. The sun is a huge nuclear reactor where hydrogen gas is continuously burning at high temperature and pressure and generating energy. A small fraction of energy radiated by the sun into the space is also reecived on the surface of the earth in the form of radiat energy. This energy is received in three main spectral regions, namely (1) Ultraviolet, (11) Visible light and (111)infarred or heat raditation, the energy content being distributed as about 2 percent, 51 percent and 47 percent respectively. From the energy content point of view,the ultraviolet radiation have no significance since most of the energy is concentrated in other two regions. The salar isolation above the atmosphere and falling on a plane surface facing the sun is 1.35 KW per metre square. This is known as solar constant. Some portion of solar energy coming towards the earth is either absorbed by the atmosphere or reflected back in the space. The amount of solar isolation available on the surface of the earth is therefore reduced, the maximum amount being in the range of 1 to 1.1 kw/m^2. This amount also does not remain same during the whole day. The amount of solar eneregy received on the surface of our country is about 5×10^{15} K W H/ Year which is an enormous amount of energy.

The most important routes of solar energy utilisation are through the conversion of solar energy into heat energy and directly converting the solar radiant energy into electrical energy utilising the process of pholovoltaic conversion. In case of photovoltaic conversion of solar energy into electrical energy the spectral region of utilisation is narrowed down, it is from about 0.8 to 2.o m m only. The energy avergy available in the remaining parts of the solar spectrum is either not utilised or wasted in the form of heat * (G.D. Sooth, 93)

Solar energy is accorded high priority in our plans. India is blessed with plenty of sunshine. The daily average solar energy available in the country varies from 5 to 7 Kwh per square metre, solar energy can be directly converted in to heat energy through solar thermal devices and systems. A large number of commercial enterprises have taken up the manufacture, distribution, installation and maintenance work of these devices. Approximately 10,000 domestic solar water heating systems, 2,25 lakh solar cookers,10,000 solar stills and 200 solar huts have so far been installed in the country. Various incentives have been provided by the goverment for promoting use of these devices.

The Department of Non-Conventional Energy sources has also the responsibility for the development, production and application of solar photovoltaic devices. The direct conversion of solar energy in to electricity using photovoltaic system is considered to have significant potential in India. This route of solar energy utilisation is attractive in view of the favourable solar radiation conditions and large reguirement for electric energy for decentralised applications. The total use of the installation and minimum maintenance, lack of noise and longlife make photovoltaic systems ideally suited for use in remote and isolated areas, forests, hilly and desert regions etc.

Solar Thermal energy/ solar photovoltaic demonstration/ exension Programme statement of achievement upto 15th January, 1986 is shown in table 3.33 below.

TABLE 3.33

Name of state/UT	No. of installed Solar water heating system	other theranal system
1. Andra prodesh	10	3
2. Assam	8	4
3. Arunachal Pradesh	–	1
4. Bihar	1	–
5. Delhi	54	14
6. Gujarat	102	89
7. Haryana	11	1
8. Himachal Pradesh	3	–

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9. Karnataka	10	2
10.Kerala	–	1
11.Madhya Pradesh	98	5
12.Maharashtra	11	–
13.Orissa	6	4
14.Punjab	11	4
15.Rajasthan	36	–
16.Tamilnadu	8	2
17.Uttar Pradesh	91	31
18.West Bengal	–	1
Total =	460	162

Source:- Augustus S. Suting" Renewable Sources of Energy", Department of Planning , Govt. of Meghalaya.

Even though solar energy is abundant yet the major Problem in harnessing solar energy is the fact that it is diffuse and variable. While solar energy can be utilised successfully for low heat applications in which large variations in energy out put are not critical, the technologies for concentrating solar energy for high heat applications or where energy storage is needed in order to provide a steady out put, are still expensive. During the last few years, a broad based co-ordinated solar energy research programme has emerged with an integrated approach of research design and development. The research and development has concentrated on solar radiation and photovdtaic devices and systems for direct conversion of solar energy in to electricity. The main effort in the development of photovoltaic cells is to bring down the cost per peak watt of electricity to a reasonable level. This is sought to be achieved by developing low cost solar grade silicon material and by improving the efficiency of solar cells and panels. Among the solar applications, heating and cooling systems power plants and desalination will receive priority.

3.5.3 WIND ENERGY :

The wind energy is ready to take its place along with conventional sources as a clear source of energy specially in coastal areas. It has been observed that the wind power can compete with hydro power in suitable situations. It is an inexhaustible source of energy which is non- pulluting and ecologically safe.At present about 43 MW aggregate wind power capacity has been established in the country including 6.5 MW in the private sector.

India is among the first few developing countries and the first in Asia to have initiated steps in this direction. The first" wind- Farm" contributing power is the Gujrat wind Farm Limited (GWFL) at Mandvi in Kachch district of Gujrat which was erected in a record time of four months at a cost of about Ro 18.4 million. The farm has a rated capacity of 1.1 MW which was commissioned on January 18, 1986. This wind farm has 21 Wind-Turbine Generators (WTGS) of different sizes 14 generators are of 55 KW, two are of 110 KW, three are of 22 KW and two are of 18.5 KW.

In April 1988, a wind-farm of 1.35 MW based on fifteen 90 KW wind electric generators become operational at Kayattar in Tamil Nadu. There are four other wind farm Projects in the country with an aggregate capacity of 4.29 MW. These are Okha in Gujarat, Inticorin in Tamil Nadu, Puri in Orissa and Deogarh in Maharashtra. (Jaswani, 1991).

Wind mills can be installed for operation in such parts of the Country where wind speeds over 10Km/hr are prevalent.There are specific places in the country such as along the Sea Coast, South Rajasthan, Gujarat, Maharashtra and Karnataka, where it would be perhaps profitable to make use of wind mills for irrigation or drinking water purposes and for generating electricity. The essential problems in the large scale utilisation of wind power is the cost of suitable plants making contribution of the wind power quite insignificant in the total energy needs of our country. (Leach,1978).

Though reliable data is not available for the mountain areas in Jammu & Kashmir, Uttar Pradesh and North-Estern Region, it is generally Known that good wind conditions do exist in these regions, specially in passes and valleys where local factors may be contributing to good wind conditions.

The energy programme is directed towards harnessing the wind potential in the country. Activities pertaining to wind pump demonstration were inlarged to include private users. Several new initiatives were taken up towards wind monitoring and wind electricity generation. In order to provide better information for concentrated deployment of water pumping wind mills and for specific project on installation of individual wind battery chargers, stand alone system and grid connected wind electric generators, wind mapping projects are proposed to be sponsored in several states. Because of the promotional policy measures initiated by the states like Gujarat, Tamil Nadu, Karnataka and Andhra pradesh the private sector participation in the wind power programme is likely to receive a boost.

3.5.4 OCEAN ENERGY :

Ocean energy is another area which is potentially an important renewable source of energy of India's first power plant producing electricity from sea wave is commissioned at Vizhinjam, fishing harbour in Kerala to provide a maximum and an average of 75 MW for 10 months of the year. The potential of ocean hermal Energy Conversion in Andaman & Nicogar Island is high. Broadly speaking the ocean sources of energy are ocean thermal energy conversion (OTEC), the tidal energy and salinity gradient, etc.

The OTEC cell established at IIT, Madras has completed the preliminary feasibility study for establishing a I MW. OTEC plant in Lakshadweep island at Kavaratti and Minicoy. The OTEC works on the principle of utilising the temperature difference of sea water at depth and at the surface. The surface water is used to vaporise a low boiling chemical which derives a turbo generator. The vapoured chemical is then compressed. It is condensed by using cold sea water from the depth.

Alternatives to conventinal hydro electric power include tidal power. The concept of using tidal power is a very old one, but it has been found that favourable sites for tidal power are relatively limited. There are about fifty such sites in the world. The initial development cost for tidal energy are quite enormous. More helpful is the use of wave energy by floating plants which would use the constant motion of the waves to drive turbines, but these would be difficult to use in areas prone to storms where mighty seas might destroy the power plants. (Josephine,1991)

In our country that is India possible sites are Bhavanagar (gulf of Combay), Navlakhi (Gulf of Kutch) Diamond Harbour and Saugar (Hooghly River). the approximate potential in power out put has been estimated at about 700MW. There is a British Project of about 800 MW and a French project of about 240 MW respectively. This clearly indicates that the contribution due to this source to the energy needs will be quite a meagre one (Leach,1978).

3.5.5 GEOTHERMAL ENERGY:

Geothermal energy is the exploitation of heat energy of earth with in the upper 10km of the earth's crust. Geothermal energy can be processed for generation of power where the geothermal fluid has a temperature of about 130°c. Geothermal manifestations are wide spread in India in the form of 340 hot spring localities. only a few direct utilization schemes have been launched by various agencies.

India's most promissing geothermal field is in Puga Valley in Ladakh. There are a number of geothermal wells drilled in the valley. As Ladakh has no energy resources like coal, petrolium etc. harnessing of geothermal energy has been engaging the attention of Scientists from RRL, Jammu who have successfully used this energy for extraction and refining of borax, sulphur and salt in the valley, besides demonstrating its use for space heating. Another on going Project for effective ultilization of geothermal energy is a 5 MW pilot power plant at Manikaran using F-113 as working fluid. The plant has been successfully test run at full load of 5KW under simulated condition at National Aeronautical Laboratory, Bangalore, (NAL) and installed at Manikara in Himachal Pradesh (S.K.Joshi, 1993.)

Plans are being made to undertake further research and development studies in the area of geothermal energy. Exploitation of this energy source for non-power sectors like poultry farming, mushroom cultivation, space heating is possible in this country on a fairly large scale.

3.5.6 BIOMASS

Biomass offers a convenient, natural route to meet the growing energy needs of the society. Some of the possible tecnologies and routes for using biomass are-Thermal energy recovery from waste and residues. Energy recovery from agriculture, industrials and urban wastes through biomethanations Thermo-chemical Conversion using gasification and pyralysis.

Biomass comprises all forms of matter derived from biological activities and is present either on the soil surface or at various depth of the vast body of water lakes, streams rivers, seas and oceans. However, the biomass of immediate consern is that growing above ground.

Biomass in its variety of forms, is a potential source of renewable energy for use as solid, liquid, and gaseous fuel. It offers an important alternative to petroleum products. Biomass programme consists of :-

a) Energy Plantation and Power Generation Programme.

b) Draught Animal Power.

c) Research and Development.

The energy stored in plant material may be released by drying the plant material and burning it directly or it may be converted to liquid and gaseous fuels through a series of process. Biomass conversion system suitable for plant wastes are shown bellow.

Biomass - B

Physical Processes	Chemical Processes		Mixed Processes
Drying	Thermo chemical,	Bio chemical	Powdering Carbo-nisation Briquettes
	Combusion	Anaerobic Digestion	
Size reduction	Glassification		
Briqueting	Pyrolysis	Fermentation	Drying, Pelletes atum, gasificat-ion.Zize reduction Anacrebic Digestion
Pelletization	Direct Liquification		

Establishment of energy plantation on sub-standard soils for demonstration purpose is one of the main thrust areas under the Biomass Programme. Under this programme, plantation of several quick growing species to meet not only the local requirements of the domestic sector but also to provide fuel for the gasifiers and power generation programme has been envisaged power generation through biomass gasifiers for lift irrigation and rural electrification is being initiated upto 500 KW capacity. (Augustus).

Biomass though abundant, in India , is a scattered resource, with an increase in agricultural productivity, human and live stock population and urbanisation and industrical output, the production of waste materials has increased. The data base in this area is however very deficient. The data available are usually normative, rather than actual.

There is therefore, a need to assess the availability of residues, their method of collection and storage, their chemical composition, calorific content and other characteristics, environmental implications of their utilisation and so forth. Only with such an over all assessment will it be possible to formulate an appropriate policy for biomass utilisation.

Non-conventional energy sources are important in view of the overall scarcity of fossil fuels in our country. Long distances and the cost of transportation of conventional fuels particularly in rural areas and for the long term sustainable development, a number of R&D, demonstration and extension programmes have been taken up. The major programme include biogas, improved chulhas, solar thermal, solar photovataic, wind, biomass and micro-hydel programmes. In addition, R&D work has also been taken up on alternative fuels, battery powered vehicles, hydrogen, geo-thermal and chemical sources of energy.

The achievements in the major programmes upto August 1992 are as follows:-

TABLE 3.34

(i) Biomass Plant	16.16 lakh
(ii) Improved chulhas	127 lakh
(iii) Domestic Solarwater heating systems	10292 Nos.
(iv) Industrial Solar water heating systems	4907 Nos.
(v) Solar Cookers	2.27 lakh
(vi) Photovotaic street lights	28,887 Nos.
(vii) Photovolaic domestic lights	11,430 Nos.
(viii) Wind Pumps	2,922 Nos.
(ix) Wind Farms	42.97 MW.
(x) Mini Micro hydel	86.44 MW.
(xi) Biomass gasifier/stirling engines	1040 Nos.

Source :- Yojana, Republic Day, special'93

CHAPTER IV

POWER POTENTIAL AND ITS DEVELOPMENT IN ASSAM

4.1 SOCIO-ECONOMIC CHARACTERISTICS OF ASSAM.

4.1.1. POPULATION

Size and Growth Pattern :

Assam is a most populous state in the North Eastern region of India. In less than 2.4 percent of India's total land area, Assam shelters more than 2.9 percent of the country's population, according to the estimates of census authorities in 1981 (R.K. Choudhary, 90). The population of the state has been growing at a rate faster than that of the country as a whole since the begining of the century and at a much faster rate in the post independence period. Between 1901 and 1971, the population of the country recorded a little over two-fold rise while the increase was more than four-fold in Assam. The decadal growth (percent) of population since 1951 had been more than 10 points higher in Assam than in the country as a whole. In fact, during the period 1901 to 1981, Assam's population increased by as much as 503 compared with only 187 percent increase at all India level. As the 1981 population census could not be conducted in Assam due to prevailing situation in the state, the Registrar General of India had made available estimates of population of the state as worked out by the expert committee on population projection setup by the planning commission. Accordingly, the total population of the state in 1981 was estimated at 199 lakhs as against 146 lakhs recorded by the 1971 census. According to 1991 census the total population of Assam was recorded at 222 lakhs with 53.26 percent increase during the period 1971 to 1991.

The trend in the growth of Assam's population and the country's alongwith their averaged density since 1901 may be observed from the following table :-

TABLE 4.1

POPULATION TREND IN ASSAM AND INDIA

Year	Population (in lakhs)		P.C. Decade variation		Density (person per Sq. Km)	
	Assam	India	Assam	India	Assam	India
1	2	3	4	5	6	7
1901	33	2384	-	-	42	77
1911	38	2521	+ 17.0	+ 5.8	49	82
1921	46	2513	+ 20.5	- 0.3	59	81
1931	56	2789	+ 19.9	+ 11.0	71	90
1941	67	3186	+ 20.4	+ 14.2	85	103
1951	80	3611	+ 19.9	+ 13.3	102	117
1961	108	4392	+ 35.0	+ 21.5	138	142
1971	146	5481	+ 35.0	+ 24.8	186	177
1981	199(a)	6852	--	+ 25.0	254(a)	221
1991	222	8443	+ 53.26	+ 23.5	284	267

(a) Estimated.

Source : i) Census of India, 1981
ii)Census of India, 1991

In the above table we find that the decadal variation in the growth rate has suddenly jumped upwards in 1950's. This was due to large scale influx of Hindu refugees from East Pakisthan. Since 1961 census, the decadal variation in population of Assam is higher than corresponding all India rate by more than 10 percentage point. As a result of the density of population in the state which remained much below the all India level upto 1961, surpassed the latter during the subsequent decades. In 1901, number of persons per sq.km. in Assam was 42 as against the country's number 77 per sq.km. But the density of population of the state in 1991 was 284 persons as against the corressponding all India figure of 267 persons.

Unnatural Increase :

The high rate of growth of population is the combined effect of natural increase and immigration. People from different parts of the country, particularly the plantation workers started to come into Assam during the British regime. The wave of immigration were continued and hence a sizeable portion of Assam's population was migrated from East Pakisthan and Nepal, besides natural growth rate. If we compare between birth rate and death rate of Assam with those of India, we do not find any significant difference. This will be evident from the table furnished below :-

TABLE 4.2

ESTIMATED BIRTH AND DEATH RATES AND NATURAL INCREASE FOR ASSAM AND ALL INDIA (1970-82).

Year	Birth rate		Death rate		Natural Growth rate	
	Assam	India	Assam	India	Assam	India
1	2	3	4	5	6	7
1970	38.8	36.8	16.2	15.7	22.6	21.1
1971	38.5	36.9	17.8	14.9	20.7	22.0
1972	36.4	36.6	17.7	16.9	18.5	19.7
1975	30.1	35.2	16.9	15.9	13.2	19.3
1980	31.9	33.3	10.7	12.4	21.2	20.9
1981	33.0	33.9	12.6	12.5	20.4	21.4
1982	33.8	33.6	12.2	11.8	21.6	21.8

Source :- 1) Draft seven five year plan, 1985-1990 Vol-1

The birth rates and death rates which remained almost same with those of the country as a whole may be due to increase in education, awareness among the educated people to hold small size of family and improved medical and health facilities. The birth rates and death rates of Assam have declined from 38.8 to 33.8 (per thousand) and 16.2 to 12.2 (per thousand) respectively during the period from 1970 to 1982 as against all India rates from 36.8 to 33.6 (per thousand) and 15.7 to 11.8 (per thousand) respectively in the same period. Hence, the wide difference between decadal variation in them has to be explained in terms of unnatural growth of population in Assam.

Diversity character :

The population of Assam bears a heterogeneous character. About 6.2 percent of the population belong to the scheduled castes. They are scattered all over the plain districts. The scheduled tribes (Hills) account for 1.8 percent of the total population and 57.7 percent of the population of the hills districts. The scheduled tribes (plains) comprising 9.2 percent of the population are partly scattered and partly concentrated in certain pockets of different districts. The corresponding all India percentages stood at 14.8 and 6.9 respectively in 1971 and 15.7 and 7.8 respectively in 1981. The areas plain-tribal concentration are now covered by 19 Integrated Tribal Development Projects. These areas account for 80.5 percent of the plains tribal population. The other backward class, including tea garden tribes account for another 23.4 percent of the population. The chars which are islands in the Brahmaputra river, are estimated to be contain about 6.6 percent of the population. These sections of population comprises more than half (52.2%) of the total population of the state.

Urbanisation :

Forces of urbanisation in a village are created only when fundamental and structural changes start taking place in the socio-economics variables in the village life. Urbanisation does not only mean great concentration of human beings in small areas, it requires certain types of socio-economic relationship (Srinivas). In the words of another sociologist, urbanisation should be regarded as involving a process of movement and change (E.P. Stein). The process of Urbanisation is the process of transformation in the structural parameters, co-efficients and exponents and also institutional environment of the village.

Assam has remained at much lower level among all the major states in India as regard to urbanisation. According to 1981 census, 89.7 percent of the states population live in rural area as against 76.7 percent in the country as a whole. There are only three cities with more than 1 lakh of population viz :- Guwahati, Dibrugarh and Jorhat. There are 21,995 villages and 72 towns in Assam according to 1971 census. Out of these only 35 towns have a population above 10,000. Besides, 8 more new towns have been notified by the Government of Assam after 1971 of which only 1 town has a population of about 10,000.

4.1.2 PER CAPITA INCOME:

Per capita income depends both on the Net State Domestic Product (NSDP) and the total number of population of the state. In Assam, the rate of growth in Net Domestic Product has not been much faster than the rate in population growth since 1961. Although during the early fifties the per capita net State Domestic Product has been higher than that of India, nevertheless, the position had been undergoing complete reversal since the begining of the Sixth decade. In 1950-51 the per capita income of Assam was Rs.299.2 at current prices and Rs.258.6 at constant (1948-49) prices as compared with India's Rs.266.5 at current prices and Rs.247.5 at constant (1948-49) prices. But in 1960-61, the per capita income of Assam was recorded at 315.3 at current prices and Rs.251.3 at constant (1948-49) prices against 325.00 and Rs.293.3 at current and constant (1948-49) prices respectively of India's per capita income. Due to sluggish growth of Net State Domestic Product, there had been a per capita income gap between the state and the country in real terms. In 1970-71 it was Rs.98.1 which rose to Rs.187.1 in 1984-85 displaying an ever-widening gap. This has been increasing at an annual compound rate of 4.7 percent over the years 1970-71 to 1984-85. The position has been improved to some extent during the period 1984-85 to 1986-87 when the per capita income of Assam rose from Rs.1820.26 to Rs.2420.00 at current prices against India's per capita income which rose from Rs.2343.8 to Rs.2975.00 at current prices during the same period. Growth rate in per capita income of India has not shown encouraging trend as compared with some other countries of the world. From 1950 to 1985, India's per capita income grew at a meagre average annual rate of 1.5 percent, compared with rates of 5.5 to 6.5 percent in the newly industrialised states of Hong Kong, South Korea, Taiwan and Singapore, and 3 to 4 percent in the three south-east Asian nations of Indonesia, Malaysia and Thailand.

The movement of Net State Domestic Product at factor cost alongwith the per capita income for Assam and India at current prices for the past few years are shown in the following table.

TABLE 4.3

NET DOMESTIC PRODUCT AT FACTOR COST OF ASSAM AND PER CAPITA INCOME OF ASSAM AND INDIA.

Year	Net S.D. for Assam.At current Prices (Rs. in Crores)	Per capita Income. At current Prices (Rs.)	
		Assam	India
1970-71	771.4	534.7	632.8
1971-72	813.9	548.1	660.3
1972.73	882.6	576.6	711.1
1973-74	1023.1	648.4	870.1
1974-75	1337.0	821.7	1003.5
1975-76	1314.4	783.3	1026.4
1976-77	1515.1	875.5	1194.1
1977-78	1701.7	953.2	1253.0
1978-79	1817.8	926.7	1336.1
1979-80	1908.3	1003.5	1550.2
1980-81	2397.8	1220.8	1739.1
1981-82	2640.4	1302.1	1882.3
1982-83	3342.0	1596.1	2180.0
1983-84	4030.6	1862.2	2180.0
1984-85(Q)	4070.6	1820.6	2343.8
1990-91	8679.6	3932.0	-
1991-92(Q)	9562.1	4230.0	5529.0

Q - Quick estimate.

Source :- 1) Directorate of Economics and Statistics, Government of Assam, Economic survey of Assam, 1985-86, P-6.

2) Statistical Hand Book, Assam, 1993.

The Net State Domestic Product which was recorded at Rs.4070.6 crores in 1984-85 against Rs.4030.6 crores in 1983-84 at current prices displayed a rise of only 1.0 percent during the year. The per capita income of Assam in real terms was Rs.584.4 in 1984-85 against Rs.586.1 in 1983-84 which showed a nominal fall of about 0.3 percent over the year. But at current prices, the per capita income of Assam stood at Rs.1820.6 in 1984-85 as against Rs.1862.2 in the previous year displaying a fall of 2.2 percent during the year. The fall in per capita at current prices was due mainly to increase in population growth than that of State Domestic Product. However, the per capita income of Assam at current prices in 1990-91 and 1991-92 has been increased to Rs.3932.0 and 4230.0 respectively. Net Domestic product of the state also rose to Rs.8679.6 and 9562.1 at current prices in 1990-91 and 1991-92 respectively.

4.1.3 EDUCATIONAL STATUS :

Assam remained quite backward in the field of educational development during pre-independence period. The British rulers did not want the people of Assam to be more educated. After independence, the national government stressed the need for the development of primary eductation in Assam by introducing an act for compulsory primary education upto 14 years of age to be implemented through the local boards. In 1947-48, number of primary schools in Assam was 7574 which rose to 29,358 in 1992-93. Number of educational institutions and their enrolement are furnished in the following table to show the development taken place in the field of education for the past few years in Assam.

Figures in the table show that no change has been taken place in respect of the number of university in Assam. However, in terms of students admitted in the Universities a little improvement has been noticed during the period from 1980-81 to 1992-93. A similar improvement has also been found in case of higher education in colleges (general). Here some improvement observed both in number of colleges established and their enrolment. The number of colleges increased by 64.9 percent while their enrolment recorded at a fivefold increase during the period 1980-81 to 1992-93. Progress in the field of professional education remained stagnant. Only two more colleges, viz. one Agricultural college and one Veterinary college were established in 1987-88 during this decade. However, the number of students admitted into these institutions have been registered an increasing trend except in Medical colleges where enrolment has been decreased from 2046 to 1958 during the years from 1980-81 to 1988-89. This may be due to the shortage of seats in these institutions. The situation needs to be improved so that deserving students may get opportunity to impart such professional education.

Table 4.4

NUMBER OF EDUCATIONAL INSTITUTIONS AND ENROLMENT IN ASSAM

Type of Institution	1980-81		1981-82		1987-88		1988-89		1992-93	
	No. Inst.	Enrol-ment	No. Inst.	Enrol-ment	No. Inst.	Enrol-ment	No. Inst.	Enrol-ment	No. Inst.	Enrol-ment
1	2	3	4	5	6	7	8	9	10	11
1. University	3	4617	3	3953	3	4552	3	4474	3	NA
2. College for General education.										
(a) Arts, Sc.,Comm.	137	1,11,075	145	1,28,440	166	6,45,320	181	NA	226	NA
3. College for Professional Education										
(a) Agriculture	1	497	1	494	2	NA	2	NA	2	NA
(b) Engineering	3	1771	3	1849	3	2669	3	NA	3	NA
(c) Law	9	3406	9	4400	9	NA	9	NA	9	NA
(d) Medical	3	2046	3	1806	3	1958	3	1958	3	NA
(e) Veternary	1	310	1	317	2	NA	2	NA	2	NA
(f) Ayurvedic	1	61	1	113	1	NA	1	NA	1	NA
(g) Nursing	1	86	1	105	1	NA	1	NA	2	NA
4. School for general Education										
(a) High Schools and H.S. Schools	1994	5,88,206	2227	6,38,720	2745	9,07,660	3110	12,18,063	3570	12,40,315
(b) Middle and Senior Basic	4194	5,65,603	4390	6,00,662	5188	11,84,444	5635	12,31,297	6729	12,44,188
(c) Primary and Junior Basic	21723	16,92,083	21729	1751,125	26670	28,28,747	28807	34,43,077	28876	29,51,857
(d) Preprimary schools	-	12,674	291	13,418	482	20,824	482	14,460	482	21,860
5. Institution for Professional Education :-										
(a) Polytechnique	7	2240	7	2478	6	3230	6	3230	9	4226
(b) Gram sevak training	1	60	1	60	1	60	1	60	1	60
(c) I.T.I.	10	2830	10	2276	NA	NA	NA	NA	27	3799
(d) Sericulture	1	40	1	40	1	40	NA	NA	1	NA
(e) Land Survey	1	250	1	250	NA	NA	NA	NA	1	NA

(i) (p) - Provisional (ii) N.A. - Not Available

Source :- (i) Statistical Hand Book, Assam, 1982, pp. -258-259
(ii)Statistical Hand Book, Assam, 1984, pp.- 259-260
(iii)Statistical Hand Book, Assam, 1990, pp.- 262-265
(iv) Statistical Hand Book, Assam, 1993, pp.- 316-317

As regard to secondary education, it reveals that the number of High schools and Higher Secondary Schools have been increased from 1994 to 3570 while their enrolment rose from 5,45,114 to 12,40,315 displaying around 50% increase during the period from 1980-81 to 1992-93. In case of middle and primary schools (including pre-primary) the number increased from 25,917 to 36,097 showing 39.27% increase over the period. Enrolment has been increased by about double i.e. from 22,70,360 to 42,17,905 over the same period. The rising trend both in number of schools and enrolment indicates that successive governments stressed the need for development in the field of secondary and primary education.

The accepted goals of universal elementary education and adult eduation has to be pursued. The quality aspects deserve more attention in all areas but more so in scientific, technical and vocational education and training. Vocationalisation of general education deserves closer attention so that the local population may drive the full benefit of schemes for development introducing new technology in all areas including agriculture, besides promoting employ ability of the students living the educational institutions at different stages.

4.1.4. LAND USE PATTERN:

The total geographical area of Assam is 78,523 sq.km. which forms 2.4 percent of the country's landmass, giving the state the areawise rank of twelfth position among the political divisions. This total land area of the state according to the utilisation pattern may be divided into the following classes (a) forests, (b) land not available for cultivation, (c) other uncultivated land excluding fallow land, (d) fallow land and (e) cropped land.

Forest occupies more than one-fourth of the total land area of Assam. Land areas which termed as not available for cultivation are occupied by roads, rivers, lakes, dwelling etc. This comprises 31.2 percent of the total land area of the state as compared to only 13.1 percent for all India in 1982-83. This is due to a vast land surface which is barren and uncultivable, accounting for almost one-fifth of the geographical area (19.6 percent) of the state. Other uncultivable land which includes pastures and grazing land, jungles and groves of ordinary trees and reeds and also cultivable waste land occupies 5.41 lakh hectares accounting for 6.8 percent of the total reporting area of the state in 1980-81. Uncultivable waste land still occupies more than lakh of hectares. Fallow land in Assam is only 2.3 percent of the total area as in 1982-83 and compares favourably to the all India figure of 7.8 percent.

Due to huge amounts of land available for cultivation, the net sown area in Assam accounts for only 33.76 lakh hectares in 1982-83 covering 34.3 percent as against the all India average of 46.6 percent of the total reporting area. Districtwise, Nalbari and Nogaon account for the largest net sown area at 3.19 lakh hectares in each, while North Cachar hill have the lowest at only 21,000 hectares.

Land utilisation pattern in Assam can be seen from the following table for the period from 1950-51 to 1982-83

TABLE 4.5

PATTERN OF LAND UTILISATION IN ASSAM

SL. NO.	Description of land	(in lakh hectares)					
		1950-51	1960-61	1975-76	1979-80	1980-01	1982-83
1	2	3	4	5	6	7	8
1.	Total Geographical area	88.20	78.52	78.52	78.52	78.52	78.52
2.	Forests	28.20 (32)	25.56 (29.1)	19.96 (25.4)	19.84 (25.2)	19.84 (25.2)	19.84 (25.2)
3.	Land not available for cultivation	N.A.	29.92 (38.1)	24.14 (30.7)	24.41 (30.8)	24.53 (31.2)	24.53 (31.2)
4.	In (3) uncultivated land excluding current fallow land	N.A.	N.A.	7.30 (9.3)	6.63 (8.4)	6.26 (7.8)	5.42 (6.9)
5.	Current fallow land	3.00 (3.5)	2.64 (3.0)	1.12 (1.4)	0.97 (1.3)	0.91 (1.2)	0.90 (1.2)
6.	Total Fallow land	N.A.	N.A.	2.44	1.95	1.77	1.78
7.	Net sown area	20.40 (23)	14.13 (18)	26.00 (33)	26.65 (34)	26.96 (34.3)	26.96 (34.3)
8.	Area sown more than once	N.A.	2.00 (2.6)	5.76 (7.4)	6.34 (8.1)	6.77 (8.7)	6.80 (8.7)
9.	Sl. No. (8) as percent of (7)	N.A.	14.3	22.1	24.1	25.1	25.2
10.	Total cropped area	N.A.	18.13 (23.1)	31.76 (40.4)	33.08 (42.1)	33.73 (43)	33.76 (43.3)

Note: i) Figures in brackets indicate percentage to total geographical area
ii) Figures for Columns (3) and (4) have been adjusted to suit the present geographical area of Assam.

Sources : (i) Statistical Hand Book, Assam, 1984
(ii) Third Five Year Plan of Assam, 1961-66, Vol-I
(iii) Economic Intelligence Service, Bombay, Vol-2, September, 1986

Forest area:

About one-fourth of the total geographical area is occupied by forest in Assam. Reserve forest occupies the major part of the state's forest area. The area of the reserve forest, however, increased very slowly from 17.17 thousand sq.km. in 1981-82 to 17.41 thousand sq.km. in 1984-85 with the proposed inclusion of reserve forest, the state forest area in 1984-85 accounted for 20.69 thousand sq.km. During 1985-86 the state had a total forest of about 21,459 sq.km. which comprised 17,409 thousand sq.km. of area under reserve forest and 4050 thousand sq.km. of area under proposed reserved forest. The reserved forest areas, thus, constituted nearly 22 percent of the total geographical area of the state.

Apart from this, there is a sizeable amount of unclassed and other legal status forests. The forest area by ownership comprised 16.4 lakh hectares under forest department, 2.2 lakh hectares under civil authorities and 9.9 lakh hectares under corporate in 1979-80 which forms about 4 percent of total forest ownership area of the country as a whole. Some statistic relating to forestry in Assam are presented in the following table :

TABLE 4.6

SOME STATISTICS OF FORESTRY IN ASSAM

Sl.	Description of Forestry	Unit	Quantity
1	2	3	4
1.	Total area of forest by legal status in 1981-82	(lakh hec)	30.8
2.	Total area by ownership in 1979-80	(lakh hec)	28.5
3.	Percentage of forest ownership area to all India	(P. C.)	3.95
4.	Total reserved forest including proposed reserve in 1984-85	(Sq.Km.)	20.69
5.	Total reserved forest including proposed reserve forest in 1992-93	(lakh hec)	21.48
6.	Timber, Pulp, Firewood and charcoal in 1980	(thousand cu.mtr)	1352.00
7.	Total value of forest produce in 1980	(Rs. lakhs)	649.00
	in 1992-93	(Rs. lakhs)	1827.00
8.	Percentage value of forest produce to the country's total in 1980	(P.C.)	1.80

Source : i) Statistics Relating to Indian Economy, Vol.-2 C.M.I.E., 1986.

ii) Statistical hand book of Assam, 1984, 1993.

4.1.5 AGRICULTURE AS A PRODUCER OF ENERGY:

Agriculture produces vast quantities of biomass (crop, crop residue and animal residue) which are used as sources of energy. Since the role of agriculture as a source of energy has not been fully recognized, few researchers have estimated the output and the pattern of energy produced. The few data available suffer from limitations arising from variations in the coverage of energy sources, refernce period, methods of data collection and unit of measurement. Therefore available estimates have to be taken as order-of-magnitude figures only.

Energy from crop re.sidues:

The difficulty of estimating energy from crop residues stems from large number of crop residues and the many uses to which they may be put. For example, an Aman (Sali) paddy crop has three types of residue leaves which are usually used for fodder and sometimes for fuel; Kher (upper tender straw), which is usually used as fodder or compost and Nara (low coarse straw), which is mostly used as fuel, but is also used for compost, construction material and animal feed. Likewise, jute sticks are used as fuel and as construction material. Second, the output of crop residues varies with the crop variety, high yielding varieties yield fewer by-products than do traditional varieties. Third, crop residues are rarely weighted by farmers. Therefore an accurate estimate of the output is impossible. Most estimates are on norms of average grain-straw ratio derived from limited observations.

The straw-grain ratios for some major crops in India for 1984-85 are used to estimate the residue yield in Assam during the period 1980-81 to 1985-86.

TABLE 4.7

POTENTIAL AVAILABILITY OF AGRICULTURE BASED BIOMASS IN ASSAM

	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
A.Potential availability of rice straw and Husk						
- Cropped area ('000 hectares)	2275.0	2258.5	2301.7	2322.2	2324.8	2464.1
- Rice production ('000 tonnes)	2522.8	2235.6	2583.2	2532.3	2438.0	2848.5
- Rice straw availability ('000 tones)	3784.5	3354.0	3874.5	3798.0	3657.0	4270.5
- Rice husk availablity ('000 tonnes)	1261.5	1118.0	1291.5	1266.0	1219.0	1423.5
B.Potential availability of Wheat straw						
- Cropped area ('000 hectares)	102.2	102.3	105.3	99.2	149.6	92.9
- Wheat prod. ('000 tonnes)	118.3	115.6	121.0	127.9	154.8	100.5
- Wheat straw availability ('000 tonnes)	157.2	154.3	161.3	170.7	206.7	133.8
C.Potential availability of Maize cobs						
- Cropped area ('000 hectares)	22.6	19.1	20.2	18.1	19.6	19.5
- Maize prod. ('000 tonnes)	13.4	11.6	12.2	10.9	12.0	12.1

Contd.....

	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
- Maize cob availability ('000 tonnes)	4.0	3.5	3.7	3.3	3.6	3.6
D.Potential availability of Bagasse						
- Cropped area ('000 hectares)	48.1	49.4	49.4	49.2	52.9	47.8
- Sugarcane prod. ('000 tonnes)	173.7	200.0	215.1	208.4	258.5	187.4
- Bagasse availability ('000 tonnes)	57.3	66.0	70.9	68.7	85.3	61.8
E.Potential availability of Jute stick						
- Cropped area ('000 hectares)	112.3	110.3	116.5	100.8	108.5	129.6
- Jute prod. ('000 Bales)	961.4	1002.8	1006.2	905.4	882.4	1231.6
- Jute stick availability ('000 tonnes)	336.9	330.9	349.5	302.4	325.5	388.8

Source :- (i) The source for Cropped Area and Production is Economic Survey of Assam, 1985-86

(ii)The source for potential availability is author's own calculation on the basis of ratio's given below.

Straw-grain ratio taken from TEDDY ' 88

A. Rice straw : 1.50 by weight of rice grain (by ICAR-1977)

B. Rice Husk : 0.5 by weight of clean rice

C. Wheat Straw : 1.33 by weight of Wheat grain

D. Bagasse : 0.33 by weight of Sugarcane

E. Jutes sticks : 3 tonnes of Jute stick produced per hectare.

Crop residues provide a substantial portion of rural energy. In the above table it is estimated that in 1985-86 about 6.281 million tonnes of crop residue were produced in Assam viz. Rice straw - 4270.5 thousand tonnes, Rice husk - 1423.5 thousand tonnes, wheat straw - 133.8 thousand tonnes, Maize 3.6 thousand tonnes, Bagasse 61.8 thousand tonnes and Jute sticks 388.8 thousand tonnes. Of the total availability of crop residues about seventy five percent was used as animal feed, twenty four percent used as domestic fuel and the remaining one percent used as industrial fuel (e.g. bagasse used as fuel in sugar factories). Energy from residues of 6.281 million tonnes is estimated to be equivalent of about 3.310 m.t.c.r. (1 mmt. = 0.527). For India, Desai (1980) has estimated that about 275 mt of crop residues were produced in 1973-74, including sugarcane tops 15 mt, tapioca sticks 12 mt. and bagasse 30 mt. The average annual output per cropped hectare was approximately 1.06 t. of the total output of crop residues 207 mt. (75 percent) was used as animal feed, 39 mt. (14 percent) as domestic fuel and the remaining 11 percent as industrial fuel. Pimentel and Beyer (1976) have estimated the total output of crop residues in India in terms of energy units. Their estimates for 1972 were the equivalent of about 2787 PJ (666 X 10^{12} Kcal) of energy. Approximately 88 percent of this energy was used as animal feed (these estimates appear to exclude bagasse).

4.1.6 LIVESTOCK POPULATION:

The total number of livestock population in Assam was 96.77 lakhs in 1982 as against 95.84 lakhs in 1979. The latest quinquennial "Livestock Census, 1982" revealed a marginal increase (less than 1 percent) in the states livestock population during 1982 over the livestock population of the previous census conducted during 1979. The cattle population numbering about 67.50 lakhs formed the largest group amongst the livestock population of the state during 1982 which alone accounted for nearly 70 percent of the total, followed by goats 18 percent and pigs and buffaloes 6 percent each. The 1982 livestock census indicates a positive growth in the population of cattle, goat and pigs over the figures of the previous census while in respect of species like buffaloes, sheep, horses and ponies the growth in their population had been found to be rather negative. This would be evident from the table given below:-

TABLE 4.8

LIVESTOCK POPULATION IN ASSAM

(In thousand heads)

LIVESTOCK SPECIES	1979	1982	% VARIATION IN 1982 OVER 1979	1988	1992	% VARIATION IN 1992 OVER 1982
1. Cattle	6604	6750	+ 2.21	7277	7713	+ 14.26
2. Buffaloes	732	558	-23.78	623	624	+ 11.64
3. Goats	1657	1729	+ 4.34	2134	1696	- 1.90
4. Pigs	514	578	+12.45	642	N.A.	N.A.
5. Horses & ponies	18	16	-11.12	134	N.A.	N.A.
6. Sheep	59	46	-22.04	67	N.A.	N.A.
7. Fowls	-	-	-	8460	8070	N.A.
8. Ducks	-	-	-	2993	2649	N.A.
Total	9584	9677	+ 0.97	22330	20752	-

Source :-

(i) Livestock Census, Assam, 1979 and 1982

(ii)Livestock and poultary population of Assam Sample survey report 1991-92

(iii)Statistical handbook, Assam, 1993.

The livestock census, 1982 also revealed total Poultary population of 104.9 lakhs in the state as against 104.5 lakhs in 1979 indicating a marginal rise over the period. Categorywise, their population during 1982 were as follows - Fowls 75.66 lakhs, Ducks 28.87 lakhs and others 37.40 thousands.

Animal wastes :

Dung, Poultry excreta etc are available in animal sheds, poultry farm etc. Estimating quantities of dung like crop residues is difficult because no one weighs it and becasuse the output varies according to animal (breed, age, sex) and feed intake which aslo varies according to season. It may vary from 0.04 kg/ day in case of hens to 15 kg/day from buffaloes. Therefore, detailed surveys are required for estimating the output of animal residues. The available estimates are mostly based on norms of daily output per animal which are based on limited observations. Since the output of animal residue is closely dependent on feed intake, the output can be indirectly estimated on the basis of feed-dung ratios. According to Desai (1980), the output of animal residue works out to 30% of the fodder intake (both measured in terms of dry weight).

On the basis of Desai's estimates, the total output of animal residue in India during 1973-74 was 119 mt. Animal residue is used partly as fuel and partly as manure (plant nutrients) and the proportion varies from region to region. According to Pimentel.and Beyer (1976), the total energy from animal residue in India amounted to 2330 PJ (557 X 10^{12} Kcal) in 1972. About 36 percent of the total was used as manure and the remainder was used as fuel and for the other purposes. The high proportion of dung used as fuel reflects its higher energy content, when burnt rather than applied as fertilizer.

On the basis of Manibög's estimates (1982) in Bangladesh, the total output of animal residue in Assam during 1982 might be estimated at about 7 mt. from 6.75 million cattle and 0.55 million buffaloes. The estimate is based on daily outputs 12 kg, 10 kg and 6 kg, of wet dung per adult buffalo, adult cow and young stock respectively. About 50 percent of the outputs might be used as fuel and the remaining used as manure and for other purposes. In terms of energy, the total output amounted to be about, 47 PJ (11.23 X 10^{12} Kcal) in 1982. In terms of coal replacement energy from 7 mt. of dung cakes in Assam (1982) might be estimated to be about of 3.689 mtcr. (1mmt = 0.301 mtcr).

4.2 SOURCES OF POWER IN ASSAM

4.2.1. INTRODUCTION:

The North-Eastern states comprising of Assam, Meghalaya, Nagaland, Tripura, Mizoram, Manipur and Arunachal Pradesh are among the most backward states in the country. Embracing a land surface of 25.5 million hectares the North-Eastern region is connected with the rest of the country through a narrow strip of land in West Bengal. The region accounts for 7.8 percent of total land space of India and contains 3.88 percent of total population of the country. About 70 percent of the area is hilly terrain. Consequently the topography is undulated in the bulk of the region. About two-third of the annual rainfall (250 cm on an average) occur during the four monsoon months of June to September. The climate of the region varies from the temperature in the hilly region to tropical in the valleys and plains.

The total installed capacity of power in the region in 1985 was of the order of 791.4 MW. The ongoing projects will add 630 MW of generating capacity during the Seventh Plan period. The Directorate of Power System, CEA has estimated the power demand at 377 MW in 1984-85 and 674 MW by the end of the seventh plan leaving a surplus generaion of 138 MW of power and 306 MW respectively. The per capita power consumption in the North-Eastern region was 35 Kwh as against 154 KWH for all India in 1983-84.

The proportion of villages electrified is low in the region which recorded at 45.30 percent as against 64.11 percent for all India in 1984-85. Nagaland ranked first in rural electrification programme as 70.83 percent of villages have been electrified in the state followed by Assam 53.67 percent, Mizoram 45.00 percent, Tripural 39.45 percent, Manipur 30.39 percent, Meghalaya 27.54 percentand Arunachal Pradesh 25.39 percent. The task of rural electrification is relatively difficult because of the topography and sparsely populated scattered villages even on the hill tops. Therefore, through improvised and improved technology smaller but local sources of Power should be tapped for providing electricity to such villages (A.K. Agarwal, 1989).

Amongst the states in the North-Eastern Region, Assam is comparatively ahead in economic development mainly due to availability of natural resources like Oil, Natural Gas and Coal and also because favourable climatic and soil conditions suitable for tea etc. The State of Assam covers a vast area and the distance between the eastern and the western tips of the state is quite considerable. The power development has, therefore, taken place seperately in upper Assam and in lower Assam. The upper Assam system is fed from Namrup Thermal Power Station based on Natural Gas and the Lower Assam System draws power from the oil-fired unit at Chandrapur near Guwahati, Bangaigaon Thermal Power Station (Salakati) based on Coal fired. (B.K. Phukan) .pa

4.2.2 CONVENTIONAL SOURCES

COAL :

Supply of commercial energy in Assam is made mainly from Coal, Oil and Natural Gas and Hydropower. Commerical coal mining in Assam started about 100 years back for supplying to the tea industries, railway and brick fields. Latter the tea industry has switched over to electric power and the railways have switched over to diesel. As a result growth in utilisation of Coal in this region did not show any encouraging trend. As against 0.20 million tonnes production in 1900 A.D., 1981 production stands at 0.64 million tonnes and 1 million tonne in 1988.

From the stand point of conservation aspects this can be treated as a favourable sign. Of the two coal belts in the N.E. Region, one along Southern-central Part of Meghalaya and the other along Assam-Nagaland border. The second belt alone accounts for a reserve of 356 miilion tonnes upto a depth of 300 meters. Studies made by various expert committees indicate that there is distinct possibility of producing metalurgical cake and synthetic crude, where India is largely dependent on import.

There are large proven coal deposits in the state of Assam and a substantial portion of this is situated in the Makum Coal fields in the upper Assam. The proven reserves of these fields have been estimated to be about 114 million tonens and less than 25 million tonnes are reported to have been raised so far. Despite these large deposits, Assam Coal has not been used for generation of power because of the ecological and technological problems. Posed by its high sulphur content and low ash fusion temperature. It may be noted in this regard that coal for the Bongaigaon (Salakati) Thermal Power Station is obtained from the Bengal/Bihar belt of Coal mines.

The largest coal field of north-east are in upper Assam. Dilli-Jaypore and Ledo-Borgolai (Makum), Margherita and Mikir Hills of Assam. The character of Coal fields found in this region is different from the Gondwana coal fields of Peninsular India. It is generally very triable and contains organic sulphur to the extent of 8 percent. In general, the ash is less than 25 percent and moisture upto 10 percent. The calorific value range from 6000 to 8000 cal/kg and some of the coal has good cooking properties which can be used in steel plants.

However, a working group constituted of the Union Government has made an indepth study of the problem associated with burning of higher sulphur Assam coal and has recommended that this Coal can be satisfactorily used for generation of Power utilising indigeneous technology. For Assam, this is of special significance because it means economic exploitation of the large reserves of coal hitherto lying unutilised and thus convert this apparent liability to a national asset.

Trend of coal production with colliers in Assam can be seen from table 4.9 below.

TABLE 4.9

COLLIERWISE PRODUCTION OF COAL IN ASSAM.
('000 MT)

Years	Collieries					Total Production
	Ledo	Borg-olai	Tipang	Jaypore	B.G/OCA	
1981	151	218	236	41	--	646
1982	144	242	229	43	30	688
1983	117	178	252	50	154	751
1984	144	142	222	118	214	840
1985	147	257	238	45	148	835
1986	244	310	208	42	60	864
1987	292	84	207	27	312	922
1988	349	90	211	26	324	1000
1989	319	102	177	33	290	821
1990	196	95	145	27	149	612
1991	564	127	146	26	119	982
1992(p)	627	105	154	24	81(N.C Hill 78)	1069

(p) Provisional

Source :- (i) Coal India Ltd Margherita.
(ii) Statistical Hand Book, Assam,1993

At present Assam has a deposit of 295 million tonnes of coal to extract which the Coal India Limited had spent Rs.85 crore out of the total of Rs.100 crore for the whole country. Out of the target of 1.5 million tonnes of

Coal extraction in 1993-94, 1.1 million tonnes had already been extracted. The Government would invest Rs.10 crore in 1994-95 to utilise modern methods of extraction in the country.

The Union Minister for Coal declared that a Coal Washery at Ledo and a 10 MW captive power plant at a cost of Rs.35 crore at Borgolai would be set up under joint venture of Coal India and the private sector. Steps are being taken to open a new coal mine at Lekhapani and a hydraulic mine at Bargolai. The minister further announced that the centre would invest Rs.60 crore for coal extraction in the region in the next five years.

OIL AND NATURAL GAS:

In Assam the first drilling for oil began in 1866 near Jaipur, a place about 30 miles South-West of Digboi. Drilling for oil started in 1889 and completed in 1890 at a depth of 662 feet. In 1898 a seperate oil company was formed for oil operation and it was named "Assam Oil Company Ltd". A small refinery was installed at Digboi Commissioned in 1901 (Shamsul'80). The Digboi oil field is worlds oldest oil field. The oil was struck on October 19, 1889 at a depth of 178 feet.

Assam with over 150.MMT of recoverable reserves of crude oil and about 150 billion cubic meter of gas has a vast untapped potential oil and gas. Intensification of search for oil and gas field has led to new discoveries in Naharkatia, Moran, Joragan, Kharsang, Borhola, Lakwa, Geleki and Rudra-Sagar. As per estimates, these fields have a reserve of 93 million tonres of oil and 71 billion standard M^3 of natutral gas. These account for 19.70 percent and 16.90 percent of India's total(on shore +off shore) reserve of oil and natural gas respectively. Search for new fields is still contined.

Due to in sufficiency of investment funds on the one hand and transport bottleneck on the other, the production of oil was slow. Financial soundness as well as managerial and techinical efficiency, on the other hand was achived by the oil industry of Assam after it was taken over by the Burma oil company from the Assam Oil Company in 1921 after which production rose significantly. Production trend of petroleum in Assam during British regime can be seen from the following table.

TABLE 4.10

PRODUCTION OF PETROLEUM IN ASSAM TILL 1946

Year	Annual Production (in million gallons)	Year	Annual Production (in million gallons)
1918	11.0	1926	24.0
1919	6.57	1920	32.0
1920	5.11	1931	65.7
1925	10.95	1946	70.0

Source :- Statistical Abstrata of India

Annual production of pertroleum went down from 11 million gallons in 1918 to only 5.11 million gallons in 1920, till the take over of the management by the Burma Oil Company in 1921. But the production shown a gradual rising trend thereafter from 10.95 million gallons in 1925 to 70 million gallons upto the end of the Britsh regime in Assam. Thus, during the period from 1925 to 1946, petroleum production was increased by about six and half times.

Petroleum of Assam had a premier position in India and was also sent to Engalnd, earning thereby a good amount of foreign exchange. However, like the tea industry in Assam, petroleum industry could not open up scope for other oil-based industries. Becuase the British interest centred round econmic drain, they were not concerned with the economic benefit of the people of Assam. There was lack of capital and local enterprise. A major part of the gains from petroleum industry went out abroad and was not reinvested. A capital intensive industrty of this kind, therefore, could not bring much impact on the economy of Assam during the British days.

The production of crude oil in Assam at present is more than 5 million tonnes per annum. Crude oil production in the state registered a growth of 5.5 percent in 1989 as compared to the level achieved during 1988. In absolute term, its production stood at 53.9 lakh tonnes in 1989 as against 51.1 lakh in the previous year. The output of petroleum which was 35.4 lakh tonnes in 1971 has shown an increasing trend in the subsequent years. During 1979, the production of crude oil marked at 45.7 lakh tonnes which was decreased to 10.6 lakh tonnes during 1980. The cause of decline was oil blocade imposed by the leader of All Assam Students Union (AASU) during the movement of foreigners issue. During 1982, the output performance was satisfactory and recorded at 51.1 lakh tonnes. The production again showed a declining trend in three subsequent years from 1983 to 1985. The output of petroleum which declined from 50.24 lakh tonnes in 1983 to 48.96 lakh tonnes in 1984, showed further decline during 1985, i.e. from 48.96 lakh tonnes in 1984 to 47.90 lakh tonnes in 1985. During this period the ONGC could not drill oil regularly due to disturbance situation prevaied in the state for infiltration problem.

So far as production performance of the state's three refineries, i.e. Digboi, Noonmati and Bangaigaon refineries are concerned, the achivement found to be encouraging during 1985. The total volume of output of these refineries reached a new high of 19.10 lakh tonnes in 1985 from the level of 18.98 lakh tonnes in 1984. The output of refineries products during 1983 and 1982 were of the order of 18.45 lakh tonnes and 17.64 lakh tonnes respectively. The total volume of output of the three refineries stood at 25.31 lakh tonnes in 1989 surpassing the previous record output level of 24.91 lakh tonnes in 1988. In percentage term, the growth in output during 1989 was higher by 1.6 percent over the preceding year. The position is expected to improve further in the coming years with the establishment of the proposed fourth Oil refinery at Numaligarh in the district of Golaghat.

Out of these three refineries operating in the state, Noonmati Oil Refinery, Guwahati is the country's first refinery in the Public sector which was set-up in collaboration, technical and financial assistance from the Rumanian Government to process .75 million metric tonnes of crude oil produced at Naharkatia and Moran supplied by Oil India Ltd., Duliajan through 16" trunk pipe line over a distance of 270 miles. The construction started in October 1959 and was inagurated by the then Prime Minister of India Pandit Jawaharlal Nehru on 1st January 1962. The overall functions can be divided into three broad division - Refinery Accounts, Administrative and Personnel Department.

The Noonmati Oil Refinery, Guwahati has the following Production structure :-

Production Capacity .85 million tonnes

Units :-

1) 01 Unit - (Objects) - Distribution Unit

2) 02 Unit Kerosene Unit

3) 03 Unit Cooking Unit

	Name of Products	Share in Percentage	
1)	MS	12.0%	
2)	SRM	5.0%	
3)	L.P.G.	.4%	
4)	Iomen	3.0%	
5)	S.K.	10.0%	
6)	ATF	5.0%	
7)	H.S.D.	30.0%	
8)	L.D.O.	10.0%	
9)	P/Coke	5.0%	
10)	LSHS	5.0%	
11)	F.O.	7.0%	
12)	Gas & Loss	0.6%	
13)	Variables		7.0%
		100.0%	

The history of Oil India Ltd. goes back to the discovery of Oil in Naharkatia and Moran in Upper Assam. After 1953, negotiations were held between the Government of India and Burmah Oil Company of U.K. and Assam Oil Company Ltd., Digboi (a subsidiary company of BOC) for exploring oil and for formation of a joint sector Rupee Company to be incorporated in India with its registered office in the state of Assam.

The agreement of the new joint venture was signed on January 14, 1958. The company was registered on the 18th

February, 1959 under the name of "Oil India Limited" where the Burmah Oil Company held two-thirds of the shares and the Government of India one-third. But as a result of amendment of Companies Act, 1956, in December 1960, Oil India Private Limited was made Public company on 28th March, 1961 and since then it came to be known as "Oil India Limited".

The Indian Oil Company was set up in 1964 through amalgamation of the Indian Refineries Ltd. with the Indian Oil Company to effect co-ordination between refining the crude Oil and marketing of refined products. The Indian Oil Company is managing the refineries at Digboi and Guwahati, whose installed capacity today are 0.5 million tonnes and 0.85 million tonnes respectively.

Assam Oil Company was formed in 1898 (incorporated in London) with its head office at London. The Burmah Oil Company Limited who made successful operation in Burma appeared on the scene after 1921 and began to take over the Assam Oil Company Ltd. progressively in stages.

The Digboi Oil Refinery is countriy's first refinery which was commissioned in 1901. With nearly 1000 wells Digboi is now an ageing oil field older than most in the world. At present the production of Digboi refinery is or an average of about 8000 barrels per day or 4,30,000 tonnes per year. (G. Saikia'75).

The Bongaigaon Refinery and Petrochemicals Ltd. (BRPL) was registered in 1974 and established at Bangaigaon in Lower Assam with installed capacity of one million tonne per annum. It was commissioned in 1979 with refining capacity of 1 million tonne which further increased to 1.35 million tonnes on April 1, 1987. During the Seventh Five Year Plan, the capacity of BRPL refinery at Bangaigaon proposed to be expanded to 3.5 million tonnes per annum.

The Numaligarh Oil Refinery Project which is going to be set up in the district of Golaghat in Upper Assam will have refining capacity of 3 million tonnes per annum. It is the outcome of the Assam Accord between All Assam Student Union (AASU) and the Union Government signed in 1985. The project was approved by the Union Government in July 1992 at a cost of Rs.1830 crore. The original date of commissioning was scheduled sometimes in October 1997. But it is learnt that due to delay in works the projects is not going to be commissioned before January 1998. Sources said that at present the site preparation work in going on. The main cause for the delay is reported to be the lack of infrastructure in the location. According to the Government's assessment the project may suffer further delay if advance planning is not done to prevent it. However, no official figure is available about the revised estimated cost of the project.

Other two on going projects under the Ministry of Petroleum and Natural Gas, in Assam namely modernization of Digboi refinery and Bongaigaon Refinery & Petrochemical Ltd. (BRPL) expansion project are very much behind schedule. Sources in the Ministry are of the opinion that these projects may be delayed further. As a result of this, the Government of India may have to carry an additional burden of Rs.1000 crore approximately.

The Refinery Expansion Project (BRPL) was approved by the Government in December 1992. The project will cost Rs. 222.94 crore and is scheduled to be completed by December, 1994. But as a large number of milestones are yet to be completed, the project is already delayed for four months. Sources are of the opinion that the project will be further delayed, because, till now, there is no sign of expeditious action in erection and fabrication of equipment, which is necessary to prevent any further delay.

The fate of the Digboi refinery is no different. The project for modernisation of the Digboi Refinery Project was approved in June 1989 at an original cost of Rs.143.74 crore. but for the delay, the cost has gone up to Rs.346.34 crore. It is learnt that the infrastructure deficiency and local disturbances are affecting the project work. There has been a hold on further financial commitments since June 1991. However the Government has approved the revised cost expenditure and according to the sources the project is likely to be completed by Fabruary 1996. (The Sentinel, 22nd March 1994).

NATURAL GAS :

Assam is rich in Oil and Natural Gas. Besides associated gas of oil wells, there are deposits of three natural gas in Assam. Natural Gas can be used with less expensive processing. It requires less time for exploitation and can be used locally. There are a number of Gas fields in upper Assam. The volume of production of natural gas in the state stood at 1005 million cubic meter in 1989 as compared to 965 million cubic meter 1988 showing thereby an increase of 4.1 percent in production over the year. Conservative estimates indicate a total reserve of about 150 billion cubic meters of Natural Gas in Assam.

Natural gas could substitute different petroleum products in the different sectors of economy as indicated below

Sectors	Energy items to be substituted by Natural Gas.
1. Industry	Fuel Oil
2. Power	Coal/Fuel Oil
3. Household	Kerosene
4. Agriculture	Diesel (H.S.D.)
5. Transport	Diesel (H.S.D.)/Petrol

Natural gas is popular in the power sector and in fertilisers. In industry Natural Gas is gradually being substituted by Fuel Oil. LPG, a fractionated product of Natural gas is popular in households; but in short supply as fractionation capacity is growing too slowly to meet the rising demands. In transport sector, Natural Gas is yet to get serious consideration.

The Assam Gas Company Ltd (AGCL) - a state undertaking - was created to market natural gas decades back. The AGCL operating from Duliajan had attain sufficient expertise on marketing of natural gas and had performed well. But the expansion scheme, unfortunately is going slow. The natural gas grid to Tinsukia and beyond are yet to mature. The trunk natural gas pipeline from Duliajan to Bongaigaon - 530 Km. linking the important centres enroute, proposed years back, is yet to see the light of day.

The State Government must be firm in getting the Natural Gas allocation for the state keeping in mind the coming events. We may not expect much from Gas Authority of India Ltd. (GAIL) in Assam although GAIL is entrusted to supply Natural Gas to the proposed Numaligarh Refinery by the Petroleum Ministry overlooking the favourable offer which was given by AGCL. The Ministry, unfortunately, is assuming to be the only repository of the wisdom on formulation and implementation of Hydro-carbon projects.

Assam having surplus natural gas, specially Lean Gas (Methane), must have an original plan to substitute High Speed Diesel (HSD) by natural gas at least to the tune of half of a million tonne of HSD within the next 3-4 years time. As pricing of Natural Gas in this region is more favourable, the CNG users could get additional benefits. The only assurance the vehicle user would need is regular supply of CNG through convenient outlets (D.K. Goswami'94).

As per study conducted by EIL, New Delhi, the various fed-stocks that could be available from the oil fields of Assam region by 1994-95 together with the expected quantity of ethylene production from those sources as estimated as below :

OIL SOURCE:	
-- Rich Natural Gas :	
Total gas avilability	5.75 MMS CMD
C^2 + Product	319,000 TPA
Ethylene yield	171,750 TPA
-- NGL fraction :	
Raw NGL	165,000 TPA
Dearomatised NGL	132.000 TPA
Ethylene yield	37,820 TPA
ONGC SOURCE	
Total Gas availability	2.00 MMSCMD
C^2 + Product	184,000 TPA
Ethylene yield	90,430 TPA
LPG surplus (including supply from 3 MMPTA refinery)	94,000 TPA
Ethylene yield	36,660 TPA
Total Ethylene Yield	336,660 TPA

The total Gas production of ONGC in Assam is only 1.38 million M^3 or 13.8 lakh M^3 per day. The committed supply of gas to consumers is 10.12 lakh M^3 per day against the availability of only 11.2 M^3 per day. Flared gas in all the fields should, thus be around 1 lakh M^3/day, if all the buyers draw the committed quantity in full. The majors conumers like ASEB and HFCL, draw only about 45-60 percent of the committed quantity. The unutilised gas has, thus to be flared. The position with regard to Gas production, unutilsation and flaring is as under :

Production		13.8 lakh M^3/day
Internal consumtion		02.6 lakh M^3/day
Gas available for other consumers		11.2 lakh M^3/day
Gas committed to :-		
a) ASEB	04.65 lakh M^3/day	
b) HFCL	04.50 lakh M^3/day	
c) Tea Gardens and others	00.97 lakh M^3/day	
Total		10.12 lakh M^3/day

Source : ONGC, ERBC, Nazira, 1994.

In addition to the commitments indicated above, there are the following commitments for gas already made, but the consumers are yet to start drawing gas :-

ASEB Maibella Phase - II	:	4.0 lakh M^3/day
NPC, Tuli	:	0.8 lakh M^3/day
LPG Plant being put up by GAIL at Lakwa	:	2.0 lakh M^3/day (LPG shrinkage only)
Total	:	6.8 lakh M^3/day

It will be appreciated that with the present availability of gas, it is difficult for ONGC to meet even the above demand unless the existing consumers scale down their committed quantitites. Gas is also required for the Amuguri Power Plant being undertaken by ASEB.

Flaring of Gas :

In Assam, at least 40 per cent of the committed gas is flared every day in addition to the one lakh M^3 flared a day by the ONGC itself. This accounts for at least 4.048 lakh M^3 + 1 lakh M^3 = 5.048 lakh M^3 of gas flared every day. Even at the concessional price of Rs. 600 per 1000 M^3, the value of this is Rs. 30 lakhs plus. Multiplied by 365 (days) the annual loss comes to Rs. 1095 lakhs or Rs. 109.5 million. Even so, there is hardly any point in rubbing in the fact that natural gas is being offered at a concessional rate of Rs. 600 per 1,000 M^3. After all, if one can not use the gas and must therefore, burn it up, does it not make good business sense at least to cut the nations losses - specially with fuels that one can not get back.

Another study reveals, since 1976 till 1986, only 45% of the natural gas has been consumed and remaining 55% has been flared. It has been estimated that the daily loss of flared gas is around Rs.15 to Rs.20 lakhs. Thus the accumulated loss of this flared gas should have crossed few thousand crores.

As the state is now facing various socio-political effects of economic backwardness, it is essential not to lose any time in making efforts to transform this god-gifted resource to use for the economic well being of the people.

The present external utilisation of natural gas available from the oil fields of OIL and ONGC in this region mainly concentrate on (i) Production of fertiliser by HFLC, (ii) Generation of power by ASEB, (iii) Methanol production by APL (iv) as fuel by a few tea gardens in upper Assam. and (v) also domestic gas supply started by AGCL. The offtake of gas by the above consuming agencies is very nominal - being in the order of only 45 percent to 50 percent, resulting in flaring of the remaining quantity for want of utilisation. The internal utilisation of the gas by OIL and ONGC is for power generation, gas injection and shrinkage in LPG extraction by OIL's LPG extraction plant.

The availability of gas feed-stock vis-a-vis present utilisation reveals that good surplus of gas is availablie in Assam for exploitation. The imperative need,is therefore, to convert in clossal waste of this scarce material into value-added product to bridge the demand supply gap position and to reduce the regional imbalances by using it for overall socio-economic development of this backward state (M.P. Bezbaruah'90).

The price of gas in the North-East is only Rs.600 per 1000 M^3 as against the base price of Rs. 2500 per 1000 M^3 alongwith the HPJ pipeline. Most of the gas produced by ONGC in Assam is associated gas and a major part of this is low pressure gas which has to be compressed before being supplied to the consumers. Compression cost of gas works out to be of the order of Rs.1000 per 1000 M^3 depending upon the pressure. This will go to show that the cost of gas in this part of the country does not cover even the compression cost. Further, ONGC has been geting no payment, whatsoever, for years together from the major consumers like ASEB, HFCL towards sale of gas, whereas the sales tax and royalty on the gas sold are being paid by the ONGC regularly from its funds to the Government of Assam.

That the price of Natural Gas in the North-East is only Rs.600 per 1000 M^3 as against Rs.2500 per 1000 is a startling revelation. It is known that LPG is generally expensive in the North-East than in the rest of the country. So the beneficiaries are, obviously, not the inhabitants of the North-East. That consumers like ASEB, HFCL have not paid years together cannot be a reason for flaring up of the product. Nor can it be a good business sense that gas is produced first and then the consumers are asked to buy it. And if the consumers do not buy, the natural gas should be flared up. Besides, financial loss, flaring of natural gas caused ecotological imbalances. To prevent this glaring loss of Assam, and thus of the Nation, the ONGC should adopt appropriate measures in near future.

Petroleum, Natural Gas and Coal are the important minerals so far exploited in the state. During the year 1984 the overall output performance of the states mineral sectors were more or less satisfactory. Except some fall in the output of the petroleum (crude, other minerals viz. coal, natural gas and limestone recorded significant improvement in output during 1984 over the level of the previous year). The performance of this sector during 1985, was, however, disappointing as almost all mineral items, should decline in output during the year. In table 4.11 below production trend of petroleum (crude), natural gas and coal in the state over the past few years may be observed.

TABLE 4.11

MINERAL PRODUCTION IN ASSAM

Year	Petroleum (crude) (in lakh tonnes)	Natural Gas(utilised) (in million cu.mtr.)	Coal (in'000 tonnes)
1	2	3	4
1971	35.4	375	578
1975	41.9	621	582
1978	40.8	889	649
1979	45.7	942	584
1980	10.6	455	575
1981	43.9	869	651
1982	51.1	875	688
1983	50.2	733	751
1984	48.9	771	840
1985	47.9	751	835
1986	51.0	843	864
1987	49.6	1003	922
1988	51.1	965	1000
1989	53.0	1005	840
1990	49.2	987	612
1991	48.3	967	982
1992 (p)	47.0	1030	1069

(p) Provisional

Source : (i) Economic Survey of Assam 1985-86, 1989-90.

(ii) Statistical Handbook, Assam, 1990,1993.

The production of petroleum (crude), natural gas and coal recorded by and large, a satisfactory performance during 1991 as most of the items registered rise during the year as compared to the earlier year. Provisional production data available for the year revealed that the production of crude oil, the most important mineral product in the state recorded a rise of 2.3 percent in 1991 over the production level of 1990. Similarly the production of natural gas (utilised) and coal during 1991 were higher as much as 2.5 percent and 50.3 percent respectively as compared to the level achieved in the preceding year. (Review of the economy of Assam, 1991-92).

HYDEL RESOURCE:

Of all the methods of electricity generation, hydro power is the cheapest, cleanest and the best from resource optimization point of view. Assam in the North-Eastern region of India is fortunate in having the great water body of the Brahmaputra in the North and the Barak in the South. The Brahmaputra river carries an annual flow greater than any other river system in India. Of the various benefits which the river system can bring, Hydro-electric power system is certainly the most attractive.

A systematic map-study of the hydro potential of the country was made only in the late fifties of this century by the Central Water and Power Commission. This estimate established the possibility of generating over 12 million Kwh of hydro power from the tributaries of the Brahmaputra. Subsequent studies made with more recent and better maps, coupled with field investigations have revealed even higher potential. While there may be some variations in these estimated figures, the Brahmaputra basin without doubt, offers the highest hydro-potential in the country in a single river basin. The North-Eastern region which also includes the Barak and Imphal basins together offer a fantastic amount of hydro power potential. The total hydro-electric potential of the North-East works out to :-

1. Brahmaputra valley	40,690 M.W.
2. Barak valley	2,455 M.W.
3. Manipur valley	205 M.W.
Total	43,350 M.W.

A tributarywise examination unfolds the picture of this mostly untapped resources fully.

The first tributary of the Brahmaputra valley was the Umtru river, where its rapids were harnessed to provide a tiny power station by the present day standard in July 1957. The station was of only 8.4 M.W. capacity with the addition of 2.8 M.W. in 1967, the capacity of this station was increased to 112 M.W. Six more power stations were planned as what is now known as the Umium-Umtru-Khri valley development in various stages with a total potential of 400

M.W. Of these six, three have since been commissioned namely Umium stage-I 36 MW, Umium stage-II 18 MW and Umium-Umtru stage-III on Kyrdenkulai - 60 MW. Work on stage IV of 60 MW capacity is nearing completion by the Meghalaya Electricity Board.

Assam State Electricity Board's proposal to develop 150 MW in two power stations on the Kopili river, a major south bank tributary of the Brahmaputra received the centre's clearance in 1974-75. One power station called the Khandong power station of 50 MW capacity was commissioned in mid 1984, while the Kopili power station with a capacity of 100 MW was commissioned in mid-1988. The existing projects can be developed into a 285 MW power station with the addition of 100 MW in the Kopili power station and developing another 35 MW by the side of the existing Khardong Power Station. The Kopili valley alone can produce 485 MW of hydro power. Work on the lower Barapani renamed the Karbi-Langpi with an installed capacity of 100 MW station was started in 1981 and is in an advanced state of completion.

On the South Bank of the Brahmaputra, the next potential site is the Doyang Hydro-electric project, on a tributary of the Brahmaputra, the Noadihing river has a potential of 100 MW if a 152 mtr. high dam is constructed some distance upstream of Miao, in Arunachal Pradesh. Further a 1000 MW damway hydro-electric project has been proposed by NEEPCO on the tributary Lohit, whereas the multipupose dam planned by the Brahmaputra Board will have an installed capacity of 3000 MW.

If we take up the North Bank tributaries of the Brahmaputra, the first tributary with major hydro-potential is the Manas river. This river was investigated for a dam at Mathanguri from the fifties. With a 266-meter-high dam it is possible to provide for a hydro-power station of 5000 MW capacity.

In the Jia-Bharali/Kameng basin, a project report for utilising the large head of the Loop of the Kameng river has been submitted to the government of India after detailed investigations to develop 600 MW power. In the lower reaches, a 211 meter high dam is possible on the Jia-Bharali river where 2000 MW project can be installed.

A 405 MW hydro-electric project has, meanwhile, been taken up for construction on the Ranganadi river a tributary of the Subansiri. In its upper reaches a 100 MW hydro electric project has been proposed by NEEPCO as a stage of the Ranganadi project. Investigation for a 100 MW hydro electric project on the adjecent Dikrong river have been completed. A detailed project report prepared by the Brahmaputra Board provides for a 4800 MW power station on the river bank of the Subansiri river.

Again the Dibang is a tribulent and major tributary of the Brahmaputra carring an annual yield of 3.91 million hectare meters of water. The Brahmaputra Board had made preliminary investigation for a storage dam with a height of 231 meters about 3 km upstream of Kronli in Arunachal Pradesh. The regulated flow will allow an installed capacity of 2500 MW. Investigations by the Brahmaputra board on the Siang river showed that with a 262 meter high storage dam, it is possible to provide for an installation of 20,000 MW of hydro-electric power.

Adding up all the potential in different sub-basins of the Brahmaputra valley, the hydro-power potential comes to :-

North Bank		South Bank	
Dibang	2500 MW	Lohit storage	3000 MW
Dihang	20000 MW	Damwe	1000 MW
Subansiri	4800 MW	Noadhing	100 MW
Ranganadi	505 MW	Doyang	75 MW
Dikrong	100 MW	Kileng	120 MW
Jai Bharali storage	2000 MW	Langpi valley	220 MW
Kameng	600 MW	Kopili valley	485 MW
Manas	5000 MW	Umium-Umtru	185.2 MW
	35505 MW		5185.2 MW

Total in Brahmaputra basin = 35,505 MW

+ 5,185 MW

40,690 MW

There are small projects like mini and micro-hydel project which can be developed. A number of micro hydel projects have been developed in Arunachal Pradesh whereas so far, the only micro-hydel sources tapped in Assam is the 2 MW BordiKharu scheme in the Karbi Anglong district. The ASEB has a proposal to develop a series of small hydro stations on the Dhansiri irrigation projects canal (S.N. Phukan'91).

4.2.3 NON-CONVENTIONAL SOURCES:

Non-conventional sources of energy are still playing a dominant role in suppling energy for domestic consumption. In the rural sector, firewood, agricultural wastes and cowdung cakes are still used as a major sources of energy. In urban household sector, firewood is considered a major source of energy and used in a larger proportion compared to other fuels. Before the invent of commercial energy, both urban and rural households used renewable sources of energy for domestic consumption. Since recent past bio-gas plant particularly gobar-gas plants are popularised among the domestic sector both in rural and urban areas. More gobar-gas plants are being set-up in rural areas by government effort. This is very essential because availability of firewood is reducing day by day.

The most urgent problem faced by the households is the inadequacy of fuel. Firewood is becoming very scarce and wherever it is available the price is very high. Kerosene is also not available to the required extent. Apart from its scarcity, it is becoming costlier day by day. In this context dried cowdung becomes the source of fuel in rural hosueholds for domestic use. In urban household sector, although the use of dried cowdung is not found sufficiently yet it uses as input in the gobar-gas plants.

Cattle-dung contains a rich soruce of energy which can be extracted and used as fuel. To extract this it should pass through what is popularly called "the gobar gas plant". The gobar gas plant takes away from the cow-dung the methane which can be stored in a gas holder and leave ramnants as a sturry very rich in nitrogen and humas. So it is possible to get both fuel and organic manure from the cowdung by which household miseries can be solved to some extent.

Among the other benefits, the expenditure on firewood and Kerosene can be saved by using gobar-gas. It is easy to handle and ensures less chance of accident. Gobar-gas is prefarable due to its cleaness and time saving also. Besides individual household benefits, it renders social benefits also by installing gobar-gas plants social environment can also be developed. Moreover it help to conservation of forest. Therefore social need for biogas plants cannot be less emphasised.

In view of the above, Government of Assam prepared a scheme to utilise gobar-gas properly. In the year 1983-84, Rural Development Department, Government of Assam prepared a scheme to install a biogas plants with the co-operation of registered firms and institutions of respective district in Assam. These are given districtwise below :-

Districts	No. of Plants
Kamrup	50
Goalpara	30
Nogaon	30
Darrang	200
Sibsagar	200
Dibrugarh	30
Lakhimpur	40
Cachar	30
Karbi-Anglong	5
North Cachar	5
Total	620

Government of Assam could install only 108 biogas plants out of a target of 1000 plants during 1985-86. Besides individual family owned biogas plants, community and institutional plants are being tried to set-up. Special grants in this regard are being given by the central government. The Directorate, Rural Development Department, Government of Assam has been taken initiate in promoting rapid progress in this field.

Assam is rich in fossil fuel like oil and natural gas. The state also has substantial renewable energy sources like solar, hydel and biomass. Even then per capita consumption of energy in the state is among the lowest in the country which indicates low level of economic development.

There is a good scope of generation of electricity from solar energy, wind power, hill streams and biomass resources to meet the energy needs of the isolated locations. It is possible to make use of solar energy for cooking, heating and drying purposes.

The specific advantages of renewable energy sources are - (a) Zero cost and minimal O & M cost, (b) Huge savings of conventional energy sources due to their displacement by the use of renewable energy sources, it has been asses that (i) 40 m^2 of solar cells at 10% efficiency can save one million tonnes of oil per year, (ii) 5000 aero-generator of 1 MW capacity each covering 50 Km^2 area can save 1 million tonne of oil per year, (iii) a 2 cubic meter bio-gas plant can save about 2 tonnes of wood per year, apart from proving dried manure of 27 kg per year (iv) a demestic solar cooker can save 550 kg of wood per year, (c) renewable energy sources are not polluting, (d) they are abundant in supply, (e) they are available in one form or another in all parts of the country, (f) they have very low gestation period for setting up, very low investment and very simple technologies of generation and control (M. Ramchandran'93).

In the above background, the Assam Science Technology and Environment Council with support of the Science Technology and Environment Department, Government of Assam has taken initiative not only to implement a number of nenewable energy programmes and projects but also have taken Research and Development, training and information dissemination activities in the different areas of renewable energy, a resume of which follows.

SOLAR COOKER:

Answer to the housewife's problem of scarcity and high price of cooking fuel, is a simple device known as "Solar Cooker", in which food can be cooked by heating in the sun. The performance of solar cookers under a demonstration programme is found to be satisfactory. There is a good demand for solar cookers in the urban areas. During the year 1994-95 limited number of solar cookers of small size will be made available to the public at a subsidised price of Rs.400 against a market price of around Rs.800 by ASTE council.

SOLAR WATER HEATING SYSTEM:

To meet the requirement of hot water, solar water heater has been indentified as one of the most promising solar energy equipments. Solar heaters are now extensively used in domestic, commercial, industrial and institutional sectors.

For domestic use a 100 liters per day (LPD) system may be suitable. For hotels, hospitals, hostels and for industrial use solar hot water systems of appropriate size may be used. The cost of a solar hot water system of 100 LPD is around Rs.15,000. At present there is no subsidy for solar hot water system either from the State or the Central Government.

SOLAR PHOTOVOLTAIC ELECTRIFICATION:

By Solar Photovoltaic technology, sunlight is directly converted into electricity. The SPV technology is now widely used for domestic lighting, street lighting, electrification of community centres for lighting and T.V., Railway signalling, Tele-communication, water pumping for irrigation and drinking water.

The ASTE council has provided high priority in electrification of domestic households by Solar Photovoltaic. Both stand alone PV domestic systems and solar lanterns are in use. Solar PV Technology has been used in Assam for water pumping for village drinking water supply, for operating ultra-violate water purifier, for community lights and T.V., as well as for operating VCR for community viewing. The council is now taking up an ambitious project to provide the benefits of Solar Photovoltaic electrification to the 368 villagers of nine very remote backward villages. The project is located in Dimoria Block of Kamrup district, 40 km from Guwahati.

WIND ENERGY:

Techno-economic viability of large scale utilisation of wind energy in Assam is yet to be established as average wind speed in most place in the state is not very high. One wind generator and one water pumping wind mill has been installed on pilot basis. Two more wind pumps and six aerogenerators are being set up within the year 1994-95. Wind data is now regularly collected at 30 stations spreaded all over the state for preparation of a wind atlas of Assam for large scale exploitation of wind energy.

MICRO-HYDEL:

The Council is taking up investigation for setting up small hydel stations in two locations in Karbi Anglong District. The Council expects to set up two portable (5-10 kw) hydel sets for rural power supply under a centrally sponsored scheme during the year 1994-95.

URJAGRAM:

The objective of setting up of Urjagram Project is to install different renewable energy devices and equipment in remote villages to meet the energy need of the village. Two Urjagram projects, one at Korapara in Kamrup district and one at Badiarpara in Goalpara district are at present under implementation of the council. (ASTE'94).

4.3. POWER SITUATION IN ASSAM

4.3.1. INTRODUCTION;

Assam is endowed with immense potentials for development of her power sector. But considering the vast power potential based on hydel, natural gas, oil and coal resources, the progress in this sector has not been taken place on a scale commensurate with the possibilities. As a result there still exist a big gap between availability and demand for power in the state.

The state of Assam accounts for only a small fraction (0.47 percent) of the total generation of electricity in the country during 1989-90. Although consumption of power in the state has been increasing in absolute term over the recent years, the average per capita consumption of electricity (utilities plus non-utilities) in the state stood at a level much below the all India average, the same was only 78 KWH in Assam during 1989-90 compared with 236 KWH for the country as a whole during the same year.

The installed capacity of power in the state increased to 514.4 MW (including in capacity of standby sets) at the end of 1988-89 from 484.4 MW at the end of 1987-88. The increase in the installed capacity is stated to be due to expansion of Chandrapur Thermal Power Station in 1988-89. The position is expected to improve further in near future with the commissioning of a few on-going power projects in the state.

The generation of power in the state which recorded some decline during 1988-89 showed some increase during 1989-90. The total units of power generated stood at 1147.2 million KWH during 1989-90 as against 1086.6 million KWH during 1988-89 and 1162.2 million KWH in 1987-88. It has further increased to 1206.4 million units in 1990-91 as against 1147.2 million units in 1989-90. In percentage term while the power generation during 1988-89 was lower by 6.5 percent over 1987-88 it was higher by 5.6 percent in 1989-90 over 1988-89 and 5.2 percent in 1990-91 over 1989-90. The position was expected to improve during 1991-92.

Power generation in the state which recorded some decline during 1984-85 showed further decline during 1985-86. The total units of power generated stood at 845.1 million KWH during 1985-86 as against the generation of 852.3 million KWH during 1984-85 and 967.7 million KWH during 1983-84. The shortfall in generation during 1984-85 and during 1985-86 was mainly due to frequent shutdowns in the Bangaigaon Thermal Power Station and two units of Namrup Thermal Power Station. The trend in the growth of installed capacity and generation of power in the state over the period from 1975-76 to 1990-91 may be seen from table 4.12 below :-

TABLE 4.12

INSTALLED CAPACITY AND GENERATION OF ELECTRICITY IN ASSAM

Year	Installed Capacity (In M.W.)	Total Units Generated (In Million KWH)
1975-76	111.5	449.4
1976-77	141.5	586.0
1977-78	141.5	588.7
1978-79	141.5	658.5
1979-80	141.5	513.0
1980-81	201.5	464.7
1981-82	310.0	726.6
1983-83	311.4	896.2
1983-84	326.4	967.7
1984-85	349.4	852.3
1985-86	409.4	845.1
1986-87	484.4	997.2
1987-88	484.4	1164.2
1988-89	514.4	1086.6
1989-90	514.4	1147.2
1990-91	514.4	1206.3
1991-92	514.4	1079.5
1992-93	514.4	1068.3

Source :- (i) Economic survey of Assam, 1985-86, 1989-90.

(ii) Statistical Handbook,Assam, 1982,1984,1990,1993

4.3.2 POWER SUPPLY POSITION:

The overall supply position in the state was non to encouraging during 1984-85. During 1985-86 also the position showed no improvement as there was frequent interruption in power supply, particularly during the latter part of the year. On account of shut down of Bangaingaon Thermal Power Station and one unit of Namrup Thermal Power Station, the state had to face some difficulties in the generation and availability of power during the few initial months of 1987-88. However, the overall position showed some improvement during the latter part of the year as a result of recommissioning of three of the four units of Bangaigaon Thermal Power Station. During 1988-89, aslo the power supply position in the state was non too encouraging. The availability of power from own generation as well as import from neighbouring systems was inadequate to meet the states requirement thereby forcing the ASEB to resort to some amount of load shedding/power cut in several areas of the state on a number of occasion. The practice of load shedding and power cut has become now-a-days a regular feature in the power supply system of Assam causing great hardship to the consumers.

Having ceded the Umtru and Umium-Barapani hydel projects to Meghalaya, ASEB was left with a modest installed capacity of just 514.4 M.W.- all of it in expensive thermal generation. The ASEB could generate only 2 M.W. from Bordikharu Micro Hydel Project although Assam has tremendous hydro electric power potential. At present, the state has six thermal power stations namely, Namrup Thermal Power Station (NTPS), Chandrapur Thermal Power Station (CTPS), Bangaigaon Thermal Power Station (BTPS), Lakwa Thermal Power Station (LTPS), Mobile Gas Turbine (MGT), Galeki and Mobile Gas Turbine (MGT), Kathalguri. Installed capacity of different power station under ASEB in Assam over the period from 1980-81 to 1989-90 can be seen from the following table :-

TABLE 4.13

INSTALLED CAPACITY OF DIFFERENT POWER STATIONS IN ASSAM

(IN MW)

POWER STATION	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
NTPS	111.5	111.5	111.5	111.5	133.5	133.5	133.5	133.5	133.5	133.5
CTPS	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	60.0	60.0
BTPS	60.0	120.0	120.0	120.0	120.0	180.0	240.0	240.0	240.0	240.0
LTPS	NIL	30.0	30.0	45.0	45.0	45.0	60.0	60.0	60.0	60.0
MGT(G)	NIL	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
MGT(KATH)	NIL	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
BORDI-KHARU (MICRO-HYDEL)	NIL	NIL	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL	201.5	310.4	311.4	326.4	349.4	409.4	484.4	484.4	514.4	514.4

Source : Assam State Electricity Board, Guwahati, 1994.

At the end of 1980-81, Assam had a total 201.5 MW power installation capacity (115.5 MW from NTPS, 30 MW from CTPS and 60 MW from BTPS) as compared to 141.5 MW during 1979-80. During 1981-82 it was increased to 310.4 MW. The increase was due to commissioning of the first unit (60 MW) of Bangaigaon Thermal Power Station, 2 units of Lakwa Thermal Power station (2 X 15 MW) and 18.9 MW from Galekei and Kathalguri Gas Turbine. Following commissioning of Bordikharu Micro-hydel project (1 MW) the installed capacity further increased to 311.4 MW at the end of 1982-83. The position further improved when one unit of Lakwa Thermal Power station (1 X 15 MW) was commissioned during 1983-84. Power supply position of the state continued to imporve further when another 2 units of Bangaigaon Thermal Power station (2 X 16 MW) and one unit of Lakwa Thermal power station (1 X 15 MW) started functioning during 1986-87). At the end of 1988-89, the installed capacity was 514.4 MW as compared to 484.4 MW during 1987-88. The increase was due to expansion of Chandrapur Thermal Power Station (1 X 30MW). During 1989-90, the installed capacity remained static due to non commissioning of on going projects.

The generation of power in the state shown in table 4.12 of this chapter cannot be accepted as net generation because the figure included auxiliary consumption of power by the generating plants. To arrive at net auxiliary consumption needs to be substracted from the gross generation. Gross generation, auxiliary consumption and net generation of different power stations under ASEB over the period from 1986-87 to 1989-90 can be observed in Table 4.14 below.

TABLE 4.14

GROSS GENERATION, AUXILLARY CONSUMPTION AND NET GENERATION OF POWER UNDER ASEB (M.U.)

Power Station	1986-87		1987-88		1988-89		1989-90	
	Gross	Auxi	Gross	Auxi	Gross	Auxi	Gross	Auxi
CTPS	156.29	7.74	153.89	7.85	134.65	6.88	253.43	14.52
NTPS	384.15	12.50	320.73	11.66	418.63	51.92	237.93	11.21
BTPS	214.27	28.21	367.77	43.96	283.99	11.43	468.52	60.98
LTPS	194.30	8.96	250.26	10.67	186.77	8.40	165.89	7.43
MGT(G)	28.71	2.65	32.57	2.90	24.53	2.49	1.88	0.36
MGT(K)	18.59	2.17	36.23	3.64	37.40	3.83	19.47	2.17
BORDI-KHARU	0.84	0.01	0.76	0.01	0.59	0.01	0.06	0.01
TOTAL	997.15	62.24	1162.23	80.69	1086.56	84.96	1147.21	96.68
NET GENERATION	934.91		1081.54		1001.60		1050.53	

Note :- Net Generation = Gross - Auxiliary Consumption.

Source :- Assam State Electricity Board, Guwahati, 1994.

From the table it has found that both gross andnet generation of power increased from 997.15 million units to 1162.23 million units and from 934.91 million units to 1081.54 million units during 1986-87 and 1987-88. The position declined again during 1988-89. A little improvement showed during 1989-90 which was marked below the net generation of power during 1987-88. But auxiliary consumption increased to 96.68 million units as compared to 80.68 million units during 1987-88.

As power generated in the state is insufficient to meet the growing demand, a part of this demand is met through imports of power from neighbouring systems. ASEB generally purchases power from Meghalaya and from regional projects like Kopili Hydro Electric projects and Loktak Hydro Electric Projects. Moreover, the state purchases power from central sector from organisations like NEEPCO and NHPC besides neighbouring states Tripura, Arunachal Pradesh and Nagaland.

The total units of power purchased by the state from other systems stood at 516.6 million KWH during 1984-85 as against 335.6 million KWH during 1983-84 and 322.2 million KWH during 1982-83. During 1985-86 the total units of power purchased from other systems was recorded at 586.6 million KWH. The purchase of power from other systems declined during 1986-87 and 1987-88 as compared to previous year. The total units of power purchased by the state from other sources stood at 780.1 million KWH and 886.8 million KWH during 1988-89 and 1989-90 respectively. The position further increased to 890.5 million KWH during 1990-91.

The total units of power purchased by the state from other systems over the period from 1982-83 to 1990-91 can be seen from table 4.15 below.

TABLE 4.15

POWER PURCHASED BY THE STATE FROM OTHER SYSTEMS

Year	Power Purchased (in million kwh)
1982-83	322.2
1983-84	335.6
1984-85	516.6
1985-86	586.6
1986-87	590.8
1987-88	508.7
1988-89	708.1
1989-90	886.8
1990-91	890.5
1991-92	996.8
1992-93	1086.5

Source :- (i) Statistical Handbook, Assam, 1990, 1993.
(ii) ASEB, Guwahati, 1994.

Assam also exports power to the neighbouring systems. The total units of power exported to the neighbouring systems during 1987-88 stood at 159.62 million units. During 1988-89 export of power reduced which recorded at 148.75 million units. The total units of power exported by the state to other systems increased to 179.42 million units during 1989-90 as against 148.75 million units in the previous year.

Export of power by the ASEB to other neighbouring systems over the period from 1987-88 to 1989-90 can be seen from the table 4.16 below

TABLE 4.16

POWER EXPORTED BY ASEB TO OTHER SYSTEMS
(in million units)

Systems	1987-88	1988-89	1989-90
MSEB	16.60	11.35	24.83
NEEPCO	27.60	6.97	6.06
MIZORAM	16.95	17.54	22.96
TRIPURA	30.44	51.36	42.13
NAGALAND	49.26	43.43	49.01
A. P.	6.42	6.08	15.54
BHUTAN	3.09	1.05	2.15
NHPC	8.97	10.97	16.74
BRPL	0.22	NIL	NIL
W.BENGAL	0.05	NIL	NIL
TOTAL	159.62	148.75	179.42

SOURCE :- Assam State Electricity Board, Guwahati, 1994.

Even though the installed capacity of power in the state went up considerably during 1989-90, the gap between availability and the demand for power is still very wide. The total power generating capacity in the state is 514.4 MW against the Peak hour demand of 420 MW. But, at present, all the power generating centres can produce 150 MW of energy only. The shortfall is over 250 MW during the peak hour adding most of the lower Assam districts reeling under severe power cuts. According to the 13th Load Survey conducted by the Central Electricity Authority the peak demand for power in our state is expected to rise to 849 MW by the end of the 8th five year plan from the present peak level of around 420 MW. In order to reduce the gap betweem availability and demand for power, the on-going projects needs to be completed soon besides existing stations are utilised in full capacity.

Some of the on going power projects in the state are (1) Karbi-Langpi Hydro Electric Project - 100 MW. (2) Dhansiri Hydro Electric Project - 19.95 MW. (3) Lakwa Extension (Gas based) - 60 MW. The Karbi Langpi Hydro Electric project (2 X 50) MW was sanctioned by the planning commission in 1979-80 at an estimated cost of Rs.3636 lakhs. The original schedule for commissioning of the project was by the end of sixth five year plan. The project is being financed under OECF loan (Yen credit) from Japan. The commissioning of the project has been delayed mainly due to slow progress in the dam. The contractors selected for the dam failed to procure the machineries and also decide on consultants for the work in time. Besides, civil works in tunnel penstock and power house building has also been delayed due to the prevailing situation in the state in the past years. During the annual plan discussions in December'84, the revised commissioning schedule has been fixed for Unit I June 1988 and the Unit II Septmember 1988. The revised cost estimate for the project was Rs.7850 lakhs. Due to slow progress of works the project could not be commissioned in time.

The sanction for implementation of the Dhansiri Hydro Electric project (15 X 1.33 MW) at an estimated cost of Rs.1053.39 lakhs has been accorded by the Planning Commission in February 1985. The project envisages installation of 15 nos. of 1.33 each Mini Hydel generating units in 5 power stations. The original cost estimate was prepared by Irrigation Department of Government of Assam. After scrutiny of the estimate, the Board has submitted a revised estimate for the work which has amounted to Rs.1540 lakhs. The revised estimate has been forwarded to the Central Electricity Authority and Planning Commission and also recorded during the plan discussions on December 1984. The CEA has sought some clarifications on revised estimate which have been compiled to. In the meantime, the Board has decided to go ahead with the project pending sanction of the revised estimate of 1540 lakhs.

Gas-based Lakwa Thermal Power Station phase II (4 X 15 MW) has been sanctioned by Planning Commissionin March, 1985 at an estimated cost of Rs.3401 lakhs. The schedule of commissioning for first two units was March, 1988 and the other two units was March, 1989. It was earlier decided to procure the machineries from M/S Mitsubishi Corporation, Japan, price bid for which was obtained along with the offer for 1 X 15 MW in 1982. But the Board has reviewed the earlier decision and decided to call fresh global tenders for machineries. Accordingly preparation of specification for machineries was taken up in hand.

Besides on-going schemes, the ASEB started to work on some new schemes. One of the schemes was Karbi-Langpi (upper stage) Hydro Electric Project (2 X 30 MW). Survey and investigation works for this project have completed and the project report has been forwarded to CEA and planning Commission in May 1985. The estimated cost of the project was Rs.8236 lakhs and the cost of generation was estimated to be 33.09 paise per kwh. The project has been included in the Seventh Plan under new scheme. A consolidated amount of Rs.5703 lakhs has been provided for all the new schemes (hydel, thermal, diesel and gas).

Other gas based new schemes are -

(1) Gas based power station in Kathalguri - 360 M.W.

(2) Kathalguri/Barhola Gas Turbine (2 X 15 MW).

(3) Lakwa Waste Heat Power (Phase-I) 1 X 22 MW).

At Kathalguri, ASEB has already installed 4 X 2.705 MW Mobile Gas Turbine Generating Units. But the entire natural gas available at this location could not be utilised by those MGTs.

In the meantime, ONGC has comfirmed availability of about 80,000 cubic meters of natural gas per day at Borhola. With the available natural gas, it will be possible to run 4 X 2705 MW gas turbine at Borhola.

ASEB has therefore, decided to shift 4 Mobile Gas *Turbine Generation Units at Kathalguri to Borhola and* install 2 units of 15 MW each gas turbine generating units at Kathalguri. Accordingly a project report has been submitted to CEA and Planning Commission for immediate investment decision. The estimated cost of the project was Rs.1269 lakhs and cost of generation is estimated to be Rs.21.68 paise per kwh.

After knowing the availability of natural gas in Kathalguri area, ASEB has submitted a project report for gas based power station in Kathalguri area with an installed capacity of 360 MW (8 X 30 MW. gas turbine and 4 X 30 MW waste heat units). Member (Thermal), CEA informed that due to non-availability of additional natural gas, they are not in a position to techno-economically clear this project. However, they will consider the project when sufficient gas is available for power generation.

In the mean time it was understood that CEA has techno-economically cleared the 280 MW gas based project at Kathalguri and the Planning commission was taking investment decision on the project under central sector Assam

Government has already submited memorandum to centre with a request to entrust ASEB with execution, operation and maintenance of the proposed 280 MW gas based power station. The final decision on this matter is awaited. As a policy of private participation in the power sector, an American based company is making contract with the government to take over Khalguri, Amuguri and Cachar gas based power projects. Some new projects included in the Eighth Plan by ASEB are Amuguri gas based power project - 360 MW Namrup extension project - 60 MW and Lower Kapili hydel project - 150 MW.

Two mega hydel projects are Subansiri and Dihang. The projects had been pending finalisation only because of the opposition by the Arunachal Pradesh Government. Despite relentless pressure from the Centre, the Arunachal Pradesh Government has refused to release the required land which would be submerged once the dam across the Subansiri and Dihang were constructed. The Power potential of Subansiri and Dihang would be of the order of 30,000 MW. Therefore if all these on-going and new schemes of power projects are commissioned, the power supply position of the state will improve to a great extent in near future.

TRANSMISSION AND DISTRIBUTION NETWORK:

Over the years an extensive network of transmission and distribution lines have been developed in the state so as to transmit power to the load centres and to distribute the same to the consumers. At the end of March 1982 the total length of transmission and distribution lines in the state was 28,824 Ckt. Kms. as against 25,879 Ckt. Kms. at the end of March 1981. Construction of more such lines with 200 K.V. and 132 K.V. capacity connecting different places of the State are reported to be in progress and the works of the following lines and sub-stations are expected to be completed soon.

Transmission lines :

(a) 220 K.V. lines :

(i) Chandrapur-Guwahati Double Circuit upto Khanapara.

(ii) Chandrapur-Samaguri second circuit stringing

(iii) Guwahati-Agia double circuit.

(iv) Agia-Salakati double circuit.

(v) Langpi-Guwahati double circuit.

(vi) Brahmaputra river crossing at Jogighopa-Panchratna.

(vii) Khanapara-Sarusajai 4 circuit.

(b) 132 K.V. Lines :

(i) North Lakhimpur-Dhemaji Single circuit.

(ii) Gosaigaon - Gauripur Single circuit.

(iii) Jorhat- Mariani Single circuit on Double circuit.

Sub-stations :

(i) 220/132 K.V. Samuguri sub-station, 1 X 25, 1 X 50 M.V.A.

(ii) 220/132 K.V. Mariani sub-station, 1 X 50 M.V.A.

(iii) 132/33 K.V. Tezpur sub-station, 2 X 10 M.V.A.

(iv) 132/33 K.V. Badarpur sub-station, 2 X 10 M.V.A.

(v) 132/66 K.V. Namrup sub-station, 2 X 25 M.V.A.

(vi) 132/66 K.V. Tinsukia sub-station, 2 X 20 M.V.A.

(vii) 132/33 K.V. Chandrapur sub-station, 2 X 16 M.V.A.

(viii) 132/33 K.V. Amingaon sub-station, 2 X 16 M.V.A.

(ix) 66/33 K.V. Dumduma sub-station, 2 X 5 M.V.A.

The works programme proposed during 1987-88 were as follows :-

(a) 220 K.V. lines:

(i) Samaguri-Mariani double circuit.

(ii) Samaguri-Tezpur double circuit.

(iii) Brahmaputra river crossing at Silghat-Bhomoraguri double circuit.

(b) 132 K.V. lines:

(i) Tinsukia - Margherita double circuit.

(ii) Lakwa-Dibrugarh single circuit.

(iii) Lakwa-Diphu single circuit.

(iv) North Lakhimpur-Majuli single circuit.

Besides, the works on the following transmission lines, which are under REC, were expected to complete during 1987-88.

(i) 66 K.V. Agia - Singimari on double circuit towers.

(ii) 66 K.V. Dhemaji - Dhakuakhana single circuit.

Sub-stations:

(i) 220/132 K.V. Guwahati sub-station, 2 X 63 M.V.A.

(ii) 132/33 K.V. Margherita sub-station, 2 X 10 M.V.A.

(iii) 132/33 K.V. Lanka sub-station, 2 X 16 M.V.A.

(iv) 132/33 K.V. Barnagar sub-station, 2 X 10 M.V.A.

(v) 132/33 K.V. North Lakhimpur sub-station, 2 X 10 M.V.A.

(vi) 132/33 K.V. Jagiroad sub-station, 2 X 16 M.V.A.

(vii) 132/66 K.V. Dhemaji sub-station, 1 X 25 M.V.A.

(viii) 132/66 K.V. Nazira sub-station, 2 X 16 M.V.A.

(ix) 132/33 K.V. Jorhat sub-station, 2 X 16 M.V.A.

(x) 132/33 K.V. Gauripur sub-station, 2 X 10 M.V.A.

(xi) 132/66 K.V. Agia sub-station, 2 X 20 M.V.A.

Besides, the Board has already sub-milled the project report for seventh plan transmission and transformation scheme to be implemented during Seventh Five Year Plan period (Draft Annual Plan 1987-88, Vol. III).

4.3.3. RURAL ELECTRIFICATION:

Village electrification is a crucial component in the strategy for a balanced development of rural India. Out of a total 5.79 lakh villages in the country more than 4.83 lakh villages have already been electrified upto 1990-91. States of Andhra Pradesh, Goa, Gujrat, Maharastra, Haryana, Himachal Pradesh, Karnataka, Kerala, Punjab, Nagaland, Sikkim and Tamil Nadu have achieved cent percent electrification. From a mere 12.8 percent in 1969, today village electrification has a coverage of over 83 percent.

The Rural Electrification Corporation (REC) set up in 1969, finances, co-ordinates and accelerates rural electrification programmes in the country. These programmes cover electrification of villages, energisation of pumpsets, provision for power for small and agro-based rural industries, lighting of rural households and street lighting.

A programme to provide assistance to SEB's for system improvement works was undertaken in 1987-88. Till December 1991, REC has sanctioned 745 system improvement schemes. Under the system of improvement schemes, assistance is also provided to SEBs for adoption of innovative and cost-effective technologies.

The Special Project Agriculture (SPA), a programmes of REC aims at ensuring continous flow of funds from the Union Government to the State Governments. State Electricity Boards (SEBs) are given financial support by commercial banks, REC and National Bank for Agriculture and Rural Development (NABARD), to draw transmission lines and other infrastructural support for pump sets energisation in rural areas under the scheme (Yojana - July 15, 1992).

In Assam, so far as achievement under the rural electrification programme is concerned nearly 95% of the total inhabited villages covering 90% of the total population have been electrified upto the year 1989-90, as against electrification of 100% villages achieved by some other states of the country even before 1987-88.

Of the total 20,064 villages in the plain districts of Assam, 13,648 villages have been electrified upto 30.3.1986. The allocation during 1986-87 was Rs.3017 lakhs. With this amount 2011 villages were aimed to be electrified during 1986-87. The proposal for rural electrification during 1986-87 was 2368 villages at an estimated cost of Rs.4033 lakhs.

2795 pump sets have been energised upto 31-3-86. The programme during 1986-87 in respect of pump energisation was 490 which depended on the requirement from the concerned department of the state government. A.S.M.I.D.C. and other Private consumers. During 1987-88 it was proposed to energise 587 pumpsets. Total number of pumpsets energised during 1988-89 were 3338 against 2795 numbers during 1986 which were futher increased to 3377 during 1989-90. The number of pump set energised during the year 1988-89 and 1989-90 was 113 and 38 respectively.

In the sphere of rural electrification the state has made a considerable improvement during the recent past. During 1985-86 altogather 1842 villages of the state were brought under the coverage of rural electrification programme as against 2251 villages covered during 1984-85. The total number of electrified villages in the state rose to 13648 at the end of March 1986 from 11806 at the end of March 1985. Thus 62.1 percent of the total number of inhabited villages of the state had been electrified till the end of 1985-86 compared with electrification of only 25 percent villages upto 1980-81.

Till the end of March, 1991 nearly 97 percent of the inhabited villages of the state has been brought under the coverage of rural electrification programme with the coverage of 89 percent and 95 percent of villages upto March, 1989 and March, 1990 respectively. The total number of electrified villages in the state which was 17,897 at the end of March 1988 rose to 19,545 at the end of March, 1989 and further to 20,984 at the end of March 1990. Altogather 1439 villages of the state were electrified during 1989-90 while during 1988-89 the number of villages electrified stood at 1648. At the end of march 1991 the total number of villages electrified was 21,344 which further increased to 21,464 at the end of March, 1992. In other words 97.6 percent of the total number of inhabited villages of the state had been electrified at the end of March 1992 compared with electrification of 97 percent at the end March, 1991. The total number of villages electrified at the end of March 1993 was 21,481 which calculates 97.7 percent of the total villages of Assam.

Progress of rural electrification in Assam in recent past can be seen from the table given below :-

TABLE 4.17

TRENDS IN RURAL ELECTRIFICATION, ASSAM

YEAR (end of 31st March)	No. of Villages electrified	% of total number of villages
1985	11,806	53.7
1986	13,648	62.0
1987	N.A.	N.A.
1988	17,897	81.4
1989	19,545	88.9
1990	20,984	95.4
1991	21,344	97.0
1992	21,464	97.6
1993	21,481	97.7

Source : Statistical Hand Books, 1990, 1992, 1993, Assam

Although 97 percent of the total inhabited villages of the state brought under the programme of rural electrification at the end of March, 1991, yet the quality of power supply has not been improved. Record of rural electrification is excellent, but with little or no power to deliver. Villages which have already been electrified remain in dark months together. REC could not render any benefit to the real consumers of the villages due to erratic supply of power. Theft of power by unauthoried person caused troubles to the legal consumers. ASEB failed to collect revenue regularly from the consumers due to inefficient management though a huge amount of capital invested on rural electrification programme. As a result the Board is incurring heavy loss every year which ultimately compensated by the State Government through subsidy. But Government also failed to pay subsidy to Board in time due to its own financial crisis. Subsidy payable by Government for loss incurred by ASEB in rural electrification is shown below :-

upto 1974-75	Rs. 1.30 cr
upto 1979-80	Rs. 9.91 cr.
upto 1984-85	Rs. 73.39 cr.
upto 1988-89	Rs.253.17 cr.
upto 1989-90	Rs.323.56 cr.
upto 1990-91	Rs.405.00 cr.

The ASEB sources charged that the state government has not released more than 400 crore of subsidy for rural electrification though almost all the inhabited villages have been electrified under rural electrification scheme. According to the Annual Financial Report (1992-93) of the ASEB, the board had incurred a loss of Rs.22,328 lakhs.

4.3.4 POWER CONSUMPTION :

The pattern of power consumption in a region provides positive indications about the structure of the economy. It is therefore essential to aim for balanced consumption pattern so that self-sustaining development can be stimulated. But large industrial development is essential for raising the internal resources for the power sector. Therefore, the achivements for the organic growth of the economy will remain a slow process needing consistent efforts for a long period (P.C.Sarma, 1986).

The average per capita consumption of electricity in Assam recorded at 78 kwh was much below the all India average of 236 kwh during 1989-90. This indicates the economic backwardness of the state in comparision to other states of the country. Since electricity is an essential input for all economic activities, it is customary to ensure that scarcity of electricity does not stand in the way of development by mathcing the power plan with the economic plan. The problem of economic backwardness can be tackled, if we take the help of the per capita consumption of electricity as the index of historic progress in backward areas. The structural composition of power consumption and the access of the people to electricity are the other issues to be tackled along with it in a time bound programme.

The woefully low electricity consumption in Assam provides a ready reason for industrial backwardness of the state. A comparative picture in regard to average per capita consumption of electricity of Assam with other states of the country can be seen from Table 14.18. In the table Assam ranks 21st among 25 states/union territories in our country which indicates a dismal performance of power sector of the state.

TABLE 4.18

PER CAPITA ELECTRICITY CONSUMPTION IN 1991-92

(in Kwh)

State/ U.T.	Electricity Consumption
Delhi	757.7
Punjab	615.4
Gujrat	504.0
Goa	495.2
Haryana	455.2
Maharastra	434.2
Tamil Nadu	335.5
Karnataka	296.2
Orissa	295.3
Andhra Pradesh	277.3
Madhya Pradesh	226.7
Rajasthan	230.9
Himachal Pradesh	209.6
Kerala	195.7
Jammu and Kashmir	188.7
Uttar Pradesh	173.5
West Bengal	152.1
Meghalaya	125.0
Bihar	108.0
Manipur	107.1
Assam	89.7
Nagaland	78.4
Mizoram	69.4
Arunachal Pradesh	57.5
Tripura	52.6

Source : U.N.I. Data Published in The Sentinel - September 1, 1993.

Inspite of deplorable condition prevails in the power sector, the consumption of electricity in the state increased by 4.9 percent in 1984-85 over the previous year i.e. from 977.5 million Kwh in 1983-84 to 1025.4 million Kwh in 1984-85. The industrial sector (excluding tea gardens continued to be the biggest consumer of power in the state. During 1984-85 this sector alone accounted for nearly 35% of the state's total power consumption. The increasing trend in electricity consumption also noticed during 1985-86 and 1986-87. During 1986-87, the total consumption figure recorded at 1130.65 million units against 1091.28 million units during 1985-86.

A continous increasing trend in the consumption of electricity could be observed in the state over the recent past. During 1988-89 the total consumption of electricity by various types increased by 12.1 percent over the previous year i.e. from 1250.51 million Kwh in 1987-88 to 1402.00 million Kwh in 1988-89. The industrial sector alone accounted for nearly 40% of the state's total power consumption during 1988-89. Tea gardens consumed nearly 14 percent of the total consumption during the same period. The consumption of electricity further increased to 1528.52 million Kwh during 1989-90 and 1569.75 million Kwh during 1990-91. The industrial sector alone consumed 40.5 percent and 41 percent of the total consumption by the state during 1989-90 and 1990-91 respectively. Table 4.19 below gives an idea about the pattern of power consumption in the state over the period from 1983-84 to 1990-91.

TABLE 4.19

CONSUMPTION OF POWER BY TYPE IN ASSAM

(in million Kwh)

TYPE OF CONSUMPTION	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
1. Domestic	87.40	99.00	106.31	121.66	137.00	150.00	170.00	192.00	243.80	232.00	270.00
2. Commercial	80.98	81.09	86.30	105.22	90.94	100.00	110.90	115.00	118.42	110.00	137.00
3. Industrial (H.Vlt)	350.99	361.10	308.33	359.03	351.00	400.00	619.85	650.68	457.47	448.00	456.00
4. Industrial (l.vlt)			75.95	70.81	144.86	165.00			66.56	70.00	59.00
5. Tea Garden	154.68	162.87	173.33	182.15	164.00	195.00	211.80	228.00	188.53	193.20	277.00
6. Public lighting	12.12	4.67	4.97	4.24	8.00	9.00	12.16	14.00	5.92	17.00	18.00
7. Extra State	175.06	164.51	175.07	114.23	159.72	165.00	179.43	142.07	76.52	107.71	35.00
8. Free Supply	8.00	8.00	8.00	10.00	10.00	10.00	10.00	10.00	125.00	135.29	226.00
9. Irrigation and Agriculture	8.56	8.68	9.24	10.98	12.87	13.00	25.57	26.00	35.32	30.00	45.00
10.Bulk supply	-	-	113.86	115.63	120.62	139.00	163.50	165.00	158.94	150.00	156.00
11.Others (rural industry and public water works)	99.70	135.53	29.91	36.70	51.50	56.00	25.08	27.00	107.80	97.00	42.00
Total	977.49	1025.45	1091.27	1130.65	1250.51	1402.00	1528.29	1569.75	1584.28	1590.00	1711.00

Source : - (i) Economic survey of Assam, 1985-86 and 1989-90.

(ii) Statistical Hand Book, Assam - 1990, 1993.

(iii) ASEB, Guwahati, 1994.

The table shows that the total consumption of electricity by various types increased by 60.6 percent over the period from 1983-84 to 1990-91, i.e. from 377.49 million Kwh in 1983-84 to 1569.75 million Kwh in 1990-91. The industrial sector (excluding tea gardens) continued to be the biggest consumer of power in the state. During the period from 1983-84 to 1990-91 this sector alone accounted for 85.4 percent increase i.e. from 350.99 million Kwh in 1983-84 to 619.85 million Kwh in 1990-91. A similar increase is also noticed in domestic sector. Percentage increase in this sector is more than the industrial sector. Total consumption of power in domestic sector was only 87.40 million Kwh in 1983-84 which increased to 192 million Kwh in 1990-91. This calculates 120.6 percent increase over the period. This may due to changing life style of people in the society. As electricity is regarded to be an essential element for modern civilisation so the demand for consumption may be expected to increase further in near future.

The total consumption of electricity in commercial sector marked a little increase as compared to domestic and industrial sector. In commercial sector the figure increased from 80.98 million Kwh in 1983-84 to 115 million Kwh in 1990-91 i.e. nearly 40.2 percent increase during the period. This indicates a poor commercial activities performed in the state. The consumption of power in other sectors observed an increasing trend during the period from 1983-84 to 1990-91 although figures in free supply had remained static at 10 million Kwh since 1986-87. Free supply of electricity to departmental staff continued since 1983-84 increased from 8 million Kwh to 10 million Kwh in 1986-87. The provision of free supply of power to the departmental staff bears a little reason in this day of power crises in the state.

A clear picture of economic progress and structural development of an economy can be observed if the ratio of different categories of consumers to the total units of per capita electricity consumption is studied. Economic progress cannot be conceived without sufficient supply of power. In India, consumption of power has been started to increase since the begining of Seventee's of the century. At the time of independence it was confined within a few selected areas. As compared to other parts of the country, the North-Eastern region particularly Assam remain more backward in her structural development due to limited internal resources. Power supply, therefore could not be increased sufficiently as a result economic development of the region hampered.

A comparative picture of per capita power consumption by various sectors in different parts of the country and Assam for 1983-84 and 1991-92 can be observed in Table 4.20 below.

TABLE 4.20

PER CAPITA ELECTRICITY USE IN INDIA - 1991-92 (1983-84)

REGION	DOMESTIC		COMMERCIAL		INDUSTRY		AGRICULTURE		OTHERS		TOTAL	
	1983	1991	1983	1991	1983	1991	1983	1991	1983	1991	1983	1991
Northern	20	49	10	17	73	94	40	83	8	24	151	267
Western	25	55	12	18	142	182	29	99	16	37	224	391
Southern	21	46	8	13	94	127	26	83	5	23	154	292
Eastern	8	20	5	8	81	78	5	14	11	39	110	159
North-Eastern	6	16	4	7	23	46	1	2	6	22	40	93
Assam	4.1	10.76	3.8	6.56	16.4	48.86	0.4	1.59	13.3	30.37	38	98.14
India	18	42	8	14	93	116	25	68	10	30	154	270

Source : An Artical by P.C.Sarma, Published in Danik Assam, January, 2, 1995.

In North-Eastern region per capita consumption of Tripura is 49 units, Arunachal Pradesh 57 units, Mizoram 69 units, Nagaland 77 units and next 98 units recorded in Assam. The region occupies 93rd position at an average in the country which consumes only 34 percent of the country's 27 units of consumption.

The table shows a very poor power consumption in the agricultural sector as compared to other sectors in the country. In North-Eastern region and particularly in Assam this sector consumes only 2 units and 1.5 units respectively during 1991-92. This clearly indicates that agricultural sector still remains under premitive system which needs to be modernised with the application of scientific method of production. Similar is the case with commercial sector although a little improvement is noticed here. Power consumption in small industries sector is not satisfactory which is one of the causes of low industrialisation in this region.

In 1990 the total population of North-Eastern region constitutes 3.75 percent of the total population of India. The total consumption of electricity in this region was recorded at 2315 million units which accounted only 1.1 percent of the all India average. Consumption of coal in this region was estimated at 0.5 million tonnes and petroleum oil 1.37 million tonnes (excluding producing centres) which constitute 0.6 percent and 2.4 percent respectively of the all India average. But the region is very rich in energy resources. It has been estimated that the region possessed 31,857 MW power potential, 144.95 million tonne petroleum oil, 135 billion cubic meter of natural gas and 700 million tonne of non-cooking coal. It is a matter of concern that the entire region remains backward amidst plenty of resources due to poor attention to this region by the centre.

4.3.5 DEMAND FOR POWER:

When India became independent in 1947, the power generation capacity in the country was merely 1400 MW. It increased to 1700 MW when the Plan era commenced in 1951. At the end of the seventh five year plan the total installed capacity has come to 55,000 MW, an increase of 32 times. The total demand for electricity at the end of first two decades of planning in India stood at nearly 9 times its level in 1951. It is estimated that total energy requirement at the turn of the century will be around 1,10,000 MW.

The demand for power in the country continues to grow at a rapid rate outstipping the availability for the same. This has resulted in continued shortage of power in different parts of the country forcing the supply authorities to impose the restriction both on demand and energy requirement and also to adopt other regulatory measures. The magnitude of these restriction has varied from time to time as well as from state to state depending upon the actual availability of power. The rate of growth of electricity consumption which average 12.19 percent per annum compounded during the decade 1960-61 to 1970-71 declined sharply to 6.54 percent during the decade 1970-71 to 1980-81 mainly due to the limited availability of power. The power supply position has since improved and the growth rate of energy demand has averaged to 8.62 percent in the five year period ending 1985-86 even though the shortages of power still persist. (CEA'87).

Upto 1951 the use of electricity in India has been confined to certain specific industries and selected urban areas. Of the total generating plant capacity in the country, about fourth belonged to 24 industries producing electricity for their own use. Only about 4000 places - mainly large cities and selected towns - were electrified in the whole country.

Looking at from another point of view upto 1951, 70 percent of the energy used in India was obtained from non-commercial sources such as wood, cowdung or vegetable wastes. Among the commercial sources of energy electricity accounted for only 10 percent of the total. By 1970-71, commercial fuel accounted for about half of the total amount of energy used in the country and of this, about 25% of the total in coal replacement units was in the form of electricity (report of the fuel policy committee of India, 1974).

Although at the national level, growth of electricity consumption may be closely connected with the growth of the economy and the national product, this is not true with the different region. This may be so because regional economies are inter-dependent and can specialise in economic activities best suited to their local resources more so than the country as a whole. The potential of available technology and natural resources has not as yet been fully exploited anywhere in the country. Therefore, development of a region does not yet have to follow a standard pattern of growth, but can branch off in any of several directions.

Growing prosperity or urbanisation of a region does not have a direct effect on electricity consumption but these factors trigger off the growth of the electricity industry which in turn has some effect on per capita use of electricity in a region.

Urban domestic energy consumption is a function of the people's habits and the devices used. As development increases people move from traditional, less efficient fuels to more efficient ones. Domestic energy uses depend on the demand for new services, choice of devices and fuels and the quantity of services demanded. In least developed areas, cooking accounts more than 90 percent of energy used in home. This percentage decreases as development increases with the introduction of lighting and electricity in leisure acitivities such as refrigiration and air conditioning. As income increases, there is a change in fuel type from traditional to modern fuels in home.

Because electricity cannot be stored on a large scale either by the producers or by the consumers, several dimensions of the demand for it apart from its bulk are relevant in making decisions regarding investment in the industry. For generating electricity as and when it is necessary, the system has to have a large enough capacity to meet all the claims that can be made on it at a given moment. Therefore, if the size of demand varies widely from time to time, the supplier will have to keep on hand enough capacity to meet the maximum combined demand that the system is ever likely to face. The shorter the time for which this maximum level of demand exist, the longer the period of idle capacity for the plant. The level of maximum demand and the actual sales during a given time period togather determine the load factor of the system for that period. This is defined as -

$$\text{Load Factor} = \frac{\text{Total Actual Sales in a year X 100}}{\text{Level of maximum demand X 87609}}$$

The higher the load factor, the smaller the period of idle capacity in the system.

The contribution of each particular class of consumer to the total maximum demand depends on his actual timing vis-a-vis that of others. If different consumers can adjust the timings of their demand so as not to coincide than the combine maximum demand of the system would be greatly reduced and alongwith it, the required capacity of the system. The capacity of the consumers to so adjust their demand is measured by the diversion factor :-

$$\text{Diversion Factor} = \frac{\text{Sum of maximum demand of different sectors}}{\text{Recorded maximum demand met by the system}}$$

The higher the diversion factor the lower the waste in the system. A higher diversion factor usually means a high load factor.

Industrial demand for consumer is far heavier than any other kind. It is also stoadier for a longer during each day and also over the year. Domestic or commercial demand comes from numerous small consumers each of whom buys relatively little and for a short time each day, but because their demands are simultaneous, their connected maximum load on the system is high. Domestic and commercial consumers, therefore, require an intricable network of transmission and distribution lines and the capacity required to meet their load can be run only for a short time each day.

Similarly, demands some kinds of consumers tend to be more erratic, more sudden and hence more unpredictable than others. For example, an unusual hot or cold spell of weather may suddenly push up domestic and commercial demand. A sudden storm may lead to a simultaneous swithching on of lights in the middle of afternoon (N. Banerjee, 1976).

Power generation capacity in Assam was merely 11.45 million units in 1958-59 the year of beginning of the ASEB's own generation. The total units of power generated over the subsequent period continued to increase by 50.5 million Kwh at an average per year. During 1980-81, the total units generated stood at 464.7 million units which further increased to 1147.2 million units in 1989-90. The increasing trend of power generation in the state continued further and during 1990-91 the total units of power generation recorded at 1206.3 million Kwh. The position is expected to improve in near future when on-going projects are commissioned in the state.

Industrial demand being the major part of total electricity demand in all parts of India, it is natural that the two are closely connected. Industrial sector in Assam, alone accounted for 85 percent of the total electricity consumption over the period from 1983-84 to 1990-91 as shown in table 15 in this chapter. There will be a positive correlation between the rate of growth of total electricity sales and the rate of growth of Industrial production. Ther per capita sale of electricity for Assam during 1971 was 21.6. The Industrial sector alone in the state accounted for 12.05 of the total sales which stood at 55.8 per cent.

Tea, Petroleum products, Fertilizer, Paper and Cement are the important industrial items which had shown positive growth in output during 1989 over the output level of the previous year. The trend in output of few important industries of the state over the recent few years can be seen from the table 4.21.

TABLE 4.21

PRODUCTION OF SOME IMPORTANT INDUSTRIES IN ASSAM

ITEM	UNIT	1985	1986	1987	1988	1989
1. Tea	Million K.G.	352	336	364	372	379
2. Plywood	Million sq.km.	42	43	32	33	29
3. Match	'000 gross boxes	4976	4696	4794	4668	4453
4. Sugar	'000 M.T.	3	2	5	7	6
5. Fertilizer	"	187	200	222	324	428
6. Refinery Prod	"	1910	2081	2289	2491	2531
7. Cement	"	169	167	160	152	166

Source :- Economic Survey of Assam, 1989-90.

Over the last couple of years number of large and medium sector industries have been set up in the state and a few more are in the offing. Some such projects under various stages of implementation in the state are - Industrial Papers (Assam) Ltd. at Dhing, Polyester Filament Yarn Project at Sipajhar, Textile Processing House at Nalbari, Cement Project at N.C.Hills and Galvanised Plain and corrugated sheet project at Changsari. The proposed fourth oil refinery at Numaligarh and the massive Gas-cum-Naptha Cracker Project in the state, when materialised are likely to usher in a new era of industrial development in the state in near future. With these development in industrial sector, the demand for power are expected to increase further to a great extent in the coming years.

Tea industries in Assam became the second big consumer of power as shown in table 4.19 in this chapter. In that table it has been observed that the total consumption of power in the tea gardens was 154.68 million Kwh in 1983-84 which increased to 228.00 million Kwh in 1990-91 and 277 million Kwh in 1993-94, the rate of increase being 47.0 percent and 79.0 percent respectively during the period. It is pertinent to mention here that the state alone produces more than 50 percent of the country's total tea production. Of the total of 13564 tea estates in the country during 1987, 845 tea estates are located in Assam. The number of tea factories totalled 580 during 1987 and number of consumer factories was 682 in 1993-94. Tea industry is also the largest single emplyment give in the state with 4.90 lakhs labour on its role in 1987.

The state saw a most encouraging performance in tea output during 1989. The output of tea reached a new high of 379 million Kilogram during 1989 from the previous record level of 372 million kilogram in 1988. Thus compared to the output level of only 150 million kilogram in 1951, the achievement in output during 1989 was marked with a growth of nearly 152 percent. The area under cultivation in the state which was 2.27 lakh hectres during 1987 accounted for more than half of the total area under tea in the country. Plantation areas are expanding and new methods of processing tea leaves are being introduced in the existed factories.

Modernisation of tea garden areas and aminities to the workers such as water supply, residential facilities with free supply of electricity by the garden authority will further aggrevate the demand for power in the state.

Power Consumption of some large industries in Assam during the month of April 1994 can be seen from the following table.

TABLE 4.22

CIRCLEWISE LIST OF EXTRA LARGE INDUSTRIES WITH CONNECTED LOAD ABOVE 2500 KV (as on 31.3.94) .

Name of Industry	Period 1994	Connected load KVA	KW	Consumption (Kwh)
1. Hindustan Paper Corporation (Jagiroad)	April	11765	10000	2688300
2. Hindustan Paper Corporation (Cachar)	April	10680	--	1470800
3. Assam Ispat Ltd. (Guwahati)	April	5882	5000	307440
4. Brahmaputra Steel Pvt.Ltd.(Guwahati)	April	3549	3000	909792
5. Brahmaput Iron & Steel Pvt. Ltd. (Guwahati)	April	3529	3000	218448
6. Assam Textile Corpn. Ltd. (Rangiya)	May	2823	2900	68750
7. Assam Polyster Co-operative Society (Rangiya)	April	3705	3151	469926

Name of Industry	Period 1994	Connected load KVA	KW	Consumption (Kwh)
8. Vinoy Steel Ltd. (Cachar)	April	-	3000	14964000
9. Prag Bosomi Synthetics Ltd. (Sipajhar)	April	2353	2000	420912
10.Hindustan Fertiliser Corpn. (Namrup)	April	21176	18000	1265000
11.Assam Petro-chemical Ltd. (Namrup)	April	7058	6000	835000
12.Cement Corporation of India (Bokajan)	April	6009	5108	1923066
13.Woodcraft Ltd. (Plywood) (Morioni)	April	2788	2370	35520

Industry	Period as on	No.of Consumers	Energy Consumption
1. Tea Industry	31.3.94	682	277
2. Oil & Coal	31.3.94	62	59

Source :- Assam State Electricity Board, Guwahati, 1994

The consumption of electricity in the domestic sector of Assam registered a higher increase during the period from 1983-84 to 1993-94. The total consumption of electricity in 1983-84 was 87.40 million Kwh which increased to 270 million Kwh in 1993-94. Apparently, domestic sector consumed less than the consumption in Industrial sector. But the rate of increase in domestic sector surpasses all other sectors as this sector recorded an increase of 208.9 percent during the decade. Increase of household income, size of the family and use of more electric gadgets will cause more demand for power in the domestic sector of Assam over the years to come.

4.4 FUNCTIONING OF ASSAM STATE ELECTRICITY BOARD:

It is needless to emphasis that the development of power and hareneessing the sources of energy are essential ingredients of the development stategy and the entire process of economic development is dependent on electrical power. Recongnising this fact in the early years of economic Planning the Government of Assam created the Apex Orgnisation Assam State Electricity Board (ASEB) in 1958 for fulfilling the onerous task of power generation and distribution in the state which emerged as the sole agency for development of this crucial input. Created on the basis of the Central Electricity (supply) Act, 1948 ASEB emerged as multifunctional agency with a wide variety of specialised functions such as power generation, construction of power station, distribution of power upto the point of consumption etc. Thus the board has been lumped together with various functions requiring skill and efficiency, without, however ensuring mechanism for effectiveness in its functioning.

As a result the ASEB's working is dismal to say the least. Instead of improving its working the ASEB is beset with a host of incurable problems such as very low and declining plant load factor extremely high operating cost, inefficient management, unaccountability low level of employee productivity, time and cost over-runs of various major projects, high transmission and distribution losses caused mainly by factors like power theft and poorly managed subsidised rural electrification programmes. The reason for ASEB failure is plain inefficiency as evidenced in its over staffing and management and there is some grain of truth in what the concerning Minsiter termed as "sheer imcopetence and plain unaccountability".

Some of the data available information and data reveal a disquieting picture of ASEB's functioning while the Board's installed capacity is 514 MW it could at present generate only 200 MW even as peak hour demand stands at 420 MW. The Board manages the situation by importing power from neighbouring Meghalaya Electricity Board and North Eastern Electric Power Corporation (NEEPCO). Whenever there is shortfall in electricity in such importing organisation due to some mechanical or natural factors like receding water in reservers, Assam experiences power disruption and load shedding. There has been a declining trend in the plant load factor which came down to 30 percent at present from 41.1 percent a decade back. It is interesting to note that the fuel cost in Assam is one of the lowest but all other costs compares favourably with all India averages. The following comparative data relating to function of ASEB and all India averages make a dismal reading. The most distressing is the fact that the Board is plagued by over staffing at all levels and employment per MW of installed capacity is one of the highest in the ASEB. While the Andhra Pradesh State Electricity Board manages it by 19.1 persons, the all India average stands at 27 persons. In ASEB it has as high as 70.7 for the same work.

Following table will give a comparative picture between the performance of the ASEB and the Andra Pradesh Electricity Board :-

As on 31-3-1992	Assam	Andhra Pradesh
The installed capacity	514.4 MW	4165 MW
Central Share	NIL	807 MW
Peak Load met	200 MW	3703 MW
Per Capita Consumption	60 MW	273 MW
No. of Consumers	0.5 million	7.4 million
No. of Employees	23,460	71,300
Annual revenue	Rs.133 cr	Rs.1600 cr.

Thus the reason for ASEB's failure can be plain inefficiency as evident in over staffing and high operational and establishment cost coupled with an ever declining PLF and transmission loss.

Some of the important facts about Assam State Electricity Board (ASEB) since its inception can be seen from the following table :-

Installed Capacity in MW		Ongoing Projects
31-3-59	- 14.84	Karbi-Langpi Hydro Electric Project - 100 MW.
31-3-75	- 111.5	Dhansiri Hydro Electric Project - 19.95 MW.
31-3-91	- 514.4	Lakwa Extension (Gas based) - 60 MW.

		Projects included in 8th plant
Coal Based	- 240	
Oil Based	- 60	Amuguri Gas Based - 360 MW
Gas Based	- 212.4	Namrup Extension - 60 MW
Hydro	- 2	Lower Kapili Hydel Projects - 150 MW
Total	= 514.4 MW	

ASEB's own Generation

1958-59	-	11.45 million units
1986-87	-	939.34 million units
1987-88	-	1162.20 million units
1988-89	-	1085.90 million units
1989-90	-	1147.20 million units
1990-91	-	1206.37 million units

ASEB's No. of Employee and No. of Consumers:

Date	No. of Consumers	No. of Employee
31-3-59	12239	1046
31-3-75	95860	14086
31-3-80	154010	18000
31-3-85	283113	19994
31-3-91	503907	23460

ASEB's revenue from sale of energy			Subsidy payable by the Govt. for loss incured by ASEB in Rural Electrification		
1958-59	--	31.5 lakhs			
1974-75	--	8.57 Crore	Upto 1974-75	--	Rs. 1.30 Crore
1979-80	--	25.05 Crore	" 1979-80	--	Rs. 9.91 Crore
1984-85	--	59.05 Crore	" 1984-85	--	Rs. 73.39 Crore
1988-89	--	111.64 Crore	" 1988-89	--	Rs.253.17 Crore
1989-90	--	123.70 Crore	" 1989-90	--	Rs.323.56 Crore
1990-91		Rs.132.92 Crore	" 1990-91	--	Rs.405.00 Crore (roughly)

ASEB's Revenue Account 1991-92 and 1992-93 (Rs. in lakhs)

Particulars	1991-92	1992-93
Income		
1. Revenue from sale of power	18,059.15	19,440.59
2. Revenue subsidies and grant	6,584.70	6,407.08
3. Other Income	290.15	589.74
4. Total Income	24,934.00	26,437.41
Expenditure		
5. Purchase of power	6,394.55	6,119.59
6. Generation of power	6,713.96	8,095.93
7. Repairs and Maintenance	1,534.66	1,522.59
8. Employee cost	9,697.21	10,585.74
9. Administration and General Expenses	791.31	1,072.04
10. Depreciation and related debit	2,233.23	3,301.93
11. Interest & Finance Charges	18,212.50	14,156.09
sub-total (5 to 11)	45,577.42	44,853.91
13. Less Interest & Finance Charges Capitalised	--	7,039.20
14. Expenses Capitalised	4,964.84	4,495.77
15. Sub-total (13 to 14)	4,964.84	11,534.97

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16.	Sub-total (12 - 15)	40,612.58	33,318.94
17.	Other debits	57.80	43.98
18.	Extra-ordinary expenses	2.35	5.05
19.	Total (16 to 18)	40,672.73	33,367.97
20.	Profit before tax (4-19)	(-15,738.73)	(-6,930.56)
21.	Provision for Income tax	Nil	Nil
22.	Profit or loss after tax (20-21)	(-15,738.73)	(-6,930.56)
23.	Net Prior period charges	6,810.79	137.29
24.	Surplus / Deficit	(22,549.52)	(7,067.85)

ASEB: Statement of Technical Particulars:

Sl.NO.	Particulars	1991-92	1992-93
1.	Installed Generation Capacity (in M.W.) at the yearend:		
	Hydel	2.00 M.W	2.00 M.W
	Thermal	352.00 M.W	352.00 M.W
	Gas	160.40 M.W	160.435 M.W
	Total	514.40 M.W	514.435 M.W
2.	Normal maximum demand on the system (in M.W)		
	a) Restricted	254.55 M.W	271.40 M.W
	b) Unrestricted	357.55 M.W	456.40 M.W
3.	Plant capacity available at the time maximum system	68%	48.23%
4.	Generation (in million Kwh)		
	Hydel	0.030	NIL
	Thermal	785.450	752.816
	Gas	294.091	315.475
	Total	1079.571	1068.291

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5.	Auxiliary consumption (in million Kwh)	103.5016	98.109
6.	Power Purchased (in million Kwh)	1035.833	1042.470
7.	Power avaiable for for sale (4+6-5)	2011.9024	2012.652
8.	Power Sold (in million Kwh)	1584.28	1590.000
9.	Transmission & Distribution Losses (in million Kwh) (7-8)	427.62	422.652
	As a % of total power available for sale	21.25%	20.99%
10.	Fuel : a) <u>Consumption</u>		
	Coal (MT)	250009.000	305178.000
	RFO/FO(KL)	37043.319	76668.000
	L.D. oil/ HSD (KL)	47222.330	---
	Gas (MMSCM)	219.632	184.4642
	HFO (KL)	64316.850	---
	b) Average calorific value per Kg. of fuel consumption (in K.Cal/Kg.)		
	Coal	N.A	4300
	RFO/FO	N.A	10445
	L.D oil/HSD	N.A	10400

Source :- Annual Statement of Accounts 1992-93, ASEB, Guwahati.

It may be mentioned here that the ASEB had a total installed capacity of 514.5 MW in its four units of the BTPS (40 X 60 = 240 MW), two units of the Chandrapur Thermal

Power Station (2 X 30 = 60 MW, four units of Lakwa Thermal Power Station (4 X 15 = 60 MW) four units of the Namrup Thermal Power Station (133 MW) and Mobile Gas Turbine and Bardikharu samll project. But the ASEB has in effect a generating capacity of only 120 MW.

One of the major reasons leading to dismal power situation in Assam is the low level of power generation despite relatively high installed capacity (514.4 MW) and enormous potential both hydel and thermal. ASEB in its initial enthusiasm started a number of multi-crore hydel and thermal power projects most of which have remained incomplete for years causing enormous time and cost over-runs.

Despite massive investment made results are yet to come and no one knows how the ASEB will manage when the power requirement in the State will go upto 840 MW by 1995-96. Thus for example, Bangaigaon Thermal Power Station started with an original cost of 47.17 crores and scheduled to be completed by 1983 showed cost and time overrun, the revised cost exceeding 99 crores. It is distressing to note that only two out of the four units have been functioning at any given time. Power production of BTPS for six months period from December 1991 to May 1992 can be seen from the table given below :-

TABLE 4.23

POWER PRODUCTION OF BPTS (DEC'91 TO MAY'92)

Month	Unit I	Unit II		Unit III		Unit IV		Total Production(mu)	Cost of generation P/Kwh paise
		Produc-tion(mu)	Average hourly load(mw)	Production (mu)	Average hourly load(mw)	Production (mu)	Average hourly load(mw)		
Dec'91	NIL	16,593	27.68	17.032	40.67	2.254	31.74	35.879	177.89
Jan'92	NIL	21,732	32.18	24.627	34.99	NIL	NIL	46.359	178.29
Feb'92	NIL	11.117	31.38	15.709	33.55	0.262	26.20	27.088	157.19
Mar'92	NIL	5.770	32.65	23.396	32.94	14.371	30.86	43.537	196.02
Apr'92	NIL	16.958	31.50	17.202	30.52	0.858	19.85	35.018	156.21
May'92	NIL	17.184	26.87	NIL	NIL	20.030	NIL	37.214	184.12

Source :- An Article by Sri Kumar Published in Prantik July 16-31, 1992.

The story of ASEB is of total mismanagement and technical breakdowns. Of the four units at Bongaigaon Power Station, three have been shut down. Two of the units have become totally non-functional due to non-availability of coal while an accidental fire in one of the machines of another unit has paralysed its operation. The damaged machine worth of Rs.70 lakh will take time to become operational due to acute financial crunch of the board. Generation of power at Bangaigaon Coal Thermal project has slumped down from its installed capacity of 240 MW to a bare 45 MW.

Against its demand for 60,000 mt of coal each month to run the four units, Bangaigaon Thermal Power Project gets around 28,000 mt coal from the Central Pool coal Linkage Committee. Coal available at Margherita cannot be utilised due to high Sulpher contents. ASEB ahs to depend upon coal from Raniganj which is released by Coal India Limited through Linkage Committee. ASEB has called for a realistic appraisal of the needs of Bangaigaon Thermal Project.

The Bangaigaon Thermal Power Project is incurring heavy loss due to its high cost of generation per unit. In BTPS, 111 ml. oil requires to generate one unit of electricity against all India average of only 10 ml. per unit showing an eleven times more than the national level. Inefficient administration and lack of proper management are the main cause of such deplorable condition in this power project. Time has come to revieve the four units and operate up to their full capacity so that 240 MW installed capacity can be materialised.

Same is the case with other power project like Karbi Longpi (100 MW). Lakwa Thermal Power Project (60 MW), Dhansiri Hydel Project (19.95 MW) which were scheduled to be completed by the early eightee's, have remained unfulfiled dreams. Inefficiency, corruption, bureaucratic bungling have stalled the completion of these projects. There is some element of truth in the saying that Karbi-Longpi Project would take another 100 years for completion. In the CAG report it has been stated that due to non-completion of civil works and non-availability of infastructural facilities at work site seven power transformers costing Rs.1.48 crores purchased during 1982-83 for Karbi-Longpi Hydro Project have been lying idle for more than seven years involving interest burden of Rs.1.14 crore on the locked up funds. The CAG report castigated that ASEB could not achieve the increase in the transformation capacity envisaged in the 5th and 6th plan periods at a time when the Board has failed to commission 20 power transformers valued at 320.94 lakhs. These transformers which remained idle for period ranging from three to nine years (upto May 1990) acquired an additional interest liability of whopping amount of Rs.237.79 lakhs.

Similar is the fate of Lakwa Thermal Power Project. Soon after the commissioning of LTP most of the units developed mechanical faults, requiring repairs, replacement and foreign expertise for fault repair. It has become a common practice with the ASEB to entrust responsibility of multi-crore projects to any one without adequate training and expertise resulting in disastrious consequences in the shape of cost and time overruns. In this dismal situation how can one expect improvement in its power situation in the state.

Even as the state is engulfed by darkness and grim prospect of further detorioration in the power sector the ASEB by publishing costly advertisement in Newspaper attempted to give laconic explanation of its failure to fulfill the task assigned to it. At present almost all the power projects which are somehow functioning need repair and overhauling. Mechanical faults of most of the power units have crippled the power supply in the state forcing the Board to restore to frequent load-shedding sometimes even for hours together. These projects involving foreign exchange and expertise are now in doldrums in view of the devaluation and foreign exchange crisis. It has been admitted by the Board that all the mobile turbine each with capacity of 2.7 MW are now out of order. All these have led to the deterioration of power situation. Nobody knows when it will improve. Thus uncertainity prevails even in the present arrangement of power supply.

It may be noted that the ASEB initiated steps for construction of a number of power projects involving massive amount of capital investment. It has been admitted by the Board that none of these projects as Karbi Langpi (100 MW), Lakwa Thermal Extension (60 MW), Dhansiri Hydel Project (19.95 MW) will be completed before stipulated time. As such there is no hope of improving the power situation even upto the middle of present decade.

In a recent advertisement issued by the ASEB it has been frankly stated whatever may be forceful or frequent criticisms from different quaters, at present, it is beyond the capacity of the Board to do something to improve the power position. It is not an admittance of inefficiency and mismanagement requiring some introspective view of the Board's functioning. (Bhuban Baruah).

In view of poor performance of the ASEB, the state government has considered the operation of some power stations by Private enterpreneurs to whom these may be leased out. This was also provided under the relevant section of the Central Electricity Act, 1948. The Board could also allow private parties to build power stations and buy power from them at pre-determined rates. The Government would do well to take a fresh look at the power policy and the ASEB union should help initiating corrective measures for saving the state from impending danger.

Hopefully the ASEB union has suggested that as a short term strategy there should be improvement of PLF which at present declined to 31 percent and reduction of transmission and distribution losses which at present are 21.6 percent. The Union has stated that with care and proper management the position could be improved and 8 percent gain could be ensured (PLF 5 percent and T&D 3 percent). It is indeed heartening to note that the union admits that for this "dedication to work is enough". As a long term strategy to bide over power crisis the union stressed on the need to commission the Amuguri Thermal Power Project and completion of on-going Karbi Langpi and Dhansiri Projects. The ASEB workers Union however has vehemently opposed the reported move to privatise the apex organisation entrusted with the task of power generation in the state.

Finally the Government of Assam has decided to set up the proposed power projects in the state with the help of the private sector. Preliminary works in this regard have already been started. Besides a number of industrial giants of the Country including Tata, a number of foreign establishments have also come forward to help in setting up of these new power plants in the state. The decision to let the private sector take charge of the Amuguri gas based project, the Namrup Thermal Power plant's extension unit, the Baskandi gas based project in Karimganj has already been taken.

The proposed Rs.1200 crore Amguri gas-based Power Project which was conceived in 1986 but could not be taken up for dearth of funds, has now been sought to be handed over to Northern Engineering Inc. of Houston Texas (USA) on a build-own-operate (BOO) basis. According to the provision MOU, the project would be made-up of six combustion turbine generating sets with a total capacity of 360 MW, six heat recovery system generators, 3 cooling towers, three steam turbine generators together with the plant and instrument air system.

The Memorendum of Understanding (MOU) signed between Northern Engineering Inc., AGRA, USA and the ASEB on the 285 gas-fired combined cycle Amuguri Power Project was given a final shape with the announcement of formation of "Assam Power Partners" (APP) comprising Sithe Energies Inc. of USA, India Power Parters Pvt. Ltd. of New Delhi and NEI, AGRA, U.S.A. as the implementing agency of the $365 million project hereon July 16, 1994. An addendum to the MOU was signed between the ASEB and the NEI, AGRA. The addendum authorises APP to implement the "engineering, design, financing, consturction, ownership and operation of the Amuguri project expeditiously. Under the agreement, the APP will "deliver a power purchase agreement" (PPA) for ASEB's consideration. The Government of Assam would provide a gaurantee to APP for payment for the electricity by either the ASEB or the Assam Government in a form which would be acceptable to both the Government of India and the financers of the project.

Thus, the crux of the Amuguri Project MOU lies in the fact that the ASEB will have to enter into a "Power Purchase Agreement" with the Northern Engineering Institute Inc. which will on and operate the project after having invested an estimated Rs.1200 crore.

According to the Government of India's policy on power project in the Private sector the purchaser has to ensure an adequate return on the investment with a minimum of 15% interest. The fact to note, that the cost of generation of power varies depending on several factors.

Thus, while hydel project can produce power cheaper, gas based power projects can generate power at much higher investment and cost. While the cost of producing a unit of power by the Amuguri project has not been estimated yet, it is learnt that it would be not less then Rs.4.50 to 5.00 per unit. Obviously, the ASEB whose finances are literally in a shambles, cannot pay for the power which it is bound to purchase from the NEI in accordance with the MOU provisions. But the fact remains that the NEI will sell power to the ASEB which must agree on a minimum quantam of the power it would purchase from the NEI.

Another scheme has been drawn up to setup two new 30 MW gas turbines in the Namrup Thermal Power Station. This would augment the capacity of the power station to 193.5 MW. The total outlay of this plant has been fixed at Rs.120 crore. A project has been drawn up to install three 7.5 MW gas turbines at Baskandi at a cost of Rs.57 crore for the generation of 15 MW of power. This project would be entrusted with the private sector and this would meet the requriements of nearby tea gardens and industrial consumers in the Barak valley. At present, the peak demand in the Barak valley is about 40-45 MW. In the same way, another project outline has been drawn up to install two 7.5 MW gas turbines at Adamtilla in Karimganj district at a cost of Rs.38 crore. This would result in the generation of 7.5 MW of power. According to the source only the responsibility of power generation in these projects would be with the private sectors. The responsibilities of transmission and distribution would rest completely with the ASEB.

It is worth mentioning that if these projects are completed within the scheduled time, then from 1995-96 onwards, 582.5 to 617.5 MW of power would be generated daily in Assam. This would meet the requirements of the consumers in the state. Assam might even be able to sell power to the neighbouring states. All these would be possible only if politics and red-tapism do not interfere.

The ASEB worker's union has stated that the root cause of the evil is the pernitious power policy of the state Government. It is, however, equally true that in the name of autonomy ASEB takes almost invariably the cover of the Central Legislation of 1948 which envisaged high degree of autonomy of SEBS. In case of any dispute with the state Government, the policy maker, the Central Electricity Authority is require to mediate. This in practice does not ensure accountability of ASEB's. The public sector organisation like ASEB funded by the state government through loan capital need to be made accountable in respect of socio economic objectives, effective utilisation of public funds and achievement of target earmarked by state policy directives. The deceptive coverage of autonomy has helped the ASEB in emerging as public organisation as something apparently non-accountable to anyone. This must be stopped.

ASEB has to be made functionally more effective. It must make determined efforts to curtail its unproductive operating costs particularly in the field of operation and maintenance and establishment expenses. It should initiate adequate steps for the restoration of employee's morale and for motivation of managerial and executive personnel. At present ASEB has inadequate arrangement for training its personnel. This also needs adequate corrective steps. In any case ASEB will have to be saved from its present moribund conditions (B.Baruah'91).

4.5 TARIFF STRUCTURE OF ASEB

The basic principle of pricing any energy product is that its price should reflect its opportunity cost to the country. Although this basic principle of energy pricing is widely accepted, it is often difficult to apply because of rapidly changing condititions of supply and demand which characterise the energy product themselves, as well as the economies in which they are used. Moreover, as energy pricing decisions may also have widespread implication for other economic sectors, the decision need to be taken within the framework of the national development policy and social development objectives.

It is for such reasons that energy prices are *administered in most countries including India; and do not* reflect the opportunity cost to the country. In fact, some energy products have usually been subsidised to such an extent that the supply industry has not been able to generate adequate resources internally to expand rapidly enough to keep pace with rising demand. Shortages of coal and power supplies have thus emerged in India over the past decade.

The basis for selling electricity prices can be very different from coal or petroleum prices, even if only because electric power cannot be usually stored; which means that the cost of meeting power requirements vary with the time of day. Therefore, it is clear that the power tariff during peaking hours must be higher than during off-peak hours- at least for major electricity consumers. This practice, however has not been adopted in general in India so far one of the reasons is that appropriate meters are too expensive or not available which can record the electricity consumption during peaking hours seperately.

In fact, the average electricity tariffs in India are usually below the cost of power generation and supply. As a result, the electric utilities in India have generally found it difficult to expand their generating capacity to keep pace with rising demand and to modernise their facilities. The problem is compounded further when due to lack of adequate financial resources, project implementation slows down, thus leading to substantial cost over-runs and a further rise in supply costs. At the same time, strengthning and expanding the transmission grid is not given adequate consideration, as investment allocated for transmission projects gets reallocated for generation schemes.

Moreover, as the rural electrification programme has continued to expand, an increasing share of electricity is consumed in the agricultural sector - which has the lowest tariff although the cost of power supply to it are probably the highest. Cost of generation and supply of electricity with average tariff of different states in India can be seen from the table given below :-

TABLE 4.24

COST OF GENERATION AND SUPPLY OF ELECTRICITY (Paise/KWh)

States	Generation cost (1984/85)		Average cost of supply in 1986-87	Average tariff in 1986-87
	Thermal	Hydro		
Andhra Pradesh	38.1	5.33	54.15	50.3
Assam	NA	NA	187.29	56.57
Bihar	58.16	16.75	132.79	78.98
Gujrat	40.26	9.13	85.11	77.15
Hariyana	82.34	7.90	73.71	42.70
Himachal Pradesh*	-	8.05	85.49	49.00
Jammu & Kashmir	NA	NA	82.08	29.97
Karnataka*	-	20.04	67.27	54.91
Kerala*	-	6.10	44.86	39.78
Madhya Pradesh	35.25	6.33	71.17	67.03
Maharastra	43.10	4.80	70.53	68.37
Meghalaya	NA	NA	97.31	47.20
Orissa	39.68	7.58	51.58	52.21
Punjab	53.16	7.99	71.02	42.23
Rajasthan	48.52	9.01	79.03	63.75
Tamil Nadu	61.10	7.37	75.47	55.67
Uttar Pradesh	67.37	15.99	87.25	66.83
West Bengal	43.92	37.27	98.96	79.53
India	-	-	-	61.09

* There are no thermal power stations.

Soruce : Centre for monitoring Indian economy, current energy scene in India, May, 1987, Bombay.

Extract of tariff structure of Assam State Electricity Board (ASEB) with effect from 1st July 1986 is presented below. The schedule of tariff is as per the order of the Board.

CATEGORY I

Supply for domestic light and power :

i) Applicability :

The tariff applicable to all supplies for general domestic purposes. This will cover consumption of energies for bonafide residential use, educational and research institutions below 50 Kva of connected load which has not covered by any other category, religious institutions without any commercial use of energy, public hospitals and dispensaries, office not engaged in any commercial activity and execept those which are specially covered under other categories of this tariff.

ii) Character of supply :

a) Upto a maximum connected load of 5 KVA, the supply will be single phase, 2 wire, 230 , 50 C/S A/C.

b) For connected load above 5 kvA and upto 25 kvA, the supply will be 3 phase, 440 v, 50 C/S A/C.

c) Beyond 25 KVA of connected load the supply will be given at HT (available voltage), 50 C/S A/C.

iii) Tariff :

60 paise/kwh for all (a), (b) and (c).

(iv) Monthly minimum charge :

(a) Rs.15 per KW of connected load or part thereof.

CATEGORY 2

Supply for commercial purpose

Applicability :

This tariff is applicable to all establishment and installations of commercial nature and connected with trading activities including commercial offices, Government and public sector, commercial installations other than residential, (to be metered seperately), commercial houses, Optical houses shop, Restaurants, Bars, Refreshment stalls, Show cases of advertisements, Theatres, Cinema, Lodgings and Boarding Houses, Guest Houses, Laundries, Dry Cleaners, Railway Station, Public and Private bus stands not covered under any other category of consumers, copyworks, X-ray installations, Private Nursing House, Photographic Studio, Battery charging units, Workshop, Petro pump, Factory and Printing presses not using electricity as motive power in manufacturing process.

ii) Character of Supply :

a) Upto maximum connected load of 5 KvA the supply will be single phase 2 wire, 230 volts, 50 c/s, A/C.

b) For connected load over 5 KvA upto 25 KvA, the supply will be 400 v, three phases, 50 c/s, A/C.

c) For connected above 25 KvA, supply will be made at HT (available voltage) 50 c/s. A/C.

iii) Tariff :

a) Upto 5 KvA of connected load.

a) 100 paise per KWH.

b) Above 5 Kva of connected load

a) 130 paise per KWH.

iv) Monthly minimum charge :

a) Upto 5 kvA of connected load

a) Rs.40.00 per KW per month or part thereof.

b) Above 5 kvA of connected load.

a) Rs.50.00 per KW per month or part thereof.

v) The above tariff is based on the supply being given through a single point delivery and metering at one voltage. Supply at other points, at other voltages shall be seperately metered and billed for and shall be considered as separate connections.

CATEGORY 3

Public Lighting Supply:

i) Applicability :

Applicable to Public street lighting system in Municipality, Town Committee/Panchayat etc. including signal system and road and park lighting in areas of Municipality, Town committee, Panchayat etc.

ii) Character of Supply :

a) Upto a maximum connected load of 5 kvA supply will be single phase, 2 wire, 230 volts, 50 c/s, A/C.

b) For a connected load above 5 kvA and upto 25 kvA, the supply will be 400 Volt, 3 phase, 50 c/s, A/C.

c) Above 25 kvA of connected load, the supply shall be made at HT or extra high voltage A/C 50 c/s.

iii) Tariff :

A) For metered supply (a) 100 paise per KWH.

(a) The tariff is for energy charge only and does not include any other charges on initial fitting, replacement of incandescent bulb or any other floroscnet tube or Mercury vapour lamp, Sodium vapour lamp etc.

(b) The cost of initial (ordinary or special) fitting, replacemnet etc has to be borne by the consumer.

(c) Labour charges on replacement of fittings/special fittings, bulbs etc. are inclusive of the energy charge at 100 paise/ KWH.

(B) Unmetered supply

Type of Fitting	Energy Charge (Rs.)	Each/Month duty (Rs.)
1. Incandescent lamp upto 40 W/ fitting/ month -	13.00	0.65
2. Incandescent lamp above 40 W upto 60 W/ per fitting/ month -	20.00	1.00

3. Incandescent lamp above 60W/ upto 100 W fitting/ month -	30.00	1.50
4. Incandescent lamp above 100W/ fitting/ month -	50.00	2.50
5. Incandescent lamp for "4 ft" florpscent tube of 40 W/ fitting/ month	13.00	0.65
6. Incandescent lamp for " 4 ft" 2 X 40W fitting/ month	26.00	1.30
7. Mercury Vapour/ Sodium vapour Lamp and other special fitting/ month	100.00	5.00

(a) The above rates do not include any cost of bulb, floroscent tube or fixtures, Mercury vapour lamp or fixtures etc. on initial fitting or on getting damaged or fused.

(b) The rates however include labour charge for such replacement of lamps/ fixtures.

CATEGORY 4

Public Water Works

(i) **Applicability** :

Applicable to all public water supply system.

(ii) Character of supply :

a) Upto connected load of 5 KVA, the supply will be single phase, 2 wire, 230 volt, 50 c/s, A/C.

b) For connected load of above 5 Kva and upto 25 KVA, the supply will be 400 volt, 3 phase, 50 c/s, A/C.

c) For connected load of above 25 KVA, supply shall be made at high voltage or extra high voltage, 50 c/s, A/C.

iii) **Tariff** :

a) 100 paise per KWH.

iv) **Monthly minimum charge** :

a) Rs.50.00 per KWH per month or part thereof.

CATEGORY 5

Irrigation

i) **Applicability** :

The tariff is applicable to irrigation for agricultural purpose.

ii) Character of supply :

a) Upto connected load of 5 kvA, the supply will be single phase, 2 wire, 230 volt, 50 c/s, A/C.

b) For connected load of above 5 kvA and upto 25 kvA, the supply shall be 3 phase, 400 volt, 50 c/s, A/C.

c) For connected load of above 25 kvA, supply shall be made at high voltage or extra high voltage, 50 c/s, A/C.

iii) Tariff :

a) 50 paise per KWH.

iv) Monthly Minimum charge :

a) Rs.15.00 per KW per month or part there of.

CATEGORY 6

Industrial Power Supply

I. Classification :

All industrial consumers are classified as under.

(A) (i) Small Industry (LT), connected load upto 25 KVA (Rural).

(ii) Small Industry (LT), connected load upto 25 KVA (Urban).

(B) Medium Industry (HT), above 25 KVA and upto 100 KVA of connected load.

(C) Large Industry (HT).

(i) Above 100 KVA and upto 2500 KVA of connected load.

(ii) Above 2500 KVA of connected load.

II. (A) (i) Small Industry (LT), connected load upto 25 KVA (rural).

1. Applicability :

Industries upto 25 KVA located in village, not included under Municipality and Town committee areas and recognised as Rural Industries, Deptt., Govt. of Assam.

2. Character of supply :

(i) A/C, 50 c/s, single phase, 230 volt upto 5 KVA.

(ii)A/C, 50 c/s, three phase, 400 volt upto 25 KVA.

3. Tariff

(a) 45 paise per KWH.

4. Monthly Minimum Charge :

a) Rs. 20.00 per KW of connected load or part thereof.

A. (ii) Small Industry (LT), connected load upto 25 kvA (Urban).

1. Applicability :

This tariff is applicable to all industries upto 25 kvA connected load and situated in urban area.

2. Character of supply :

(i) A/C, 50 c/s, single phase, 230 volt upto 5 kvA.

(ii)A/C, 50 c/s, three phase, 400 volt upto 25 kvA.

3. Tariff

(a) 75 paise per KWH.

4. Monthly Minimum Charge :

a) Rs. 35.00 per KW of connected load or part thereof.

II(B)Medium Industry (HT), above 25 kvA and upto 100 kvA of connected load.

1. Character of supply :

(i) A/C, 50 c/s, three phase, 11,000 volts. At the discreation of the Board.

(ii) A/C, 50 c/s, three phase, 33,000 volts.

(iii) A/C, 50 c/s, three phase, 66,000 volts.

(iv) A/C, 50 c/s, three phase, 132,000 volts.

2. Tariff

(a) 90 paise per KWH.

3. Monthly Minimum Charge :

a) Rs. 40.00 per KW per month or part thereof.

II (C) Large Industry (HT) :

i) Above 100 KVA and upto 2500 KVA of connected load.

1. Character of supply :

(i) A/C, 50 c/s, three phase, 11,000 volts. At the discre-ation of the board.

(ii) A/C, 50 c/s, three phase, 33,000 volts.

(iii) A/C, 50 c/s, three phase, 66,000 volts.

(iv) A/C, 50 c/s, three phase, 132,000 volts.

2. Tariff

(a) 100 paise per KWH.

3. Monthly Minimum Charge :

a) Rs. 45.00 per KW per month or part thereof.

II (C) Large Industry (HT) :

i) Above 2500 KVA of connected load.

1. Character of supply :

(i) A/C, 50 c/s, three phase, 33,000 volts. At the discreat-ion of the Board.

(ii) A/C, 50 c/s, three phase, 66,000 volts.

(iii) A/C, 50 c/s, three phase, 132,000 volts.

2. Tariff

(a) 110 paise per KWH.

3. Monthly Minimum Charge :

a) Rs. 50.00 per KW per month or part thereof.

CATEGORY 7

Bulk Power Supply

1. Applicability:

This tariff is applicable to bulk consumers which means supply to a consumer including lincensee in bulk with a connected load of not less than 50 KVA provided that the said consumer is not covered by any other category such as any domestic connection, industries, Tea etc. who makes his own internal distribution arrangement at his own cost and receives power at the point of supply in high or extra high voltage. This category is further classified as under :-

A. Educational Institutions :-

Like Universities, Engineering colleges, Medical colleges etc. with residential facilities.

B. Others :-

II. Character of supply :

Supply will be made at one of the following high or extra high voltages at the discreation of the Board.

(i) A/C, 50 c/s, three phase, 11,000 volts.

(ii) A/C, 50 c/s, three phase, 33,000 volts.

(iii) A/C, 50 c/s, three phase, 66,000 volts.

(iv) A/C, 50 c/s, three phase, 132,000 volts.

III. Tariff

(a) For Educational Institutions :- @ 80 paise per KWH.

(b) For Others :- @ 110 paise per KWH.

IV. Monthly Minimum Charge :

a) For Educational Institutions Rs. 40.00 per KW per month or part thereof.

b) Others @ Rs.55.00 per KW per month or part thereof.

CATEORY 8

Bulk Supply (outside State)

I. Applicable to Bulk Consumers outside state (included in the state supply) and to a licencee.

II. Character of Supply :

A/C, 50 C/S extra high voltage or high voltage such as 132,000 volt, 66,000 volts and 11,000 volts.

III. Tariff :

@ 110 paise per KWH.

IV) Monthly Minimum charge :

@ Rs.65.00 per KW of contract demand per month or part thereof.

CATEGORY 9

Supply for Tea, Coffee and Rubber Gardens

I. Applicability :

Applicable to supply take by Tea, Coffee and Rubber gardens only for their factory consumption, irrigation and other consumptions in the Estate.

II. Character of Supply :

A/C. c/s three phase 11000 volts and above.

III. Tariff :

@ 115 paise per KWH.

IV. Monthly Minimum Charge:

@ Rs.55.00 per KW per month of connected load or part thereof.

CATEGORY 10

Rural Unmetered Supply:

1. Applicability :

Applicable to rural domestic and commercial consumers having connected load upto 5 KVA in villages when number of consumers are not more than 300, only without metering in villages not covered under municipality and town committee areas and are classified as under :-

a) Rural Deomestic Consumer (Unmetered Supply).

b) Rural Commercial Consumer (Unmetered Supply).

II. Character of Supply :

A/C, 50 c/s, single phase, 230 volts.

III. Tariff :

a) For rural domestic consumers

@Rs.2.00 per point per month.

b) For rural commercial consumers

@ Rs.3.00 per point per month.

The above two charges are inclusive of Electricity duty @ 10 paise per point per month.

IV) Monthly Minimum charges :

a) For rural domestic consumers

@ Rs.12.00 per service connection per month.

b) For rural commercial consumers

@ Rs.18.00 per service connection per month.

The above two monthly minimum charges are inclusive of Electricity duty @ 60 paise per service connection per month.

CATEGORY 11

Temporary Power Supply

I. Applicability :

Temporary power supply shall be connected at special rates during festival, ceremony and other purpose of temporary nature. Temporary consumers are deemed "consumer" only for a brief period for which temporary power supply has been sanctioned and shall be guided by the special agreement made thereon only for a specific purpose. Depending upon the nature of consumption this is classified as under :-

a) Commercial/Industrial and

b) General Supply

II. Character of Supply :

As may be decided by the Board.

III. Tariff :

a) For commercial/Industrial supply of power.

i) Tariff for first 30 days is @ 200 paise per KWH. The minimum charge is @Rs.75.00 per KW of connected load or part thereof per day.

ii) For all consumption beyond 30 days and upto 180days the tariff is @ 250 paise/ KWH. The minimum charge beyond 30 and upto 180 days is @ Rs.100.00 per KW of connected load or part thereof per day.

b) For temporary general power supply for consumption upto 180 days the tariff is @ 100.00 per KW. The minimum charge is @ Rs.30.00 per KW of connected load or partthereof per day.

In addition. the usual meter charge and connection & disconnection charges shall also be levied. All consumptions will be metered. Connection to supply will be given only after obtaining proper security for meters aand minimum charge which will be finally adjusted against consumption.

MISCELLANEOUS CHARGES - 13

I (a) Meters :-

For hire of each meter or instrument supplied by the Board for measuring energy, the following rent will be charged for Per meter Per month or Part there of 1. For single phase 230 V.AC or 440 V.DC meter Rs. 3.00 Per month.

2. 3 phase, 400 V.AC or 440 V.DC meter, Rs. 6.00 Per meter Per month.
3. 3 phase, LT metering at 400 V.AC 50 c/s with CT Rs. 45.00 Per meter Per month.
4. Mimimun demand meter with P.T. and C.T. and H.T. meter Rs. 40.00 Per meter Per month.
5. H.T. or EHV Trivector meter Rs. 150.00 Per month.

b) Testing of Meters :

For testing a meter which is the property of the Board at the request of the Consumer, no charge will be leviable, if the meter Prroved to be incorrect with in limits laid down by the Indian Electricity Rules, 1956. If however, the meter proved to be correct, The testing fee charged shall not be refunded.

i)	Single phase meter	@ Rs. 15.00 Per meter.
ii)	3 phase meter	@ Rs. 45.00 Per meter.
iii)	HT meter	@ Rs. 75.00 Per meter.
iv)	Trivector maximum demand meter	@ Rs. 90.00 Per meter.

c) To connect Sub Meter :

i)	Single phase / 3 phase meter	@ RS. 30.00 Per meter.
ii)	HT meter	@ RS. 150.00 Per meter.

II. Disconnection and Re-conection charge :

Disconnection and Re-connection charges for the following category of comsumers shall be as under :-

1. Domestic 2. Commercial 3. Public lighting 4. Irrigation 5. Category 6(a)(i) 6. Category 6(a)(ii)

7. Rural domestic/ commercial consumer.

8. Tmporary connection under category-II, where supply is given at L.T.

For the above consumers the charges will be -

@ Rs. 15.00 Per disconnection.

@ Rs. 15.00 Per re-connection.

9. Public Water Works.

10. Industries under category 6(b) & (c) and 6(c) (ii).

11. Bulk supply under, category 7(a),7(b).

12. Bulk supply outside state, category-8.

13. Tea, Coffee, Rubber Garden, category-9.

For the above consumers the charge will be :-

@ Rs. 200.00 Per disconnection.

and @ Rs. 200.00 Per re-connection.

14. Temporary HT. COnnection, CAtagoy-II (a)

For the above consumer the charges will be

@ Rs. 250.00 Per disconnection.

and @ Rs. 250.00 Per re-connection.

III. Meter Security Deposit :

Before resuming supply to a consumer, the Board shall realise from the consumer a security in cash payment for the meter connected to recod his consumption as meter security. The Board will allow interest on this cash meter security deposit with effect from 1-1-88. The amount of security deposit against meters are as under :-

i)	Single phase meter	@ Rs. 200.00 Per meter.
ii)	3 phase meter for connection load upto 100 KVA	@ Rs. 300.00 Per meter.
iii)	3 phase meter for connection load upto 100 KVA	@ Rs. 450.00 Per meter.
iv)	Maximum demand meter with C.T.	@ Rs.1500.00 Per meter.
v)	11 KV metering (complete set)	@Rs.20,000.00 Per meter per set.
vi)	33 KV metering (complete set)	@Rs.20,000.00 Per meter per set.

(Schedule of Tariff, '86, ASEB)

In exercise of powers conferred upon the Assam State Electricity Board under section 49 and 59 of the electricity (supply) Act. 1948, the ASEB Published the revised schedule of tariff rates applicable to the different catagories of consumers to come into force with effect from 1st April 1992. Details of revsed tariff rates is outlined below.

Category of Consumers	Schedule of Tariff (Rs. Per KWH)
1. Domestic (connected load)	
a. 0 - 1 KW	0.60
b. Above 1 KW - 5 KW	0.80
c. Above 5 KW	1.00
2. Commercial (connected load)	
a. 0 - 5 KVA	1.50
b. Above 5 KVA - 25 KVA	1.75
c. Above 25 KVA	2.00
3. Public Lighting	1.50
4. Public Water House	1.50
5. Irrigation (connected load)	
a. 0 - 5 KVA	0.50
b. Above 5 KVA- 25 KVA	0.80
c. Above 25 KVA	1.00
6 Industries (connected load) 0 - 25 KVA	
i. Rural ------	0.15
ii. Urban ------	1.00
a. Above 25 upto 100 KVA	1.25
b. Above 100 KVA upto 25 KVA	1.50
c. Above 2500 KVA	1.75

7. Bulk Supply (connected load)

a.	Educational Institutions	0.80
b.	Others	1.25
8.	Outside state	1.10
9.	Tea, Coffee, Rubber	1.75
10.	Oil & Coal Industry	1.75
11.	Unmetered supply	
a.	Domestic	1.00/Point
b.	Commercial	10.00/Point

Surcharges for delayed payment and rebates where applicable as per existing terms & conditions shall continue till further notification on the subject.

The electricity duty leviable as per the Government of Assam order under Assam State Electricity Act, 1964, released vide Gazette notification no. 177 dated 21-9-84 with latest amendments and any other statutory levey, duty, sales tax, toll etc. imposed by the Central/State Government or any other authority as per law from time to time shall be charged over and above the tariff as shown above. (ASEB circulator).

Considering the continuous going up in cost of production of electricity due to increase in cost of inputs like furnace oil, H.S.D., coal, natural gas, machines, spares required for maintenance of machines and also due to increase in the emoluments of employees, Assam State

Electricity Board notified the following revised tariffs in all areas to come into force with effect from the consumption of the month of June, 1993.

Category	Schedule of tariff rate per KWH (w.e.f.18/6/93)
1. <u>Domestics</u>	
Consumers whose consumption during the month (30 days) or average daily consumption falls in the following range :-	
a. Upto 1 KWH/day average consumption	Rs. 0.75
b. Above 1 KWH to 2 KWH/day average consumption	Rs. 1.20
c. Above 2 KWH to 3 KWH/day average consumption	Rs. 1.60
d. Above 3 KWH to 4 KWH/day average consumption	Rs. 2.00
e. Above 4 KWH/day average consumption	Rs. 2.40
2. <u>Commercial</u>	
a. Upto 2 KWH/day average consumption	Rs. 2.00
b. Above 2 KWH to 4 KWH/day average consumption	Rs. 2.45
c. Above 4 KWH to 8 KWH/day average consumption	Rs. 2.95
d. Above 8 KWH to 16 KWH/day average consumption	Rs. 3.25
e. Above 16 KWH/day average consumption	Rs. 3.65
3. Public Lighting	Rs. 3.25
4. Public Water Works	Rs. 3.25
5. <u>Irrigation</u>	
a. Upto 20 KWH/day average consumption	Rs. 1.60

b. Above 20 KWH to 100 KWH/day average consumption	Rs. 2.00
c. Above 100 KWH/day average consumption	Rs. 2.45

6. <u>Industry</u>

A. Small Industry (L.T.)

i) Rural (L.T.) upto 25 KVA connected load	Rs. 0.90
ii)Urban (L.T.) upto 25 KVA connected load	Rs. 1.50

B. Medium Industry (H.T.)

i) Above 25 KVA and upto 100 KVA connected load	Rs. 2.20

C. Large Industry (H.T.)

i) Above 100 KVA to 500 KVA fo connected load	Rs. 2.80
ii)Above 500 KVA to 2500 KVA of connected load	
a) Fixed charge	Rs. 75/KVA/month
b) Energy charge	Rs. 2.25/KWH

7. <u>Bulk suply</u>

a) Educational	Rs. 1.40
b) Others	Rs. 3.00

8. Tea, coffee and Rubber

a) Fixed charge	Rs. 57/KVA/month
b) Energy charge	Rs. 2.65/KWH

9. OIl and Coal

a) Fixed charge	Rs. 85/KVA/month
b) Energy charge	Rs. 2.45/KWH

10. Unmetered Supply in rural area

a) Domestic	Rs. 0.75/KWH
b) Commercial	Rs. 2.00/KWH

The tariff notified are in supersession of the prevailing tariff and shall be applicablle to all consumers availing supply of electricity from the Board and are subject to terms and conditions of supply of the Electricity Board.

The surcharge for delayed payment and rebates where applicability as per existing terms and conditions shall continue till further notification on the subject.

The Electricity Duty leviable as per the Government of Assam order under Assam State Electricity Duty Aact, 1964 with latest amendments and any other statutory levy, duty, sales tax, toll etc. imposed by the central/state Government or any other authority as per law from time to time shall be charged over and above the tariff as shown above.

The foregoing tariffs are liable to be increased at any time as may become necessary and as may be decided by the supply on account of increased in cost of generation, purchase and supply of electricity due to increase of inputs and increase in emoluments of employees, interest cost or increase in other expenses.

Other schedule of charges like mimimun charges, temporary Power Supply Connection, meter rent, meter security deposit, meter testing fee, load security deposit, dis-connection and reconnection charges, will remain unaltered.

In case of unmetered supply in the villages, meter will be installed in a phased manner and the tariff Prescribed would be applicable. Until conversion to the meter system, the Present Point system of billing would continue. (ASEB, Notification, 13th May'93).

Another notification has been issued by Assam State Electricity Board which caused further change in the tariff structure. The new tariff structure, as defailed in the notification, is in slight modification to original revised tariff structure approved by the State cabinet while in the original revision, the tariff for domestic consumption had been divided into six catagories, in the new structure, it has been confined to three broad catagories.

According to the new tariff structure, domestic consumers utilising upto four units of electricity will have to pay Rs. 1.00 per unit consumed, while those consuming between four to eight units per day will have to pay Rs. 1.50 per unit. Those consuming above eight units per day will pay Rs. 2.25 Per unit.

In the earlier revised structure, Rs. 1.00 Per unit was the charge fo those consuming upto a uniit per day and those consuming between one to two units a day. The charge for those consuming between two to three units a day and three to four units was Rs. 1.50 Per unit, and for those consuming between four to eight units Per day and above eight units per day was Rs. 1.80 Per unit.

The other modification in the latest revise tariff struvcture has been in the case of the rural unmetered supply. According to it, The unmetered supply to the domestic consumers will cost Rs. 4.00 per point per month, While the commercial consumers will have to pay Rs. 10.00 Per point Per month. The ASEB notification says that in case of unmetered supply, meters will be installed in a phased manner, and the tariff prescribed will be applicable to such unmetered consumers.

The new tariff structure will result in an average of nearly 83 percent over the Present tariff, if one takes into account all catagories of consumers - domestic, commercial,Public lighting, public water works, irrigation, industry, educational institutions and other bulk consumers, tea, coffee, rubber, coal and oil industries and the rural domestic and the commercial consumers having unmetered supply. The average cost of Power Per unit, as a result of new tariff structure , wll be around Rs. 2.30 in comparision to the Present Rs. 1.25. After the new tariffs become applicable, the ASEB will earn around Rs. 407 crore Per annum. At present it earns Rs. 223.36 crore Per annum as revenue.

The proposed hike in the power tariff is a death blow to industries of Assam. This will lead to closure of most of theindustrial units in the small scale and the medium sector only in the three sectors of industries viz. Rolling Mills, Steel furnance and Flour Mills, this increase shall render a mimimun of 13,000 direct workers and another 40,000 indeirectly employed as jobless. The Unemployment situation in Assam shall further aggrevate.

An estimated capital investment of crores of rupeesin industries of Assam shall become dead. Consequent loss to banks and financial institutions and as such to the country shall run into hundreds of crores. Even before the Preposed increase in tariff, the lower tariff in neighbouring states of Assam have been hindering the industrial development of Assam. For the industrial undertakings located in Assam, the competition with other states in respect of finished Products would be unequal as most of the inputs have to be imported from other region.

The proposed hike of the already existing higher rates of ASEB shall nock down the incentives offered by State and Central Government for industrial development of Assam. Industries with high power loads Proposed rate is Rs. 2.25 to Rs. 2.45, but taking into, account the newly Proposed Maximun Demand charges, the rate comes to more than Rs. 3.00 to Rs. 4.00 Per unit depending on industry to industry. Whimsical hike by ASEB shall crush existing industries bringing economic disasters, uneployment and other socio-economic problems and shall result in cruel and un-natural death of industries in Assam.

Without a gauranteed power supply of 24 hours in a day throughout the year and with peak hour restriction and irregular power supply with low and fluctuating voltage, is ASEB justified in imposing newly proposed demand charges. Is ASEB justified in charging the higher rate to bulk consumers compared to other consumers, whereas the electricity board of Orissa provides power at substancial discount rate of 63 paise per unit to mini plants and other SEB's also give discount to bulk consumers. Even in developed states like West Bengal against the demand for increase of 15 percent in tariff, only 5 percent for domestic and 10 percent for industry has been agreed by West Bengal Government from August 1993.

So the state Government should not remain a mute spectator to the exploitative attitude of the ASEB. That would amount to striking at the root of the industries as also the industrial climate of the state. Power rates should be much lower than the rate proposed, if only to attract more capial investment in a state ravaged for too long. A positive reponse from the state government to save existing industrial units from extinction was never as much as a crying need as it is now. The helping hand of the State government is needed for creating a climate conducive to industrial growth. This is the only answer for a rapid economic revival of Assam.

The Federation of Industries of North-Eastern Region (FINER) has severely criticised the proposed hike in power tariff by the and ASEB and demanded its immediate strapping. FINER president alleged that the ASEB, by its proposal to arbitarily hike the power tariff, was attempting to make the consumers pay for its inefficiency and mismanagement. He said that the ASEB was producing hardly 30 percent of its installed capacity of over 500 MW. Against an all India average of five employees per million units sold and 16 employees per thousand consumers the ASEB had 15 and 43 employee respectively.

Again, against the norm of 15 ml/kwhr, the oil consumed by the ASEB on secondary fuel, it is 70 ml to 90 ml while the quality of coal used by its generating stations, was never tested. The losses in transmission and distribution were 23 percent against the norm of 8 percent. Billing cost in ASEB varied from Rs.11.00 to Rs.33.00 per bill in the ASEB.

The ASEB purchases 50 percent to 70 percent of the power at an average price of 68 paise per unit which has not been raised by the suppliers. However, if one were to add the hike in coal and oil prices, it should be not more than 25 percent though the actual impact of the hike on ASEB would never be more than 10 percent. But the ASEB's proposed hike would be between 100 and 150 percent which is really a matter of great concern as this would only give a death blow to industries in the north-eastern region.

A comparative statement of tariff rates per unit of power consumption in Assam with some other states can be seen from table 4.25 below.

TABLE 4.25.

TARIFF RATES OF ASEB AND SOME OTHER STATES OF INDIA.

States	Average tariff	Proposed tariff By ASEB	% higher
Orissa	Rs. 1.03	Rs. 2.80	172%
Bihar	Rs. 1.32	Rs. 2.80	112%
West Bengal	Rs. 1.63	Rs. 2.80	72%
Madhya Pradesh	Rs. 1.16	Rs. 2.80	141%
Gujarat	Rs. 1.27	Rs. 2.80	120%
Haryana	Rs. 1.23	Rs. 2.80	128%
Kerala	Rs. 0.84	Rs. 2.80	233%

Proposed tariff rate in Assam is much higher than the existing tariffs of some other states of India. While the average tariff in Orissa is Rs.1.03 per unit, Assam's is Rs.2.80 per unit which is 172 per cent higher than Orissa. If the proposed tariff rate of Assam is compared with the existing tariff rate of Kerala, then Assam recorded a much higher rate by over 233 per cent. Similarly in comparision to the tariff rate of other states like Bihar, West Bengal, Madhya Pradesh, Gujarat and Haryana Assam's rate is much higher. Again while industry should be supplied H.T. power at lowest rate, it was being charged at the highest rate in Assam.

It is purtinent to know the various tariff rates of the ASEB during the period since 1971. The ASEB's rate for domestic comsumption in 1971 was 43 paise per unit. This rate was in vague till 1977 when it was raised to 48 paise. It was further raised to 60 paise in 1981 which is also the current rate of the tariff. This rate is beside the minimum of Rs. 20 that a domestic consumer has to pay the ASEB every month.

Despite the financial crisis, certain hackneyal ill-conceived policies of the State Government have been draining its exchequer. A classic case of such colossal waste is the Governments decision to continue the system of concessional electricity billing for Government quarters at Disput which was introduced in 1972. The State Government had decided on a system of concessional electricity billing for Government Servants including the ministers and the MLA's residing in capital complex at Dispur. As a result, the Government has to bear a colossal amount to pay for the electricity consumed by the previleged officials and staff at Dispur.

The Government has also special arrangements for electricity supply to the Dispur Complex from a single point. None of the quarters at Dispur has a meter. There is a single meter at the single point of connection. The monthly bill is paid by the Government on the basis of the reading in this meter only. Obviously, there is no way the Government or the ASEB can know which quarter has consumed how much of electricity.

The officers and the employees only pay the rental fixed in 1972. This is an internal transaction between the Government and the officers and staff at Dispur. Thus, while the common custonmers in the state have to pay a minimum of Rs. 20.00 to the ASEB, there are officials and others at Dispur who are paying just Rs.5.00 or Rs.10.00 as electricity charges. This is beside the fact that electricity consumption is much higher at Dsipur with every household using all types of gadgets and appliances run by electricity like refregerators, TVs, VCR's etc. It is worth mentioning here that while the entire state has to bear load-ehedding, the Dispur Complex is provided with 24 hours electricity.

It is a known fact that the State Government owes the ASEB not less than Rs.200 crore on other accounts. An ASEB spokesman squarly blamed the State Government for not releasing the plan and non-plan amounts, sanctioned for the Board, saying out of the Rs.124 crore planned amount, the

State Government had so far released only 28 crore and again in the non-plan, about Rs.35 crore had been released against the total allocation of Rs.87 crore during 1992-93.

The revenue of the ASEB was Rs. 16 crore per month against a monthly expenditure of more than Rs.23 crore leaving an unmanageable gap of Rs.6-7 crore. Of the 23 crore, Rs.7 crore went to paying salaries, Rs.4 crore to coal purchase, Rs.3 crore for maintenance of input, Rs.6 crore to debt serving and another Rs.3 crore for power purchase. It is worth mentioning that the ASEB owed to MSEB about Rs. 30 crore at the end of March 1995 for purchase of power. The ASEB charged the State Government with not releasing more thaan Rs.400 crore of subsidy for rural electrification, though altogather 21,995 villages had been electrified under the rural electrification scheme but the State Government was yet to release the amount. According to the Annual financial report (1991-92) of the ASEB, the Board had incurred a loss of Rs.22,328 lakhs.

CHAPTER V

ANALYSIS OF SURVEY DATA

5.1 DEMOGRAPHIC DATA

In our survey we have selected 260 households from 10 district headquarter towns and 10 villages from two districts. Of these, 200 households were selected from urban areas and 60 households from rural areas for the purpose of enquiry. The population consisted of different ethnic groups belonging to different religion. The sex composion of population according to sex is not available. Neither in our survey, we have provision for age-sex pyramids of population, although, such information leads to other information such as fertility and growth of population.

We have tabulated data for the purpose of analysis. The important exogeneous variable in estimating the demand for energy is the number of people. For cooking alone the amount of fuel used by one person may be sufficient for a family of three persons. Also the more people there are in a family more energy is used for lighting. Below we present the distribution of families in different income groups to estimate mean family size in different income groups of the sample households.

TABLE-5.1

FAMILY DISTRIBUTION IN DIFFERENT INCOME GROUPS

Family income (Rs)	No family	Total family members	Average family size
Below-500	34	251	7.4
500---1000	31	182	5.9
1000—1500	32	224	7.0
1500—2000	30	194	6.5
2000—2500	23	170	7.4
2500—3000	24	178	7.4
3000—3500	20	168	8.4
3500—4000	15	115	7.7
4000—4500	12	101	8.4
4500—5000	8	60	7.5
5000—5500	6	55	9.1
5500—6000	9	100	11.1
6000—6500	8	69	8.6
6500—7000	4	39	9.8
Above–7000	4	21	5.2
	260	1927	7.4

Next we present the family size distribution to estimate the mean family size with sex ratio of the sample households.

TABLE 5.2

FAMILY SIZE DISTRIBUTION

Family size	No.of households	Population		Total
		Male	Female	
1——2	6	4	7	11
2——4	32	65	51	116
4——6	74	213	192	405
6——8	78	299	282	581
8——10	37	181	164	345
10— 12	14	76	76	152
12——14	10	75	64	139
14——16	3	23	22	45
Above 16	6	73	60	133
Total=	260	1009	918	1927

The average family size of 260 sample households is 7.4. with 3.9 male Population and 3.5 female Population and sex ratio is 909 female per 1000 male population.

The type and quantity of fuel or energy used by a household would depend on its social status. Often an educated family would desire a change in the cooking fuel. In fact, among the 260 houscholds we visited there are a few families specially in urban areas use kerosene wickstove and a few families use L.P.G. wheras families in rural areas use fire wood and agicultural wastes, dry leaves etc. Following table will give us about the socio-ecenomic characteristics of the sample households.

TABLE -5.3

SOCIO- ECONOMIC COMPOSITION OF POPULATION

Family size	No.of Literates	No. of Illiter-ates	Family occupation			
			Agriculllture	service	Busine-ss	others
1-3	25	19	2	4	4	4
3-5	191	99	7	25	21	7
5-7	316	186	10	44	20	4
7-9	301	198	12	26	21	nil
9-11	118	93	6	7	13	nil
over 11	192	189	7	7	9	nil
Total	1143	784	44	113	88	15

The table shows the number of people literates and illiterates and the number of households engaged in occupation. In case of services and business the occupation of the owners of the households are considered. Very often there is only one earning member while for agriculture more then one family members are helping in the field. The percentage of literacy in the surveyed households is nearly 60 percent which is a little high as compared to 53.4 percent for the whole state, given in 1991 census record. The rise in literacy may be due to the high rate of growth of enrolment in the primary schools. The percentage of households having the occupation of agriculture is only 6.93 as the households in urban areas engaged with services and commercial activities other than agriculture. Only in rural areas, households were found with occupation of agriculture. In our survey data 43.46 percent of households engaged in service while 33.84 percent of the households engaged in the commercial activities and only 5.77 percent of the households was found with other activities.

The number of households having access to the minimum of amenities like electricity, possessing radioes, televisions, refrigerators, fans and automobiles like scoter, motorbyke, car etc. is given in the following table.

TABLE- 5.4

ACESS TO AMENITIES

Amenities	No. of households	p.c. of total households
Electricity	202	77.69
Pump set (Electric)	4	1.53
Motor cycle	14	5.38
Scooter	22	8.46
Car (private)	8	3.07
Fan	186	71.53
Radio	171	65.76
Television	114	43.84
Refrigartors	31	11.92
Others	26	10.00

5.2 ENERGY COUSUMPTION IN DOMESTIC SECTOR

By Domestic sector we mean the households exclusively, since hardly any family Cousumes energy for lighting Comercial purpose in their premises. The entire consumption can be factored into cooking and lighting. The energy consumed for warmth is mostly associated with cooking.

The fuel used for cooking is firewood. However in urban set up some families used kerosene and L.P.G. None of the families in our sample households reported useing electricity for cooking. The traditinoal chulah with three erect stones or bricks make a tripod to put the kettle on. We present the following tables to show the consumption of fuel.

TABLE. 5.5

NO.OF FAMILIES USED DIFFERENT COOKING STOVES IN DIFFERENT INCOME GROUPS.

	No. of families used			Total number of households in each income group
Income (Rs)	Traditional chulah	Kerosene stoves	Gas stoves	
Below -- 500	32	4	0	34
500 --- 1000	26	15	6	31
1000 --- 1500	29	20	3	32
1500 --- 2000	21	21	12	30
2000 --- 2500	20	13	8	23
2500 --- 3000	16	20	8	24

cond..

3500 --- 4000	13	9	8	15
4000 --- 4500	11	9	10	12
4500 --- 5000	7	7	4	8
5000 --- 5500	1	5	5	6
5500 --- 6000	6	8	6	9
6000 --- 6500	7	8	8	8
6500 --- 7000	4	4	3	4
Above -- 7000	0	3	4	4
Total =	210	160	86	260

The table shows that the families with low income use more traditional chulah than families of higher income group. Use of kerosene stoves has found increased with a rise in income but after a certain level of income it appears to decrese. In case of gas utilisation also the rich families prefer to consume more gas instead of firewood and kerosene. Although total number of households decreased in case of both kerosene and gas utilisation in higher income groups but in percentage term of households fallen in each income group the number of families used kerosene and gas has been increased with a rise in income. For example, total number of households in come groups above Rs. 7000.00 is only 4. Of these, 3 families usued kerosene stoves and 4 families used L.P.G stoves for cooking which calculates 75 P.C and 100 P.C. of the total households. Number of households used traditional chulah is 210 which calculates 80.76 percent of the total sample households. In case of kerosene and gas stoves the numbers of households are 160 and 86 which represent 61.53 percent and 33.07 percent of the total households respectively.

TABLE 5.6

ENERGY CONSUMPTION FOR COOKING AND LIGHTING PER SAMPLE HOUSEHOLDS PER MONTH (RURAL)

	Cooking			Lighting	
Family Size	Fire wood (kg)	Kerosene (Lit)	Gas (kg)	kerosene (Rs.)	Electricity (Rs.)
1 ----- 3	50.00	---	----	16.60	----
3 ----- 5	80.50	0.5	1.42	13.50	22.90
5 ----- 7	58.84	---	----	16.11	12.61
7 ----- 9	108.23	---	----	17.94	19.29
9 ----- 11	325.70	---	----	21.50	17.00
Over -- 11	360.62	---	----	23.00	9.62

TABLE - 5.7

ENERGY COUSUMPTION FOR COOKING AND LIGHTING PER SAMPLE HOUSEHOLD PER MONTH (URBAN)

	Cooking			Lighting	
Family Size	Fire wood (kg)	Kerosene (Lit)	Gas (kg)	kerosene (Rs.)	Electricity (Rs.)
1 ----- 3	33.30	2.07	3.24	4.08	57.38
3 ----- 5	88.96	5.50	7.40	9.05	44.82
5 ----- 7	110.50	6.47	7.64	9.64	50.32
7 ----- 9	154.02	7.97	7.61	12.12	50.14
9 ----- 11	200.00	5.50	9.46	10.33	51.55
Over -- 11	229.50	8.80	9.36	12.95	92.10

TABLE 5.8

ENERGY CONSUMPTION FOR COOKING AND LIGHTING PER SAMPLE HOUSEHOLD OF BOTH RURAL AND URBAN AREAS PER MONTH.

	Cooking			Lighting	
Family Size	Fire wood (kg)	Kerosene (Lit)	Gas (kg)	Kerosene (Rs.)	Electricity (Rs.)
1 ----- 3	46.27	1.50	5.95	7.56	41.44
3 ----- 5	87.95	4.69	6.43	9.77	41.29
5 ----- 7	101.92	5.39	6.37	10.72	44.03
7 ----- 9	140.60	5.63	5.38	13.82	41.12
9 ----- 11	225.00	3.12	5.32	15.21	36.43
Over -- 11	245.53	6.46	6.68	15.82	68.53

TABLE 5.9

PERCAPITA ENERGY COUSUMPTION FOR COOKING AND LIGHTING OF SAMPLE POPULATION PER MONTH.

			Cooking			Lighting	
Family Size	No. of Households	Total Population	Firewood (kg)	Kerosene (Lit)	Gas (kg)	kerosene (Rs.)	Electricity (Rs.)
1 ----- 3	18	44	19.83	0.61	2.43	3.09	16.95
3 ----- 5	62	290	18.72	1.00	1.37	2.08	8.82
5 ----- 7	78	502	15.83	0.83	0.99	1.66	6.84
7 ----- 9	58	499	16.34	0.65	0.62	1.60	4.77
9 ----- 11	16	211	19.33	0.23	0.40	1.15	2.76
Over -- 11	28	381	19.61	0.47	0.49	1.16	5.03

The table shows that the percapita consumption of firewood per month which is exclusively used for cooking has increased due to increase of population in the sample households. similar increasing trend is noticed in the consumption of both kerosene and gas when the size of families become large. In rural areas, use of kerosene and gas for cooking was not reposted by sample household except one at the time of sarvey. The sample households used both kerosene and electricity for lighting as the families not having electricity or at intermission Period when there is no electricity kerosene lamps are used. In case of kerosene and electricity consumption, the table reveals that as the number of population in households in creases, the amount consumed is also increases. It may be mentioned here that the quantity consumed for lighting expressed in terms of money in the above table as the data in physical units for electricity consumption could not found available at the time of enquiry. Therefore, we took only the amount of money shown in the bill or reported by the sample households.

Percapita monthly energy consumption both for cooking and lighting has shown a decreasing trend when the family members increased in sample houeholds. In table 5.9 it has been observed that families with 1-3 members used 19.93 kg firewood per head per month which has fallen to 19.61 kg in families having over 11 members. Similar decreasing trend has also found in case of kerosene and gas consumption. The reasons for the decrease in per capita energy consumption is the growth of population in households. Total consumption of electricity is much less in a family of less than 3 members while the consumption figure is much more in a family with more than 11 members. But the per capita consumption of electricity is less in a big family as compared to a small family. Now we Present the size of familes and number of electric bulb used by the sample households. Cell frequencies in the table represent the number of households used bulbs. Table 5.10 below shows that a big family used more bulbs as compared to a small family. This indicates that there is a strong co-relation between the size of families and number of bulbs used.The number of households is shown 202 of the total 260 households because 58 households do not have electric connections.

TABLE - 5.10

SIZE OF FAMILY AND NUMBER OF ELECTRIC BULB USED

Size of family	Number of bulbs							Total No.of households
	1-2	2-4	4-6	6-8	8-10	10-12	over 12	
1--3	1	5	3	2	-	-	-	11
3--5	1	6	16	12	7	4	4	50
5--7	-	1	13	21	16	7	1	59
7--9	-	1	7	17	12	6	4	47
9--11	-	-	1	4	4	4	2	15
Over 11	-	-	1	4	4	3	8	20
Total	2	13	41	60	43	24	19	202

TABLE- 5.11

DISTRIBUTION OF ELECTRIC GOODS AND NO. OF FAMILIES IN DIFFERENT IN COME GROUPS

In come grups Rs.	No.of families used					Total
	Fan	TV	Refigertor	Radio	Others	
Below--500	7	2	0	10	0	19
500----1000	17	2	2	22	2	45
1000---1500	20	10	2	19	3	54
1500---2000	20	11	4	17	5	57
2000---2500	20	8	2	17	2	49
2500---3000	22	10	1	21	4	58
3000---3500	16	13	4	14	2	49
3500---4000	13	8	2	12	2	35
4000---4500	13	12	1	8	1	37
4500---5000	8	8	4	7	0	27
5000---5500	6	6	2	4	1	19
5500---6000	8	8	3	5	0	24
6000---6500	8	8	1	8	0	25
6500---7000	4	4	1	3	1	13
Above--7000	4	4	4	4	3	19
	186	114	33	171	26	530

Next we present the consumption of different types of fuel and electricity per month for cooking and for lighting with size of families. This has been done in order to analyse them seperately.

TABLE 5.12

MONTHLY COUSUMPTION OF ELECTRICITY AND SIZE OF FAMILIES.

(CELL FRIQUENCIES REPREAENT THE NUMBUR OF HOUSEHOLDS)

Size of family→ Consumption(Rs) ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Over 16	Total No of households
Below----10	0	0	0	0	0	0	0	0	0	0
10-------20	1	2	7	2	2	2	0	0	0	16
20-------30	0	4	6	4	5	1	2	0	0	22
30-------40	0	6	13	7	5	1	0	0	0	32
40-------50	1	3	16	12	4	1	1	0	0	38
50-------60	1	2	8	10	6	1	1	1	0	30
60-------70	0	2	4	12	4	2	0	0	0	24
70-------80	0	0	3	4	3	1	0	0	1	12
80-------90	0	1	1	4	0	0	1	0	1	8
90------100	0	1	1	2	0	1	1	0	0	6
Above---100	0	4	1	4	0	0	1	2	2	14
Total=	3	25	60	61	29	10	7	3	4	202

TABLE-5.13

MONTHLY CONSUMPTION OF KEROSENE FOR LIGHTING AND SIZE OF FAMILIES

Size of family→ Consumption(Rs ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above 16	Total No of household
Below--10	2	14	33	32	14	2	2	0	0	99
10-----20	2	10	20	32	16	6	4	3	3	96
20-----30	0	0	9	9	3	5	2	0	1	29
30-----40	0	1	0	1	0	0	0	0	0	2
40-----50	0	0	0	0	3	0	0	0	0	3
Above--50	0	0	0	1	0	0	1	0	0	2
Total=	4	25	62	75	36	13	9	3	4	231

TABLE 5.14

MONTHLY COUSUMPTION OF FIRE WOOD AND SIZE OF FAMILIES.

Size of family→ Consumption(Rs ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above16	Total No of households
Below--20	1	3	5	2	1	0	0	0	0	12
20-----40	1	5	11	18	3	2	2	0	0	42
40-----60	1	1	4	3	4	1	0	0	0	14
60-----80	0	4	11	12	7	2	1	0	0	37
80-----100	0	1	2	2	2	0	0	0	0	7
100----120	0	4	5	5	4	0	0	0	1	19
120----140	0	3	0	0	0	0	0	0	0	3
140----160	1	1	14	8	6	0	1	1	0	32
160--- 180	0	0	0	0	0	0	1	0	0	1
180----200	0	0	2	10	5	0	0	0	0	17
Above--200	0	1	3	4	6	7	4	2	3	30
Total=	4	23	57	64	38	12	9	3	4	214

TABLE 5.15

MONTHLY COUSUMPTION OF KEROSENE FOR COOKING AND SIZE OF FAMILIES

Size of family→ Consumption(Rs) ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above 16	Total No of household
Below--20	1	6	18	16	10	1	2	0	1	55
20-----40	0	6	15	21	10	5	1	2	3	63
40-----60	0	0	2	7	0	0	2	0	0	11
60-----80	0	0	1	1	0	1	1	0	0	4
80-----100	0	1	1	1	0	0	0	0	0	3
Total=	1	13	37	46	20	7	6	2	4	136

TABLE 5.16

MONTHLY CONSUMPTION OF GAS AND SIZE OF FAMILIES.

Size of family→ Consumption(Rs) ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above 16	Total No of households
40-----60	1	6	4	7	0	0	0	0	0	18
60-----80	1	4	3	4	1	1	0	0	0	14
80-----100	0	1	15	20	8	2	1	1	1	49
100----120	0	1	2	1	2	0	1	0	2	9
120----140	0	0	2	1	1	0	0	0	0	4
140----160	0	0	0	0	0	0	1	0	0	1
	2	12	26	33	12	3	3	1	3	95

Relationship between the consumption of energy and size of families can be seen from the tables 5.12 to 5.16 presented above. From table 5.12 it appears that the number of households concentrated in columns 4-6 and 6-8 of electricity consumption where total number of households were found 60 and 61 respectively and they spend more amounts for electricity consumption whereas in Kerosene consumption in table 5.13 we found that the households though their number is large in the same range as indicated above spend less amount of their income. This indicates that there is a tendency to opt Kerosene for electricity for lighting. Table 5.14 shows that the consumption of fire wood increases with a rise in population. As the table reveals that 30 families of the total 214 houseolds spend above Rs.200.00 for firewood consumption. Consumption of Kerosene for cooking is also found less in families with more family members which means to say that people use more firewood when their family members increases. In case of gas consumption, table 5.16 reveals that people with medium family size prefer to use gas. In our table, 35 households of size 4-6 and 6-8 spend Rs.80.00 to Rs.100 for the consumption of gas. Overall we may conclude that families with more members consume more energy than small families.

TABLE 5.17

COMBINED ELECTRICITY AND KEROSENE CONSUMPTION AND SIZE OF FAMILIES

Size of family→ Consumption(Rs) ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above 16	Total No of households
Below 20	3	7	11	9	5	2	1	0	1	39
20 --- 40	1	7	17	12	7	3	3	0	1	51
40 --- 60	2	10	28	17	12	2	0	0	0	71
60 --- 80	0	3	14	25	9	4	3	1	0	59
80 --- 100	0	1	4	7	4	0	2	0	2	20
100 -- 120	0	3	0	3	0	0	1	0	0	7
120 -- 140	0	0	0	2	0	1	0	1	2	6
140 -- 160	0	0	1	0	0	0	1	0	0	2
160 -- 180	0	0	0	0	0	0	0	0	0	0
180 -- 200	0	2	0	0	0	0	0	0	0	2
Above 200	0	1	0	1	0	0	0	1	0	3
Total	6	34	75	76	37	12	11	3	6	260

TABLE 5.18

COMBINED FUEL CONSUMPTION AND SIZE OF FAMILIES

Size of family→ Consumption(Rs) ↓	1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	Above 16	Total No of households
Below 20	1	5	0	2	0	0	0	0	0	8
20 --- 40	0	3	5	10	3	3	1	0	0	25
40 --- 60	3	4	6	5	3	1	0	0	0	22
60 --- 80	2	6	9	3	1	0	0	0	0	21
80 --- 100	0	8	8	3	5	0	0	0	0	24
100 -- 120	0	4	16	5	2	0	0	0	0	27
120 -- 140	0	3	6	9	1	1	0	0	2	21
140 -- 160	0	0	10	10	4	0	0	1	0	25
160 -- 180	0	1	5	8	3	1	2	0	0	20
180 -- 200	0	0	5	14	5	1	0	0	0	25
Above 200	0	0	2	10	11	7	7	1	4	42
Total	6	34	72	79	38	13	10	2	6	260

Besides size of families, the income of the households has influenced the demand for energy in domestic sector. Hence income of the households is considered to be an important factor. To analyse the consumption of electricity and Kerosene per month by the sample households in different income groups we Present data in the following tables.

TABLE 5.19

CONSUMPTION OF ELECTRICITY AND NO. OF HOUSEHOLDS IN DIFFERENT INCOME GROUPS.(per month)

Income Group	Total Consumption (Rs.)	Total No.of Households	Average consumption (Rs.)	Average consumption of (Rs.)
Below - 500	315.00	9	35.00	
500 - 1000	1296.00	22	58.90	
1000 - 1500	1248.00	23	54.26	LIG 49.34
1500 - 2000	966.00	22	43.90	
2000 - 2500	1148.00	21	54.66	
2500 - 3000	991.00	21	47.19	
3000 - 3500	1076.00	19	56.63	
3500 - 4000	998.00	15	66.53	MIG 59.93
4000 - 4500	649.00	12	57.83	
4500 - 5000	572.00	8	71.50	
5000 - 5500	524.00	6	87.33	
5500 - 6000	582.00	8	72.75	
6000 - 6500	616.00	8	77.00	HIG 80.71
6500 - 7000	314.00	4	78.50	
Above - 7000	352.00	4	88.00	
TOTAL	11692.00	202	57.88	

Note : LIG = Lower Income Group, MIG = Middle Income Group, HIG = High Income Group.

TABLE 5.28

CONSUMPTION OF KEROSENE FOR LIGHTING AND NO. OF HOUSEHOLDS IN DIFFERENT INCOME GROUPS.(per month)

Income Group (Rs)	Total Consumption (Rs.)	Total No.of Households	Average consumption (Rs.)	Average consumption of (Rs.)
Below - 500	476.50	31	15.37	
500 - 1000	353.20	27	13.08	
1000 - 1500	440.80	29	15.17	LIG 13.32
1500 - 2000	312.00	24	13.00	
2000 - 2500	180.50	18	10.00	
2500 - 3000	413.50	23	17.97	
3000 - 3500	221.50	18	12.30	
3500 - 4000	141.00	13	10.84	MIG 12.21
4000 - 4500	137.00	12	11.41	
4500 - 5000	68.50	8	8.56	
5000 - 5500	57.00	5	11.40	
5500 - 6000	115.00	8	14.37	
6000 - 6500	81.00	8	10.12	HIG 11.32
6500 - 7000	51.00	4	12.75	
Above - 7000	24.00	3	8.00	
Total	3072.50	231	13.30	

TABLE 5.21

COMBINED ELECTRICITY AND KEROSENE CONSUMPTION FOR LIGHTING AND NO. OF HOUSEHOLDS IN DIFFERENT INCOME GROUPS.(per month)

Income Group (Rs)	Total Consumption (Rs.)	Total No.of Households	Average consumption (Rs.)	Average consumption of (Rs.)
Below - 500	791.50	34	23.27	
500 - 1000	1649.20	31	53.20	
1000 - 1500	1688.80	32	52.77	LIG 46.72
1500 - 2000	1278.00	30	46.60	
2000 - 2500	1328.50	23	57.76	
2500 - 3000	1404.50	24	58.52	
3000 - 3500	1297.50	20	64.87	
3500 - 4000	1139.00	15	75.93	MIG 69.72
4000 - 4500	831.00	12	69.25	
4500 - 5000	640.50	8	80.06	
5000 - 5500	581.00	6	96.83	
5500 - 6000	697.00	9	77.44	
6000 - 6500	697.00	8	87.12	HIG 89.32
6500 - 7000	365.00	4	91.25	
Above - 7000	376.00	4	94.00	
Total	14,764.50	260	56.78	

From tables 5.19, 5.20 and 5.21 it appears that the total consumption of electricity decreased when the income of the households increased. But average consumption increased with the increase of income. Because the number of households in less in higher income groups. We have made three categories of consumers such as lower income group (LIG), Middle income group (MIG) and Higher income group (HIG) according to the income of the households. Here we find that the average consumption of electricity is much less in Lower income group than middle and higher income groups. This means that people buy more electricity when their income rises. But in case of Kerosene the average consumption in Lower income group is higher than middle and Higher income groups. This indicates that people buy less Kerosene for lighting when their income increase and prefer to use more electricity. Average consumption of both electricity and Kerosene together has increased as a result of increase in income of the households. Average figures, in table 5.21 shows a decreasing trend as compared to the average figures in table 5.20 where we find an increasing trend of firewood consumption with the increase in income.

THE COST OF ENERGY :

Except a very few families who collect their Part of fire wood from the community forest, the rest buy from the market in rural areas. The Price of a "bundle" consists of about 20 kg of firewood varies from place to place and time to time. It costs about Rs.10.00 to 15.00 per bundle. In urban areas fire wood was bought from nearby selling agents at a price of about Rs.80.00 per quantle. The cost per litre of Kerosene was ridiculously high. Although, the price at a petrol pump or at fair price shop was Rs.2.60 but most of the people have to buy at a price ranging from Rs.4.00 to Rs.10.0. Sometimes people have to buy even more than this price as unscrupulous businessmen sometimes create artificial scarcity. We have found that the cost of L.P.G. per cylinder and electricity is fairly stable. The price of L.P.G. per cylinder was Rs.70.00 which some times varies from place to place due to transportation cost. Price of electricity per unit for domestic consumption was Rs.0.60. Upon examination we found that the number of units consumed by a family was not given but the amount of money.

5.3 ENERGY CONSUMPTION FOR TRANSPORTATION

We have presented earlier in Table 5.4 the different means of transport possessed by the sample households. Besides these automobiles, there are other means of transport such as trains to cover long distance, Passenger bus for medium distance and by cycle for short distance. In rural areas, people generally go for their working fields and local markets on foot. For attending schools, children have to walk. The health and postal facilities are not locally available. For the market centres specially on the weekly market days and to nereby towns bus services are available. Some people use bycycle to cover short distance. Simply there is no adequate transport facilities even in the vilages which are touched by highways. Interior villages are completely cutoff. In course of our survey work we found that people have no other choice but to use his own energy. In the absence of Proper transport facilities the incentives to grow more or to produce more are less and whatever produced they do not get fair price for their products.

We have surveyed households both in rural and urban areas in the month of July 1992. Mode of transport in urban areas are private cars, scooter, Motor cycle, moped, autorickshow, rickshow, bycycle. In Guwahati city people avail the city bus services to attend offices and markets. Children also attend school by city bus & Rickshow. A few person use their own vehicles for going to offices and markets. Now we shall present data on transportation from survey which were collected for one month.

TABLE 5.22

TYPES OF VEHICLES USED BY HOUSEHOLDS IN DIFFERENT INCOME GROUPS

Income Group	Car	Scooter	Motor cycle	Bycycle	Total No. of House holds
Below - 500	0	0	0	9	9
500 - 1000	0	1	1	16	18
1000 - 1500	0	2	1	22	25
1500 - 2000	0	2	2	31	34
2000 - 2500	0	3	1	37	41
2500 - 3000	0	2	2	14	18
3000 - 3500	0	2	1	10	13
3500 - 4000	0	2	1	5	8
4000 - 4500	1	2	0	3	6
4500 - 5000	0	2	1	2	5
5000 - 5500	1	1	0	0	2
5500 - 6000	1	1	1	0	3
6000 - 6500	1	1	0	0	2
6500 - 7000	1	1	0	0	2
Above - 7000	3	1	0	0	4
Total	8	23	10	149	190

TABLE 5.23

DISTANCE TRAVELLED AND NO OF HOUSEHOLDS IN DIFFERENT INCOME GROUPS

Income Groups (Rs.)	Km - travelled by						No. of Households	Km travelled per households
	Train	Bus/Car	Scooter /M.cycle	Bycycle	Walking	Total		
Below - 500	0	3437	0	1346	992	5775	34	169.85
500 - 1000	0	3320	400	1108	442	5270	31	170.00
1000 - 1500	4,000	2366	800	829	314	8309	32	259.65
1500 - 2000	400	4432	641	452	228	6153	30	205.10
2000 - 2500	2,000	2910	400	656	127	6093	23	264.91
2500 - 3000	1,200	3215	535	613	235	5798	24	241.58
3000 - 3500	500	2820	860	759	168	5107	20	255.35
3500 - 4000	3,200	3424	500	179	117	7420	15	494.66
4000 - 4500	0	3000	720	.380	110	4210	12	350.83
4500 - 5000	0	3359	700	47	58	4164	8	520.50
5000 - 5500	0	1816	500	90	50	2456	6	409.33
5500 - 6000	1,500	1935	1000	173	62	4670	9	518.88
6000 - 6500	2,000	2480	200	170	40	4890	8	611.25
6500 - 7000	0	1265	400	120	35	1820	4	455.00
Above - 7000	0	4300	250	0	20	4570	4	1150.00
Total	14,800	44,079	8906	6922	2998	76705	260	295.01

TABLE 5.24

MONTLY ENERGY USED FOR TRANSPORTATION BY BUS/ CAR IN

DIFFERENT INCOME GROUPS.

Income group (Rs)	Km-travelled	No. of Households	Population	Km-travelled per Houschold	Per Capita km-travelled	Energy used Diesel(ltr)
Below--500	3437	34	251	101.08	13.69	0.59
500----1000	3320	31	182	107.09	18.24	0.62
1000---1500	2366	32	224	73.93	10.56	0.43
1500---2000	4432	30	194	147.73	22.84	0.86
2000---2500	2910	23	170	126.52	17.11	0.73
2500---3000	3215	24	178	133.95	18.06	0.78
3000---3500	2820	20	168	141.00	16.78	0.82
3500---4000	3424	15	115	228.26	29.77	1.33
4000---4500	3000	12	101	250.00	29.70	1.45
4500---5000	3359	8	60	419.87	55.98	2.44
5000---5500	1816	6	55	302.66	33.01	1.76
5500---6000	1935	9	100	215.00	19.35	1.25
6000---6500	2480	8	69	310.00	35.94	1.80
6500---7000	1265	4	39	316.25	32.43	1.84
Avobe 7000	4300	4	21	1075.00	204.76	6.26
Total =	44,079	260	1927	169.53		22.96

TABLE 5.25

MONTHLY ENARGY USED FOR TRANOPORTATION BY SCOOTER/M.CYCLE IN DIFFERENT INCOME GROUPS

Income groups Rs.	km-travelled	No. of Househoble	Population	km-travelled per Household	km-travelled percapita	Enargy used petrol (ltr)
Below---500	0	34	251	0	0	0
500----1000	400	31	182	12.90	2.19	0.23
1000---1500	800	32	224	25.00	3.57	0.45
1500---2000	641	30	194	21.36	3.30	0.38
2000---2500	400	23	170	17.39	2.35	0.31
2500--3000	535	24	178	22.29	3.00	0.40
3000--3500	860	20	168	43.00	5.11	0.78
3500--4000	500	15	115	33.33	4.34	0.60
4000--4500	720	12	101	60.00	7.12	1.09
4500---5000	700	8	60	87.50	11.66	1.59
5000---5500	500	6	55	83.33	9.09	1.51
5500---6000	1000	9	100	111.11	10.00	2.02
6000---6500	200	8	69	25.00	2.89	0.45
6500---7000	400	4	39	100.00	10.25	1.81
Above 7000	250	4	21	62.50	11.90	1.13
	8906	260	1927	34.25	4.62	12.75

From tables 5.24 and 5.25 we observed that there is a positive relationship between the income of the households and distance travelled by the households. People travels more kilometers when their income rises. This has evidenced in table 5.24 as households with income below Rs.500.00 travelled 101.08 km in average which is much less than the average distance travelled by households of higher income groups. similar is the case with percapita km travelled by each person of the different income groups. Energy consumption per person has increased with a rise in income. Table 5.25 also shows that as the income of the households increases, they used to travel more distance by scooter/ moter cycle for which more Petrol required. In the table we found that per capita Petrol consumption is only 0.23 litre in income groups of Rs.500.00-1000.00 which is much less than the Per capita petrol consumption in income group of Rs. above 7000.00.

TABLE 5.26

MONTHLY ENERGY USED FOR TRANSPORTATION ON BYCYCLE IN DIFFERENT INCOME GROUPS.

Income group (Rs)	km-travelled	No. of households	population	km-travelled per Household	km-travelled percapita
Below---500	1346	34	251	39.58	5.36
500----1000	1108	31	182	35.74	6.08
1000---1500	829	32	224	25.90	3.70
1500---2000	452	30	194	15.06	2.32
2000---2500	656	23	170	28.52	3.85
2500---3000	613	24	178	25.54	3.44
3000---3500	759	20	168	37.95	4.51
3500---4000	179	15	115	11.93	1.55
4000--4500	380	12	101	31.66	3.76
4500---5000	47	8	60	5.87	0.78
5000---5500	90	6	55	15.00	1.63
5500---6000	173	9	100	19.22	1.73
6000---6500	170	8	69	21.25	2.46
6500---7000	120	4	39	30.00	4.13
Above 7000	0	4	21	0	0
	6922	260	1927	26.62	3.59

TABLE 5.27

MONTHLY ENERGY USED FOR TRANSPORTATION BY WALKING

IN DIFFERENT INCOME GROUPS.

Income group (Rs)	km-travelled	No. of households	popula-tion	km-travelled per-Hosehold	km-travelled percapita
Below---500	992	34	251	29.17	3.45
500----1000	442	31	182	14.25	2.42
1000---1500	314	32	224	9.81	1.40
1500---2000	228	30	194	7.60	1.17
2000---2500	127	23	170	5.52	0.74
2500---3000	235	24	178	9.79	1.32
3000---3500	168	20	168	8.40	1.00
3500---4000	117	15	115	7.80	1.01
4000---4500	110	12	101	9.16	1.08
4500---5000	58	8	60	7.25	0.96
5000---5500	50	6	55	8.33	0.90
5500---6000	62	9	100	6.88	0.62
6000---6500	40	8	69	5.00	0.57
6500---7000	35	4	39	8.75	0.89
Above 7000	20	4	21	5.00	0.95
	2998	260	19.27	11.53	1.9

The tables show that km travelled per household by Bus/car and by scooter/motor cycle has increased in the families of higher income group while in case of bycycle distance travelled by average households has decreased. This means that as the households income rises, they prefer to shift from bycycle to automobiles like scooter, motorcycle etc. Similar trend is observed in case of km. travelled per household on foot. In villages most of the people travells on foot. About 90 percent of the adults travel for going to markets and the children going to school.

CHAPTER VI

ECONOMETRIC ANALYSIS OF DATA.

6.1. INTRODUCTION :

In this chapter we shall discuss about the Collection of data and their empirical analysis. The study makes use of both Primary and secondary data in order to make a comparative study between the past and present trend in energy consumption. Sampling frame and methodology used for collection of data also explained here. A brief description of demand function and also the nature of consumers behaviour is given in the chapter. Models adopted for empirical analysis for different types of fuel from survey data have been presented and explained in the chapter.

6.2. DATA BASE:

The study is based on primary as well as secondary data. In collecting primary data we could not cover all the districts of Assam as the geographical area of the state is quite large. All possible efforts were made to get as many informations on the power sector of Assam regarding production, distribution and consumption from various sources. Data in regard to energy consumption could not found available as the sample households do not keep records of their consumption. Moreover, correct informations about the income of the housholds and size of families in which we are primarily interested were not found at the time of survey.

The present work mainly deals with the power consumption in Assam and hence requires data in this regard from various sectors specially from the domestic sector. But in most of the cases we lack adequate information because of the gross inadequacy of the research and development activities which have retard the growth and functioning of power supply industry in the state.

Although published data are availble but often they are either old or discontinuous . Therefore it is thought to be appropriate to collect primary data for analysing the demand for electricity with special reference to influencing factors such as income, price, population, educational status etc. This will serve the need for studying both the consumption schedule as well as trend in consumption.

PRIMARY SOURCES OF DATA :-

In our study we have considered the following types of fuel while collecting data from the field.

1) Electricity.

2) Coke and Coal.

3) Kerosene.

4) Liquidified Petroleum Gas (L.P.G).

5) Fire wood.

6) Cow-dung.

Of these six types of fuel mentioned above, electricity has been treated as the Principal unit because the study concentrates more on demand for electricity in domestic sector. However we feel that not all the households are capable of giving exact amount of expenditure involved. This is so when the number of income earners in a family are more than one.

Also woods as fuel, people with reasonable income buy in bulk which lasts for months. Only those people specially the lower-middle income group and the poor they buy in small quantity. Their accounts for expenditure on fuel could not be considered so reliable, specially of the upper income group with in the lower middle class.

From our survey work, i.e. the households visited, none of them reported the use of coal or cow-dung as fuel. It may be so that firewood is essentially available and kerosene and L.P.G. are not so scarce commodities in the urban areas. Therefore, people prefer to use other types of fuel other than Cow-dung and coal. In urban set up, People generally do not have more cattle for which the use of dung cake was not found in time of data collection.

In our survey, it has been found that the households used electricity in urban areas in multiple ways. Demand for electricity is influenced by the income of the household and size of the families. Moreover, facilities for getting electricity connection and supply condition also deter mine the amounts of energy demanded. Use of electric gad-gets and changing lifestyle with modernisation leads to more demand for elcetricity in the urban set up.

METHODOLOGY AND SAMPLING DESIGN:"-

In collecting primary data, personal in vestigation was carried out on the spot. For this purpose we have used a comprehensive household schedule containing 14 questions relating to socio-economic conditions of the households and energy consuption pattern. Since this is an one man job and the study covers a vast geographical area, it is formidable task to collect data from each of the 23 distrcts of Assam. Therefore, we have decided to collect data from eight districts namely Dhuburi, Goalpara, Barpeta, Nalbari, Kamrup, Darang, Sonitpur and Nagaon. We have adopted stratified simple random sampling technique. At first we selected 25 percent of the total Municipal words from each district headquarter town at random and each word so selected was treated as a stratum. For each of the words the number of the households with house numbers were made available to us by the town Municipality. We have used this list of households as a primary sampaling frame.

Due to the financial and time constraints we have decided to take 6 percent of the household units into the sample. The sampling fraction is .06. so the sampling interval between any two chosen sample units i.e. households is 16 and the total number of representatives households from the lists of 40 Minicipal wards of eight district headquarter towns is 200. Actualy while we were collecting data we had resorted to systematic sampling. According to the procedure of systematic sampling, to select the random number between 1 and 16 is if first unit happens to be 8 then the successive households to be taken into sample will be 24,40, etc.

We have selected 10 villages from two districts namely, Goalpara and Kamrup district. From each district fives blocks were selected and we took one village from each block in consultation with the Block Development officer who is well informed about the villages in the block. Thus we have selected 10 blocks from two districts and took 10 villages. The villages with 75 or more households we have taken 5 percent of the households into sample and villages with less than 75 households we took 6 percent into the sample. In this way we have taken 60 representative households from the list of 10 villages. Thus, we took representative households totalling 260 both from urban and rural areas in our survey work.

The survey was conducted during the month of summer, 1992. Any estimate of Consumption should therefore be taken to reflect the pattern of power consumption during summer only. In summer season, Consumption of electricity is probably more on account of increasing use of fans, airconditioners, refrigerators etc. while the consumption of other fuels such as gas, kerosene, coal and firewood decreases as compared to winter season.

SECONDARY SOURCES OF DATA:-

Since the study covered a vast geographical area of Assam, and also time and resource constraint, hence we could not collect necessary information through correspondence and Contacts. We have to face with the problems like dis inergration and inadequacy of data. Unreliable data leads to wrong inferences which needs to sort out. We have been dealing with potential source of energy production for which both conventional and nonconventional energy have been taken into account. Data for conventional energy were found available on a regular basis. But data on the demand side of petroleum, no proper records on consumption has been found over the years. On the production side of petroleum. there is a gap between the target and the actual production. Reasons for the gap may be due to some technical problems and political upheavals in the oil producing area of the state. In order to get necessary information, we have visited some oil producing stations and requested the official to help us generously by supply concerning data required for. Stations visited are-Noonmati Oil Refinery, Guwahati, Bongaigaon and Petrochemical ltd. Bongaigaon, Digboi oil Refinery, Digboi in upper Assam. Moreover, we have approached the planning commssion, Government of India, New Delhi, department of Planning & Development, Department of power, Govt. of Assam, Dispur, and Oil and Natural Gas Commission, Nazira, Assam.

Data with regards to production of electricity from hydel resource it is yet a matter dream, because mass of water flows through neighbouring states like Arunachal Pradesh and Meghalaya. There is boundery disputs between the Government of Assam and the Governments of states sharing the boudary of Assam for which Commissioning of hydel projects delayed. Although the Brahmaputra basin has the largest hydel power potential, yet the chance of its exploitation seems to be less possible in the near future. Hence, we could not produce mass data in regard to the production of electricity from hydel sources. Only we have mentioned the potentiality that could be harnessed with much developed technological effort.

Production of electricity from the nuclear stations which is the cheapest form of electricity could not achive the target set for due to non-availabilty of indigeneous reactors, dearth of hard water, import of uranium etc. Only a limited nuclear stations are operating in our country to produce electricity. For Assam it can not be imagine even to have such station at this present state of affairs.

Regarding other sources of electricity, production from coal has immense potentiality because India has large deposits of coal specially in Gondowana area in West Bengal and Bihar. In the North- Eastern Region, Assam also takes place in the map of coal production. But due to pullusion and health- hazard the environmentalist do not prefer production of electricity from thermal stations using Coal. In Assam only one power station namely. Bangaigaon thermal power station, salakathi (BTPS) has been producing electricity using coal. Other thermal stations namely Chandrapur Thermal Power Station, Guwahati is Producing electricity from oil and Namrup Thermal Power Station is producing electricity from natural gas. For coal, we have collected data from the publications of the planning commission, Government of India, Coal India Ltd. Margherita. Department of planning & Development. Government of Assam.

While Collecting secondary data on electricity we have relied mostly on the publications of Central Electricity Authority, Tata Energy Research Institute, Central Electricity-Generating Board, Ministry of Energy and Environment, New Delhi, North-Eastern Electric Power Corporation (NEEPCO), North Eastern Electricity Board and North Eastern Council at Shillong. Data concerning with electricity production, generation and distribution in Assam, we have approached the Assam state Electricity Board, Head office at Guwahati. In comply with our request the officials supplyed necessary information regarding category wise consumption of electricity installed capacity in different stations and units generated by the power plants over the past few years. Some necessary data have been collected from the publications of the directorate of Economics & Statistics, Government of Assam, Guwahati.

Some required data were collected from the Book Depot.Government of Assam, National sample survey (NSS), office Guwahati, Assam Science technology and Environment council, Directorate of Panchayat and Rural Development, Assam and Institute of Advanced Study in Sceince & Technology, Guwahati.

Some other published data were collected from books, Megazines, Journals, papers etc. in the Libraries of Ratan Tata Library of Delhi University, Tata Energy Research Institute, New Delhi, Indian Council of Social Sceince Research (ICSSR), New Delhi and Shillong North Eastern Hill University, Shillong and Gauhati University,Jalukbari, Assam, Other publications are-Economic survey, Govt of India(various issus), Economic survey of Assam (various issues), Statistical Hand book of Assam (various issues), Statistical Abstract Assam , Draft seventh five year plane 1985-90 and Annual plan 1985-86 (volume-I), Draft Annual plan 1986-87 (volume-III), Draft Annual plan 1987-88 (volume III) of Government of Assam, Dispur.

6.3 DATA ARRANGEMENT:

SURVEY DATA:-

We have tabulated survey data accordng to the average size and average monthly income of the sample households and total number of households fallen in each income group. Soci-economic charactistics of demographic data showing literacy of Population, Occupational status of the households and number of households in each occupation are given in the table while arranging primary data. Access to amenities of sample households in shown in the table. We have arranged data regarding total number of households and their family sizes in different income groups ranging from above zero rupee as minimum and above Rs.7000.00 as maximum with 500 as class interval. Number of families used different types of cooking stoves in different income groups and percentage of families using different cooking stoves have shown in the tables. Number of bulbs used by households in different family sizes and distribution of electic goods with number of families in different income groups have been arranged in tables.

Categoriwise consumption of electricity per month ranging from above zero rupee as minimum and above Rs. 200.00 as manimum with 20 as class interval and number of households with their family size are shown while arranging survey data. similarly, consumption of kerosene ,L.P.G and firewood for cooking and Korosene for lighting both in urban and rural households with their family sizes have been arranaged in different tables. Monthly combined electricity and kerosene consumption for lighting with family sizes are also shown in our data arrangement. Data regandinq combined fuel consumption per month and number of households fallen under each comsumption category with their family sizes have been arranged in the table.

In our survey we have collected data on energy used for human transport.Such data were categorised in accordance with distance travelled by the number of households in different in come grups using various types of vehicle such as private cars, scooters motorcycles ,and long distance covered by Buses and trains. Energy used for human transport per month and distance travelled by each household with per capita milage covered in different in come groups have been tabulated while arranging transportation data. Vehicle kilometre and passenger kilometre with energy consumption have also been shown in data arrangment. Distance travelled by bycle and by walking in rural areas and percapita milage covered by each family were tabulated in the arrengement of data.

As it is mentioned earlier, we have surveyed 260 households for collecting primary data. Of these, 200 households were selected from urban areas and 60 households from rural areas. In order to have a manageable set of data for analysis purpose it has felt necessary to categorise data into certain groups. We have used the following methods to modify the data according to the fillowing manner.

It is permissible to re-arrange only the exogeneous veriable and not the endogeneous variable. Therefore, we have re-arranged monthly income in this manner.

First we look at the minimum income and the maximum income so that minimum is succeded by the maximum. Suppose in our 260 observations there are 34 households with the minimum income of Rs200.00 and Rs500.00 as the miximum income. For the purpose of analysis, we have added all the income of the 34 households and took the average in order to get a single figure. So far indegeneous variables i.e., fuel expenditure is concerned, we have also different values for different households as given in the master table.

In order to get a single figure for these indegenous variable we have added all the fuel expenditures of the 34 families and took the average of it as the representation of fuel expenditure of a family with minimum income of Rs. 391.00. This Procedure has been adopted for other incomes and expenditures on fuel consumption. AMaster table containing monthly incomes of different households and expenditures on different types of fuel with family number per household both for urban and rural areas is given in the appendix.

SECONDARY DATA :

We have also tabulated Secondary data collected from various sources mentioned above in this chapter. Published data on energy consumption pattern in different sectors viz, Industry, Railway and Road transport,Domestic sector and Agriculture sector, sourcewise energy consumption, conventional and non-conventional, commercial and non-commercial and Per-capita energy consumption in India have been tabulated in chapter III of the study. At the begining of chapter IV we have arranged data in different tables concerning with socio-economic characteristics of Assam specially on educational status , Population and land use Pattern and livestock population of Assam. The chapter deals with the arrangement of data on energy production and consumption pattern in Assam. In this chapter secondary data on collierwise production of coal for past few years in Assam, production of Petroleum since 1918, production capacity in three oil refineries, production of natural gas since 1971 have been tabulated. We have arranged secondary data on power consumption and power production in this chapter. Yearwise total generation of electricity and installed capacity from 1975-76 to 1990-91 installed capacity of different power stations from 1980-81 to 1989-90, Gross generation, Auxiliary consumption and net generation of Power in different Power stations under ASEB from 1986-87 to 1989-90 have arranged in different tables.

Power purchased by the State from other systems from 1982-83 to 1990-91, Power purchased from different source by ASEB from 1987-88 to 1990-91, Power exported by ASEB to other systems during the period 1987-88 to 1991-92 are shown in different tables. Progress in rural electrification in Assam from 1985 to 1992, Per-capita electricity consumption by different states/union Territories of India in 1991-92, categoriwise consumption of Power in Assam over past few years development in Electricity Industry in India from 1970-71 to 1990-91, ASEB's own generation from 1958-59 to 19090-91, number of employees, consumers and revenue from sale of energy from 1959 to 1991, subsidy payable by the government to ASEB upto 1990-91, cost of generation and supply of electricity in different states of India, schedule of tariff and different categories of consumer in Assam, average tariff of some states in India and proposed tariff in Assam and hydro-power potential in different sub-basins of the Brahmaputra valley have been presented in different tables.

Published data with regard to power production of Bongaigaon Thermal Power Station (BPTS) for the period from December 1991 to May'92 is shown in a table in this chapter. In the table, Power production in different units (there are four Productive units), average hourly load, total Power Production by the units, cost of generation P/KWH Paise have been presented. Production of some important industries in

Assam like tea, plywood, match, sugar, fertilizer, refinery product and cement for the period from 1985 to 1989 have also been presented here. Concumption of power by different industries in Assam during April/May'1994 hasshown in a table while arranging secondary data.

6.4 NATURE OF CONSUMER BEHAVIOUR AND DEMAND FUNCTION.

Consumer behaviour is made up out of a veriety of decisions and choices. A Consumer's decision in respect of any commodity is based on three important factors. These are firstly habit formation which means a consumer whetehr or not consume a given commodity at all. Secondly, he must decide on the quality that he will buy. And thirdly the prices he affords to pay for the commodity, These three things taken together can be ascribed as an utility function of the individual consumer. Since price in this context is an operational variable one may think of it as one of the units of disposable income. Hence the earlier two factors are governed by income which is nothing but a multiple of prices.

The concept of utility which is based on consumers behaviour subject to income constraint is to yield maximum utility provided other things being equal or constant. Both in case of scarce or rationed commodity the same theory may not be applicable also if the rationed commodity is the most essential.

Consumer's utility can be measured by new name and call it the Marginal Rate of substitution between the two commodities. We may define the Marginal Rate substitution of X for Y as the quantity of Y which would just compensate the consumer for the lose of a marginal unit of X. If an individual is to be in equilibrium with respect to a system of market prices, it is directly evident that his marginal rate of substititition between any two goods must equal the ratio of their prices.

Consumer's demand changes with the effect of a change in prices, income being unchanged. If it is the case of two goods income is now to be taken as fixed and the prices of Y as fixed, but the price of x is variable. In such a case the price-consumption curve varies when the price of X variesand other things remain equal.

Demand function:-

The usual approach in demand analysis is to set out a relationship between quantity consumed and prices with disposable income as the relevent budget variable (H.Houthekker'70). The law of demandstatus that the amount of good demanded by a consumer increases with a fall in prices and diminishes with a rise in price. The law of proportionality is supposed to prevail.

The Law of Demand is based on the Law of Diminishing Marginal Utility which states that when a consumer buys more units of a commodity the marginal utility of that commodity continues to decline. Therefore a consumer will buy more units of that commodity only when its price falls. Thus demand will be more at a lower price and less at a higher price.

An individual consumer's demand refers to the quantities of a commodity demanded by him at various prices other things remaining equal. An individual demand curve shows the effects of a fall or rise in the price of a commodity on the consumers behaviour. These are income effect and substitution effect.

The market demand is the summation of the individual consumers demand for a homogeneous commodity. If we sum up different quantities of a commodity demanded by a number of individuals at various prices we have a market demand curve or it is the summation of all the individual demand curves.

The most obvious price of information of a demand function is an indication of the effect on the "dependent" variable of a change in the value of one of the other variables. In the case of a demand curve this involves measurment of the response to quantity demanded which can be explained to result from a given change in the price of the commodity. A shift in a demand curve is normally accounted for by a change in the value of some other variables which affect demand. For example, a rise in consumers income lead to an upward shift in the demand curve. This means at any given price consumers will demand more than before. It should be noted however that if price happens to rise sufficiently at the same time, consumer may end up buying less despite an upward shift in the demand curve. In such a case, the shift in demand curve is accompanied by an offsetting movement along the curve (J. Baumol).

Demand is a function of price, income, prices of related goods and testes. It is expressed as

$$D = f\ (P, Y, Pr, t)$$

When income prices of related goods and tastes are given, the demand function is expressed as

$$D = f(p)$$

To summarize, besides income demand is a function of many variables such as price, advertizing and decisions relating to competing and complementary products. The relationship which decribes this many variables intra connection is called the demand function.(Jinghan'84)

6.5 MODELS FOR EMPIRICAL ANALYSIS

We have in the previous sections discussed in details the economic principles based on consumer demand the utility theory. We could have obtained as per dictation of economic theory a demand function or a consumption function for any item as follow:

$$Q = f\ (y, p)$$

Where, Q is the commodity demanded, y is the income and p is the price of the commodity.

The Engel type of equation differs from the demand function already mentioned. Since we have already accepted that income is the most influencing variable in consumption of any item and we have never assumed here that all disposable income of the family are exhausted by spending where as in Engel type of function we have tried to substitute total expenditure as the disposable income of the family. Hence in the truest sense Engel function could be described as market share equation showing the proportion of expenditure on different commodities of consumption of the respective households

In order to compare the analysis given by empirical equations we have to be cautious in retaining a distintion between the demand function and the Engel function. We probably should not assume in come elasticity given by the demand function as similar to or as substitute of expenditure elasticity.

The equation that considered for empirical analysis of all fuels thus,

$$F = a_0 + a_1 y - a_2 p + a_3 N + u \qquad \text{------------} \quad (1)$$

Where,

F = Total expenditure on fuels per month.

Y = Median family income per month

P = Price of fuel

N = Average family size

U = Disturbance terms

The problem here is that we do not have a time series data where the price would have vary over the time periods. But at any point of time and space as the case with us price will remain constant. Therefore, the effect of price can not be studied with cross-section data. Hence we have taken income of the households and size of families as the regression for the demand for energy.

Since we are using Engel Type of Demand Function where our dependent variable is only the cost of electricity. Therefore the Price of electricity is inherent in the dependent variable itself. Therefore, the Price variable may be redundant.

The equation for empirical analysis of electricity is thus -

$$E = a_0 + a_1 Y + a_2 N + u \qquad \text{-------------------(2)}$$

Where

E = Expenditure on electricity per month.

Y = Median family income per month.

N = Average family size.

u = Disturbance terms.

Similarly we can define the other econometric equations for other types of fuel which are given below.

$$K = a_0 + a_1Y + a_2N + u \quad \text{----------------(3)}$$

$$G = a_0 + a_1Y + a_2N + u \quad \text{----------------(4)}$$

$$F.W. = a_0 + a_1Y + a_2N + u \quad \text{----------------(5)}$$

Where,

K, G and F.W. stand for expenditure on kerosene, Gas and Fire wood Per month respectively. In the equations we shall use symbols R and U to mean rural and urban areas with respect to their energy consumption.

6.6 EMPIRICAL ANALYSIS.

In this section we shall present empirical findings for each type of fuel demand function. We have two macro equations where the expenditures of all sample households on different types of fuel irrespective of their variability either in efficiency or in appearance have been combined. These equations are given below.

A. Macro Equations

(a) Empirical for Energy Consumption (Urban)

$$F_u = a_0 + a_1Y + a_2N$$

$$= 40.1483 + \underset{(2.112)}{.0109Y} + \underset{(2.883)}{19.0093N} \quad \text{---------------(1)}$$

$R^2 = .69$

$n_y = 0.19$

Where,

F_u = Total expenditure on fuels per month in urban areas

Y = Median family income per month

N = Average family size.

The figures within brackets are the respective t $= \frac{\hat{a}}{s.e}$ values, the co-efficient of determination R^2=.69 and the income elasticity n_y = 0.19.

In the equation it appears that parameter of income is not of considerable magnitude as one may expect keeping in mind that the fuel is very essential item for cooking, lighting as well as heating. It is also true that fuel is not necessarily comprising a very high proportion item of consumption compared to all other items specially in an urban setting where nearly 25 percent of the monthly income is spent on house rent.

One can also think of fuel for heating purpose is almost negligible in tropical climate as most people use fuel only for lighting and cooking which is difinitely an item involving considerable less expenditure as compared to other items. Therefore, we are not least surprise for the income parameter to be just. 0109 This estimate of the parameter of the income variable is highly significant. The equation, from the megnitude of co-efficient of determination has a good fit. The ratio of explained variance to total variance, R^2 = .69 in this equation has been considered as very high.

So far the constant the parameter a is of such a high magnitude we have to wonder how in an urban setting this automatic consumption could play such a great role although statistically speaking this parameter a is of less consequence. We have also found that the standard error of parameter Y is comparatively less than half of the estimate of the parameter itself. This makes parameter Y highly significant.

In the analysis of variance test of the regression equation, we found that the F-ratio = 13.438 with 2 and 14 degrees of freedom which is highly significant. This confirms the fact that the reggression equation explains the cost energy throughly by two independent variables median family income and the family size.

We also found that the income elasticity of fuel consumption is only 0.19 making theoretically speaking in elastic even though fuel is an essential item. Probably this could be explained off as we have mentioned in the earlier section that fuel is not a major item of expenditure. In general we conclude that this equation is statistically adequate in all respect.

(b) Empirical for Energy Consumption (Rural),

$$F_R = a_0 + a_1Y + a_2N \qquad \text{-------------(2)}$$

$$= 6.1887 + \underset{(7.517)}{.0541Y} + \underset{(1.522)}{7.0120\ N}$$

R^2 = .93

n_y = 0.60

Where,

F_R = Total expenditure on fuels per month in rural areas.

Y = Medium family income per month.

N = Average family size.

Figures in the parenthesis is the t values.

In this equation also the parameter of income has not come out with a considerable magnitude although it is a little higher than the previous equation. In rural areas consumption of energy does not involve more amount of income although energy is considered as an essential item. As compared to urban areas were people spend a minimum percent of their income on fuel consumption the people in rural areas spend more proportion of their total income. This means that if a person spends Rs 10.00 out of his total income Rs.100.00, he is parting with 10% percent of his total income for the consumption of energy only. Hence the income parameter in this equation is higher than the privious equation. The estimate of the parameter of income variable in this equation is .0541 which considered as highly significant. Co-efficient of determination R^2 = .93 has a good fit which makes the equation very highly significant.

Constant a has shown a good fit from the point of magnitude. Because in rural areas people generally do not keep up-to-date record of their spending on fuel consumption. What ever data supplied are purely on their supposition. So the probability of getting correct answers from the households is very low. Moreover people in rural areas do not spend more money on fuel consumption as they purchase many other consumer goods to meet their wants. Another point is that in case of fire wood, people generally collect either from their own fields or from nearby jungles without cost. So we are least surprised at constant a value which is shown only 6.1 in this equation.

The standard error of parameter y is comparatively less than half of the estimate of the parameter itself. This makes the income parameter highly significant. We have also found that the F- ratio 44.52 with 2 and 9 degrees of freedom in the analysis of variance test of the regression equation. This considerd as highly significant as it confirms the explanation of energy cost by two independent variables family income and family size.

The equation shows a high income elasticity on fuel consumption. In rural areas as the income of the family increases more money spends on energy consumption. Demand for energy rises due to change in life style. In order to maintain higher standard of living people generally consume more energy for their comport. Hence income elasticity appears as high as 60 in this equation. In summing up, we can say that the equation has a good fit from all aspects.

B. Micro Equations

We shall present and describe here some micro equations which worked out from our survey data on the Consumption of different types of fuel.

(a) Empirical for Electricity, Rural,

$$E_R = a_0 + a_1 y + a_2 N \qquad \text{-----------------------} \quad (3)$$

$$= 25.1585 + \underset{(4.464)}{.0086y} - \underset{(-1.907)}{2.3707N}$$

$$R^2 = .74$$

$$n_y = 0.73$$

Where,

E_R = Expenditure on electricity per month in rural areas

Y = Median family income per month.

N = Average family size.

The figurs with in the bracket are the respective $t = \frac{\hat{a}}{s.e}$ values, the co-efficient of determination $R^2 = .74$, and income elasticity of demand $n_y = 0.73$.

Regarding the sign of parameters we have one drawback of the situation. Since we know bigger is the size of the family higher is the expenduter on electricity because more family members means more rooms in the household as a result of which we expect that the family size will have a positive influence upon the consumption of electricity. Therefore, the negative sign implies that there is no such influcence. We might possibly put forward an explanation in this particular case. There are lots of cutbacks of electricity either for load shedding or in the stormy days. Also some people use electricity judiciously in order to avoid payment of large bill. May be for these reasons, family size is to be negative.

Another point we have classified the data which might relent the importance of family size due to grouping. Take for example, we have surveyed sixty families in rural areas which were grouped into ten class intervals as a result we expect some changes in the analysis. Looking into other variable income, we have found that it has a positive effect upon energy consumption. Since electricity is one of the three principal energies and as such electricity is used only for lighting purpose. Therefore, it is understandable that in the total consumption of energy, electricity plays a minor role. The estimate of the parameter of the income variable is very highly significant. Therefore, as such our result is almost expected this way. Also the co-efficient of determination R^2 = .74 which is very high and makes the equation significant.

Further, we have done analysis of variance test of the regression equation. We find that the F = 9.975 with 2 and 9 degrees of fredom which is highly significant. This confirms the fact that the regression equation explain the cost of energy in electricity thoroughly by two independent variables median family income and the family size.

The equation shows a higher magnitude in respect of income elasticity of demand n_y = .73. This indicates that consumption of electricity varies with the variation of income of the household. As the income of the families increases, move bulbs are used for domestic lighting and electricity also used for other purposes like heating and cooking.

(b) Empirical for electricaly, Urban,

$$E_u = a_0 + a_1y + a_2N \qquad \text{--------------(4)}$$

$$= 23.7532 + \underset{(7.340)}{.0079Y} + \underset{(.501)}{.6837N}$$

$$R^2 = .87$$

$$n_y = 0.52$$

From the equation it appears that the parameter of income has a positive sign but not in higher magnitude as one may expect. Because in urban set up the households spend a small fraction of their total income on electricity consumption for lighting. However electricity would have been used for various pourposes if households possess more electric gad-gets. But in our survey hardly any family used electricity for purpose other than lighting. The t value given within brasket below the parameter of income shows that the estimate is significant.

Regarding the parameter of popution, the equation has a good fit as we expected positive sign for the estimate of parameter. Households consume more electricity when their family members increase. This tenable hypothesis is supported by the equation. On the other hand, t value within bracket for population does not give a significant estimate of the parameter. The equation has the best fit as indicated by its $R^2 = .87$ which is reasonably very large. Income elasticity in this equation has a good sign. This indicates that households use more electricity when their income increases. This is evidenced from $n_y = .52$ which is considered economically elastic. From this we can infer that income as well as population are the important influencing variables in estimating demand for electricity.

(c) Empirical for electricaly, (Urban + Rural):

$$E = a_0 + a_1 Y + a_2 N \qquad \text{------------------(5)}$$

$$= \underset{(8.653)}{12.6372} + \underset{(.599)}{.0094Y} + .9834N$$

$R^2 = .89$

$n_y = 0.65$

Equation (5) yields satisfactory results of the estimates of parameters of both income and population as compared to equation (4). Here income of the households influenced the consumption of electricity not as much as we expected. Because althogh electricity is treated as an essential item for lighting yet people spend a small proportion of their total income on electricity consumption. The t value given below within bracket shows that the estimate of income parameter is highly significant. From this we can infer that income of the household is the influencial variable in estimating demand for consumption of electricity.

The parameter of population has also positive sign as we expected for estimating demand for electricity consumption. People buy more electricity for lighting as well as for other purposes such as cooking heating etc. When their family member increases. Population parameter in this equation has confirmed this supposition. The equation has the best fit from the value R^2 =.89 which is considered to be large and make the equation highly significant. But the t value for the population parameter estimate in equation (5) is not found significant. The consumption of electricity is found elastic in this equation. This means that the families have a tendency to consume more electricity when their income increases. From the parameters of income and population we may conclude that the equation is statistically significant.

(d) Empirical for Kerosine for lighting (Rural):

$$K_R = a_0 + a_1Y + a_2N \qquad \text{--------------(6)}$$

$$= \underset{}{1.2795} + \underset{(.646)}{.0018Y} + \underset{(.965)}{1.7367N}$$

R^2 = .27

n_Y = 0.17

Here parameter of income has no influnce on the consumption of kerosene for lighting. As we know people in rural areas can not spend more money for the consumption of kerosene because their income is limited and need to purchase other essential commodities. Moreover, use of kerosene is also limited. They burn kerosene for lighting for short time at the evening. That is why they need a little quantity and spend a small proportion of their income on the consumption of kerosene. Hence, income parameter is in lower magnitude. From the t value it appears that the estimates of parameter is not reliable and hence the equation makes insignificant. From the R^2 = .27, the equation can not be accepted as best fit which makes the equation totally insignificant.

However, regarding Parameter of population, we can say that the number of family members has influence on the consumption of kerosene. Households with more members need more kerosene for lighting as they require more rooms for their family members. So population parameter in the equation has a little higher magnitude than the income parameter. The other condition is the reliability of the estimates of parameter. From the t value, given with in bracket below the parameter estimate shows that the estimate of population is significant. From this we can say that population is an influencial variable in estimating the demand for consumption of kerosene.

Regarding income elasticity the equation yields poor result. This indicates that people do not buy more kerosene when their income increases. As a result income has little influence on the consumption of kerosene in rural areas.

(e) Empirical for kerosene for lighting (urban) :

$$Ku = a_0 + a_1 y + a_2 N \qquad \text{---------------(7)}$$

$$= 5.3016 + -2.1955E - 04Y + .6904 N$$
$$\quad\quad (-.651) \quad\quad\quad\quad (1.604)$$

$$R^2 = .18$$

Income parameter in this equation shows negative sign as one may expect. Because, families in urban set up do not buy more kerosene when their income increase. In stead of using more kerosene for lighting they prefer to use more electricity with a rise in income. From the t-valuue also the estimate of parameter shows that the income parameter is quite insignificant. The equation is not a good fit as indicated by R^2 =.18 which makes it statistically unreliable. Therefore it can be inferred that the income of the households do not have any influence on the consumption of kerosene for lighting in urban set up.

The equation shows a positive sign regarding the value of population parameter. From the magnitude, it yields a satisfactory result. Families in urban areas use kerosene at the time of interval when electricity supply cut off due to load shedding or for other reasons. Kerosene is also used by a family who has no electricity connection. In both cases size of families determine the quantity of kerosene to be purchased for lighting. A large family requires more kerosene and hence purchased more quantity as compared to a small family. The other most important condition is the reliability of the estimates of the parameter. From t-value given with in bracket shows that the estimate of population parameter is significant. Hance, population can be treated as the only influential independent variable in estimating the demand for consumption of kerosene in urban areas.

The equation does not show income elasticity in reqared to the consumption of kerosene. In urban areas, the households buy kerosene in quantity what they exactly needed. Hence variation of income plays insignificant role in its purchase.

(f) Empirical for, fire wood (Rural):

$$F.W_R = ao + a_1y + a_2N \quad \text{------------------------(8)}$$

$$=52.4210 + \underset{(6.963)}{.0402y} + \underset{(3.143)}{11.6586N}$$

R^2 =.94

n_y =0.62

We expected that the consumption of firewood is linearly related to the income and the size of family. Statistical evidence of income parameter clearly shows that as the income of households in creases, they spend more money on firewood consumption. This means that people buy more fuelwood and collect less from nearby jungles at free cost when their income increases. The t-value given with in bracket indicates that the equation is highly significant. From the value of the co-efficient of determination R^2 = .94 We can say definitely that the empirical equation is a best fit, explaining 94 p.c. of the total variance by the estimated values of the dependent variable i.c. firewood consumption.

The population parameter has supported our asumption that the demand for fire wood consumption increases with an increase in population. A big family requires more quantity of fuel wood than a small family. In our survey we did not find households in rural ares using of kerosene or gas for cooking other than fire wood. Exceptionally a very few families use kerosene or gas. From the magnitude, the equation yields a satisfactory result the sign of parameter as ought to be. The t-value given within bracket gives a good result which makes the equation significant. From this it can be inferred that number of population has a positive influence upon the demand for firewood consumtpion in rural households.

As we have seen in the equation income elasticity of fire wood consumption is positive. Households income determines the consumption of fire wood. With the variation of income, the demand also varies. From the magnitude, we may Conclude that the demand for firewood in rural households is elastic.

(g) Empirical for, Fire wood (Urban) :

$$F.W_u = a_0 + a_1 y + a_2 N \qquad \text{---------------(9)}$$

$$= 30.1272 + -.0082\, Y + 11.8997\, N$$
$$\qquad (-2.120) \qquad (2.412)$$

$$R^2 = .36$$

$$n_y = .37$$

The statistical evidence of very low influence of income on fuelwood consumption is clearly substantiated by the negative sign of the estimate of income parameter. The non-significant t value with in bracket indicates high standard error of the parameter.We are least surprised about negative sign of income parameter as we know that families in urban areas use less firewood when their income increase. Instead, they prefer to substitude fire wood for kerosene and L.P.G. So income can not be accepted as an influential variable in estimating demand for firewood in urban house holds. However in rural areas the situation is completely reverse and people buy more fire wood when their income increases.

Population parameter has shown higher magnitude from statistical point of view. This confirms the view that as the family members increase the household use more quantity of fule wood for Cooking. The t-value of the parameter indicates that it is significant. From the value of co-efficient of determination $R^2 = .36$ we can say that the equation is not a good fit. From above it can be inferred that income of the households has no influence on the demand for firewood while number of population in a family can be considered as the only influencial variable in estimating demand for firewood consumption in urban areas.

From the magnitude the equation of firewood consumption is less elastic. Households in urban areas do not buy more firewood with the increase of their income. Variation in income has not influence on the consumption of firewood as households prefer to use other form of energy in urban areas.

(h) **Empirical for kerosene for Cooking (urban)**

$$K_u = a_0 + a_1Y + a_2N \quad \text{---------------(10)}$$

$$= -\ 7.4151 + .0016Y + 2.7927\ N$$
$$\qquad (2.397) \quad (3.201)$$

$$R^2 = .74$$

$$n_y = 0.32$$

It assumes that the variables which are influencing kerosene consumption are income of the households and number of family members. Looking at the equation it is inferred that income has positive influence on the Consumption of kerosene for Cooking in urban households. The income parameter from the magnitude does not yield satisfactory result as we expected. Because households in urban set up though use kerosene for cooking also prefer to use other efficient fuel like gas. Some families use kerosene as alternative fuel when there is no gas or fire wood. Morever, small families require a small quantity for which low proportions of their income spend on kerosene consumtion.The use of kerosene is not regular and it is not as essential as firewood and electricity.

The population parameter as shown in the equation indicates that it has positive effect on the consumption of kerosene. Generally big families buy more kerosene for cooking as compared to small families. The empirical equation supported this obvious hypothesis by its magnitude. The equation gives reliable estimates of parameters evidenced by the highly significant t values of the estimates given with in brackets of each parameter. The Co-efficient of determination R^2 = .74 for the equation above shows that the equation has the "best fit". From above we can infer that both income and size of families are the influencial variables in estimating demand for kerosene consumption in urban areas.

Another point is the income elasticity of demand for kerosene Consumption.Statistically the equatiotn shows in elastic demand. As kerosene is not essential as fire wood, so people buy small quantity irrespective of their income level.

(i) Empirical for Liquid Petroleum Gas (urban)

$$G_u = a_0 + a_1y + a_2N \quad \text{-----------------(11)}$$

$$= -12.2292 + \underset{(6.226)}{.0100y} + \underset{(1.447)}{2.9514\ N}$$

$$R^2 = .85$$

$$n_y = 0.80$$

As it is mentioned earlier, no other form of energy is popular in a backward agrarian society except firewood for cooking in rural areas. However, in urban areas, a few well to do families use L.P.G. for cooking purpose. We expected positive sign for the parameter income and family size while estimating the demand for L.P.G. consumption. From the magnitude the empirical equation equation yields very satisfactory results. People in urban areas with means collect L.P.G. from supply agency. Demand for L.P.G. increases with an increase in income of the households. This tenable hypothesis is supported by statistical evidence of high income parameter in the equation. The other most important condition is the reliability of the estimates of the parameters. From the t-values given with in bracket shows that the income parameter is highly significant. The estimates of the population parameter in the equation is also with correct sign although this estimate is not significant at 95 p.c. level of probability. Neverthless, the estimate is at 10 p.c. levl of significant. From the value of the co-efficient of determination R^2 = .85 we can say definitely that the empirical equation is a "best fit"

The other regressor population has influence on the demand for L.P.G. consumption. The empirical equation yields good result regarding population parameter. The t-value for the population parameter estimate is significant. This indicates that a family demands more than one cylinder when family members increase. Looking at the equation it can be inferred that the demand for L.P.G. is elastic. People use more L.P.G. when their income increases and less when income decreases. From this we can conclude that income as well as size of family are the important influencial variables in estimating the demand for Consumption of L.P.G. in urban set up.

6.7 POSSIBILITY OF SUBSTITUTION:

Another aspect of the problem that energy economists often like to study is substiution of one fuel by another. As per economic theory the reason for substitution of one fuel by another is due to differences in price Substitution takes place if there is competition among prices of different types of fuel. But as the case with us, hardly there is any chance of substitution among fuels because electricity, kerosene and L.P.G. are rationed items and prices of these scarce items are fixed by the government. In case of electricity price, the Assam State Electricity Board, (ASEB), Guwahati, is authorised by the State government to determine the price of electricity per kwh. Similarly price of kerosene is fixed by the government. If there is any variation of price then this can entirely attributed to bad strategy adopted by the marketing sector.The price of L.P.G. per cylinder is also fixed by the union government which is marketed by the Indian Oil Corporation (IOC), a public sector enterprise. In case of fire wood, there is no organised pricing system. It varies from place to place. In rural areas people Collect firewood from nearby jungles and much of them are not sold commercially. In urban areas, however, these are bought and sold commercially at various prices.

The pure reason for substitution of one fuel by another is not so much due to the differential price but for the efficiency of one fuel is superior to another.The other reason may be availability. The people who could afford to change over from fire wood to Liquid Petroleum Gas (L.P.G.) for Cooking have bezare experience in getting continuous supply. Although, there is enough production of L.P.G. but due to scarcity of gas cylinder, the users of gas have often keep stock of kerosene or fire wood. Non-availability of kerosene at a cheaper rate forced people to use fire wood for Cooking. The price of time waiting with anxiety in the long queue in a kerosene Depot costs more than the 5 litre of kerosene sold to a family at any point of time. Also electricity is not a substitute of firewood due to the differences in price. Only a few well to do families can think of usiunug electricity for Cooking (Bez'90). Therefore, technically speaking there is hardly any case for substitution.

6.7.1 Bez Reaction Function

This is a model based on the theory of probability because most of the events that are happened are due to some reactions between two or more objects. For example, in our case if we consider income as one of the agents and price as one of the objects then a series of prices will be not only reaching to one set of income by the entire set of income and the resultant will be the consumption of that particular item. Now here we have in our data for respective income group that is the vector of income relates to other vectors of consumption like electricity, kerosene, gas and firewood etc. which is again classified according to number of households in each category of fuels. The descriptive accounts of this Model can be found elsewhere (Bez'90). He wrote down the final form of the Model -

$$P\ (x^{(m)}/X^{1} = \frac{f(m)\ (Y_t Z_j)}{f(m)\ (Y_i Z_j) + f\ (q)(Y_i Z_j)} \qquad \ldots\ldots\ldots\ldots(1)$$

Which after summation

$$P\ (x^{(m)}/X^{1}) = \frac{f(m)\ (Y_i\ Z_j)}{f(m) + (q)(Y_i Z_j)} \qquad \ldots\ldots\ldots\ldots(2)$$

Where x relates to any type of fuel n and X relates to the entire family of fuels. Now Y and Z they will be Called agent and object respectively which may be income, price, family size or any other socio-demographic variable. This finally for estimating in demand for or consumption of any type of fuel and estimating equation is evolved. The estimating equation will be

$$Z_j t = C + dx_i t + ut \qquad \ldots\ldots\ldots\ldots(3)$$

$$\text{Log } Z_j t = \log c + d \log z_j t + ut \ \ldots\ldots\ldots\ldots(4)$$

In our case we have arranged the data in the following formate -

The Column vector relates to income groups and Raw vector relates to number of households which is again sub-divided in to electricity, kerosene, L.P.G. and fire wood. In this particular analysis we have persued is the not the consumption of types of fuel in the sense but the number of families with respect to the particular group of income and the type of fuel. Actually we wanted to see how the consumption behaviour of the different types of family with respect to different types of fuel. For this purpose we have calculated the expected number of households for each income group and for each type of fuel. Then we take the log value of them.

The last column which gives the total number of each raw of log value. We are using it at abscissa and respective column of each category of fuel as ordinates. Then we plotted the graphs.

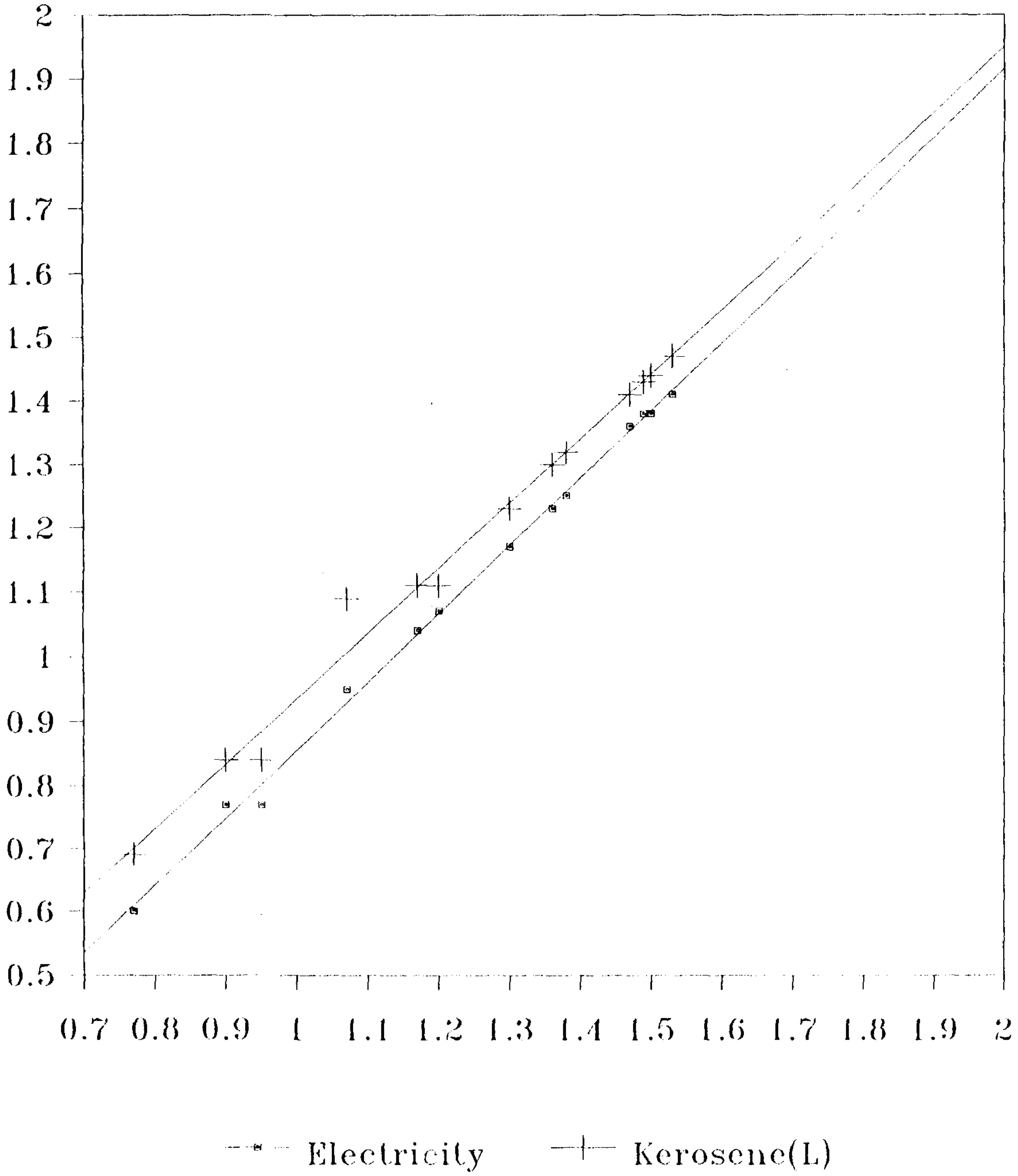
The interpretation of the results is like this. If the income is a dominating factor in choosing a particular type of fuel then each graph will have an unit value or θ. If it is higher than one then the income plays more role than expected and if this value is less than one we may say that there may be some other factors other than income which may be influencial for choosing a particular type of fuel. So we have calculated in tangent value in the following graphs for each type of fuel.

TABLE 6.1

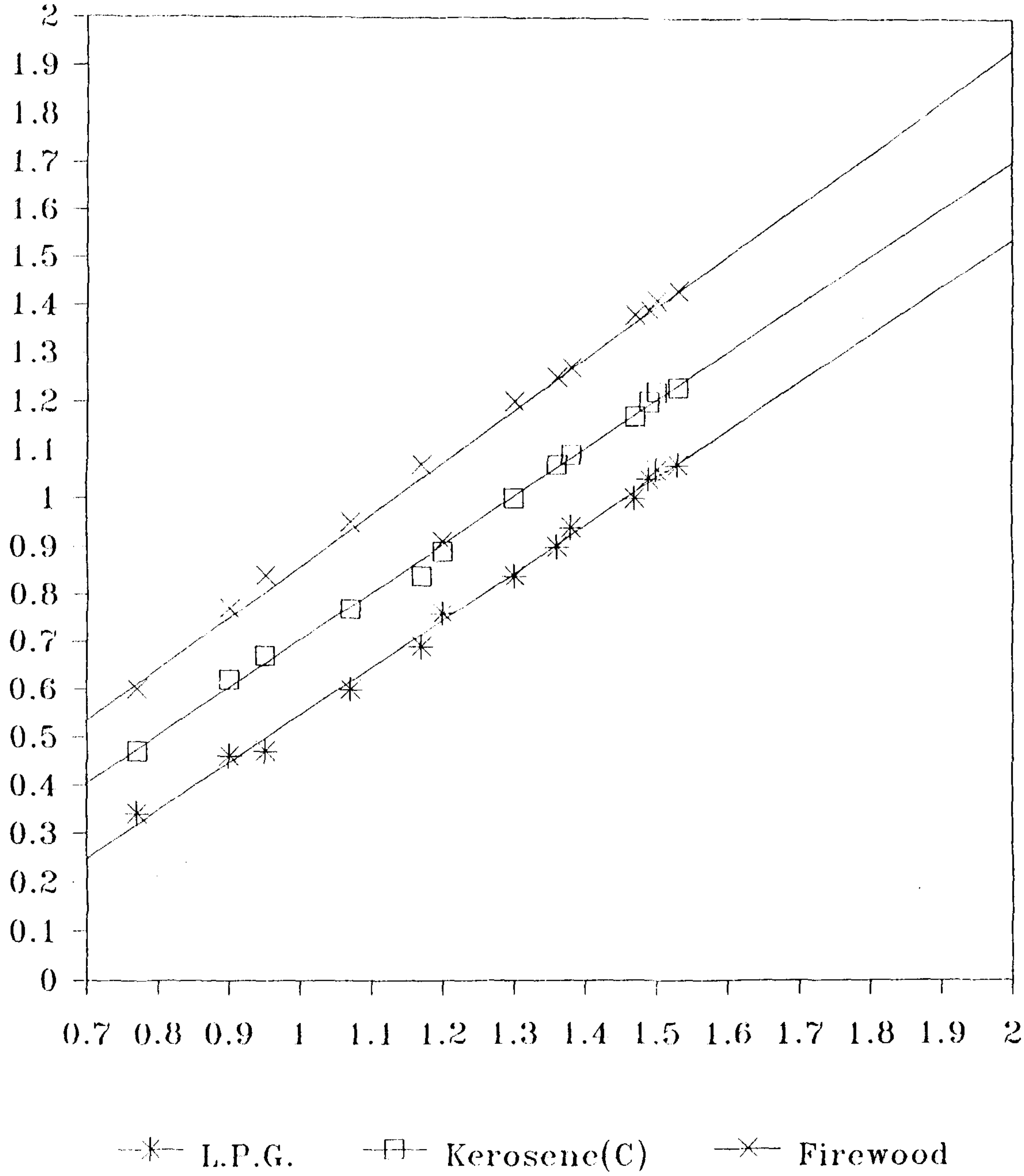
NUMBER OF HOUSEHOLDS WITH DIFFERENT TYPES OF FUEL IN DIFFERENT INCOME GROUPS.

Income group (Rs.)	No. of households used										Total No. of households	
	Electricity		Kerosene (L)		L.P.G.		Kerosene(c)		Fire wood		(Raw total)	Logs
Below 500	9	1.41	31	1.47	0	1.07	0	1.23	34	1.43	34	1.53
500 -1000	22	1.38	27	1.43	6	1.04	8	1.20	28	1.39	31	1.49
1000 -1500	23	1.38	29	1.44	4	1.06	14	1.22	27	1.41	32	1.50
1500 -2000	22	1.36	24	1.41	11	1.0	17	1.17	19	1.38	30	1.47
2000 -2500	21	1.23	18	1.30	8	0.90	13	1.07	18	1.25	23	1.36
2500 -3000	21	1.25	23	1.32	8	0.94	21	1.09	20	1.27	24	1.38
3000 -3500	19	1.17	18	1.23	11	0.84	12	1.0	18	1.20	20	1.30
3500 -4000	15	1.04	13	1.11	8	0.69	10	0.84	14	1.07	15	1.17
4000 -4500	12	0.95	12	1.09	9	0.60	8	0.77	10	0.95	12	1.07
4500 -5000	8	0.77	8	0.84	4	0.46	7	0.62	6	0.77	8	0.90
5000 -5500	6	0.60	5	0.69	4	0.34	4	0.47	4	0.60	6	0.77
5500 -6000	8	0.77	8	0.84	6	0.47	7	0.67	6	0.84	9	0.95
Above 6000	16	1.07	15	1.11	16	0.76	15	0.89	10	0.91	16	1.20
Total	202		231		95		136		214		260	

Note: L= Lighting,C= Cooking.



Graph of Table 6.1



Graph of Table 6.1

CHAPTER VII

CONCLUSION

Energy since 1973 has become crucial issue in international economics. The nation that produced the bulk of the world production of petroleum when resorted cartel as well as manifold increase in price per barrel of crude oil, the industrial nations felt threatened.

Although the depression has reduced considerably, but the right thinking people are worrying over depletion of nonrenewable sources of energy. Due to pressure of population in country like India more and more woodlands are cleared for agriculture and hence the firewoods are also becoming costlier. The much talked geothermal, wind and solar energy are yet to be commercially explorited.

This study is a micro-study relating to demand for electricity with special reference to urban areas may be considered as exploratory. The author has tried to the best of his ability and effort to focus the pattern consumption.

Due to the nature of cross-section data, energywise consumption is not reflected by variation of Price of different fuels. Our approach is more or less dogmatic in the sense that we make use of income as well as population of the households as the principal independent variables. The energy as a every essential item should have been income elastic but we could not find support to that end from empirical analysis. It may be so that every household in the sample uses firewood, kerosene and electricity. Another reason for less electricity consumption is that still nearly no household possesses electric kitchenwares, washing machines etc.

The influence of other independent variable population on energy consumption has found positive from empirical analysis. As is enpected households used more energy when the number of members of families increases. In case of electricity, housholds use more bulbs for lighting different rooms when family member increases. Similar is the case with other fuels also.

The substitution of one fuel by another is not possible due to nonexistence of price variation since there is no oligopolistic market for energy. As we have cross-section data which were collected during a specified period of time, varition of price dose not come here. Morcover, energy items are treated as rationed items prices of which are fixed by the government except in case of firewood. Substitution may also take place due to the sources of supply and efficiency of one fuel over another. But as the case with us hardly any family could find use of one fuel for another as substitute because there is no such competitive similar items available. However, we have found income as dominating factor in choosing a particular type of fuel in our graphs.

It is understandable that when income status increases the family tends to substitute firewood for LPG. Again for lighting purpose they would prefer electricity to kerosene. In the graphs each curve produces an angle of an unity or more than unity. In case of L.P.G. the tan θ is less than unity which means that there may be some other factors such as availability of cylinder in choosing gas as substitute over other types of fuel or the sources where they could be made available is not with in the reach of consumer.

Assam is rich in oil and natural gas reserves among other states in our country. Natural gas is found available in the oil fields in Upper Assam. But this precious natural gift is burnt down every day worth of several lakh of rupees. This could be tapped as a source of energy in producing electricity. There is immense potentiality for hydro-electric power in Assam. Due to financial constraint, these could not utilise for power production exept only 2 MW in Bardikharu Station. The Union Government should therefore, make earnest efforts to utilise this renewable resource of energy without further delay.

Though the country has a vast potential for other renewable sources of energy, their commercial exploitation at present is not up to the expectation. The much talked about solar and wind energy are yet to make commercial use in a big way. Although utilisation of solar energy through photovoltaics is being undertaken, but the higher capital cost at the initial stage will continue to be a major constraint. In Assam along the Brahamaputra bank, the wind speed on the average is about 6 to 10 Km per hour which is very low windspeed. But the technocrates of the wind energy suggest that still wind energy could be produced if the mast of the blades of the wind mill is on very high altitude. Therefore we can not have so much scope to produce wind energy except in a few places along the Brahmaputra velly.

Biogas could be accepted as an alternative source of energy in domestic sector. Biogas plants help in removing laborious work of women and children from collection and head-loading of fuelwoods, working in smoky kitchen, washing of blackened utensils and suffering from eye and lung diseases due to smoke. From the point of energy cost, biogas is less expensive as compared to other types of fuel.

Energy is so important that no country can achieve its overall development without proper and timely supply of it. With regard to power supply, the present system is that the Centre and the State Governments are responsible for supplying electricity in their respective States. Although power development programme are joint responsibility of both Centre the State Governments, but the State Governments have been given more responsibility for the expansion and development of power industry. This is done with consultation with the Planning Commission in respect of financing the projects. In order to reduce the gap between demand and supply as we have seen in our State, power generation needs to improve. The Centre should play a vital role in establishing major power producing projects and also on-going projects which are laying without completion for years together. Moreover, at the present state of affairs of power supply in the State, the Government may consider the operation of some power stations by private enterpreneurs to whom these may be leased out. Also from our study we found that ASEB is running a debt of Rs.50 crores which is payable to Meghalaya Electricity Board alone. There is certainly some financial irregularities with ASEB. Had there been competing electricity generating Boards certainly ASEB would like to be a violative State enterprise.

Finally, the author finds it a very interesting subject. He would, in future like to continue further research into the field of energy. For any lapse or omission due to the time limit set for completing the research are alone borne conscientiously by the author.

APPENDIX I

MASTER TABLE (URBAN)

EXPENDITURE ON DIFFERENT TYPES OF FUEL AND SIZE OF FAMILIES WITH INCOME PER MONTH.

Income (Rs.)	Lighting		Cooking			Total (Rs.)	Family Size
	E. (Rs.)	K. (Rs.)	F.W. (Rs.)	K. (Rs.)	L.P.G. (Rs.)		
1	2	3	4	5	6	7	8
200	50.00	-	20.00	-	-	70.00	3
400	-	16.00	54.00	-	-	70.00	5
450	-	16.00	55.00	-	-	71.00	7
500	40.00	4.00	20.00	-	-	64.00	3
500	50.00	-	54.00	-	-	104.00	9
500	32.00	-	38.00	-	-	70.00	6
500	25.00	4.50	80.00	-	-	109.50	4
600	100.00	-	-	12.50	56.30	168.80	3
600	-	13.00	80.00	-	-	93.00	5
700	-	10.60	80.00	-	-	90.60	5
800	-	8.80	80.00	-	-	88.80	2
800	25.00	2.60	80.00	13.00	-	120.60	5
800	35.00	12.50	36.00	-	-	83.50	6
800	35.00	12.50	120.00	-	-	167.50	6
825	55.00	-	-	-	67.50	122.50	2
900	40.00	6.20	30.00	-	-	76.20	5
900	42.00	6.20	160.00	-	-	208.20	5
1000	-	13.00	160.00	13.00	-	186.00	5
1000	25.00	5.00	120.00	5.00	-	160.00	9

Contd...

Contd...

1000	35.00	-	-	7.50	70.00	112.50	4
1000	100.00	-	-	38.00	56.80	194.80	4
1000	100.00	9.00	-	20.00	112.60	241.60	4
1000	125.00	8.00	18.00	4.00	57.00	212.00	7
1000	20.00	10.00	90.00	-	-	120.00	4
1,100	-	13.00	80.00	-	-	93.00	4
1,200	48.00	2.60	80.00	-	-	130.00	3
1200	13.60	-	140.00	30.00	-	183.60	4
1200	-	37.50	140.00	-	-	177.50	4
1200	40.00	5.00	160.00	-	-	205.00	9
1200	55.00	6.20	120.00	26.00	-	207.20	7
1200	20.00	2.60	40.00	13.00	-	75.60	2
1200	30.00	5.20	80.00	20.00	-	135.20	4
1200	-	18.00	160.00	-	-	178.00	6
1300	-	24.00	-	66.00	-	90.00	5
1400	-	30.00	200.00	-	-	230.00	7
1400	225.00	2,30	-	7.00	114.00	348.30	8
1400	52.00	-	-	-	57.00	109.00	8
1400	50.00	2.50	77.00	-	57.00	109.50	7
1400	-	30.00	40.00	60.00	-	130.00	5
1500	35.00	6.20	120.00	39.00	-	160.20	7
1500	75.00	-	-	5.00	114.00	194.00	10
1500	45.00	12.50	100.00	-	-	157.50	8
1500	-	37.50	120.00	37.50	-	195.00	7
1500	30.00	7.50	65.00	17.50	-	120.00	9

Contd...

Contd...

1500	-	30.00	240.00	-	-	270.00	9
1500	55.00	6.20	160.00	13.00	-	234.20	10
1500	36.00	6.00	160.00	-	-	202.00	10
1500	75.00	4.00	95.00	9.20	-	183.00	7
1500	120.00	25.00	120.00	50.00	-	315.00	14
1600	-	24.00	200	-	-	224.00	8
1600	-	1500	80.00	30.00	-	125.00	3
1600	-	13.00	160.00	13.00	-	186.00	7
1600	-	27.00	160.00	-	-	187.00	5
1600	-	24.00	200.00	-	-	224.00	7
1700	50.00	-	-	-	57.00	107.00	1
1800	24.00	9.00	80.00	30.00	-	143.00	7
1800	36.00	-	80.00	30.00	-	146.00	5
1800	16.00	-	-	-	56.00	72.00	6
1800	-	20.80	120.00	-	-	140.80	6
1800	-	15.00	120.00	-	-	135.00	5
1800	42.00	3.00	160.00	15.00	-	220.00	6
1800	35.00	5.20	80.00	26.00	-	143.20	5
1800	-	21.00	200.00	-	-	221.00	5
1800	16.25	18.00	280.00	-	-	314.25	8
2000	50.00	2.50	20.00	12.50	140.00	225.00	9
2000	104.00	6.20	40.00	6.20	67.30	223.70	3
2000	45.00	6.00	200.00	-	-	251.00	7
2000	42.00	6.00	40.00	15.00	67.00	170.00	8
2000	80.00	-	-	30.00	56.80	166.80	7

Contd...

Contd...

2000	100.00	2.50	-	12.50	56.30	171.30	7
2000	100.00	-	-	25.00	113.60	238.60	8
2000	25.00	12.00	-	16.00	57.00	110.00	5
2000	16.25	15.00	-	-	56.30	87.55	5
2000	10.25	-	60.00	37.00	-	107.20	9
2000	50.00	12.50	-	5.00	64.35	131.85	5
2000	30.00	6.00	240.00	15.00	-	291.00	9
2000	27.00	6.00	200.00	15.00	-	248.00	8
2200	50.00	5.00	65.00	37.50	-	157.00	5
2200	35.00	-	-	100.00	-	135.00	6
2200	45.00	6.00	160.00	-	-	211.00	8
2200	24.00	3.00	160.00	-	-	187.00	6
2200	-	30.00	160.00	30.00	-	220.00	9
2200	38.00	9.00	200.00	-	-	247.00	7
2400	30.00	9.00	200.00	-	-	239.00	7
2400	-	24.00	160.00	-	-	184.00	6
2400	-	30.00	160.00	-	-	230.00	7
2400	36.00	6.00	200.00	-	-	242.00	5
2500	36.00	6.00	40.00	15.00	67.00	166.00	7
2500	35.00	12.50	28.00	-	114.00	189.50	9
2500	300.00	-	-	12.50	113.60	426.10	25
2500	80.00	-	-	20.00	56.30	156.30	5
2500	45.00	-	8.00	25.00	75.00	153.00	6
2500	48.00	3.00	-	-	67.00	118.00	8
2500	38.00	9.00	200.00	30.00	-	277.00	9

Contd...

Contd...

2500	48.00	6.00	80.00	15.00	67.00	216.00	7
2500	65.00	12.00	77.00	240.00	60.00	377.00	7
2500	42.00	6.00	200	45.00	-	293.00	8
2800	40.00	9.00	160.00	45.00	-	254.00	7
2800	50.00	15.00	240.00	15.00	-	320.00	13
2800	42.00	6.00	-	15.00	82.00	145.00	3
2800	45.00	12.00	160.00	18.00	-	235.00	5
2800	42.00	6.00	80.00	15.00	67.00	210.00	10
2800	-	15.00	160.00	15.00	-	190.00	7
3000	60.00	6.00	80.00	30.00	67.00	243.00	12
3000	-	30.00	280.00	75.00	-	385.00	9
3000	16.25	24.00	350.00	12.50	-	402.75	11
3000	16.25	30.00	170.00	45.00	-	261.25	5
3000	45.00	12.00	80.00	30.00	-	167.00	6
3000	30.00	12.00	120.00	-	-	162.00	6
3000	60.00	12.00	320.00	75.00	-	447.00	14
3000	68.00	5.00	-	15.00	57.00	145.00	4
3000	90.00	2.50	-	7.50	85.20	184.70	3
3000	57.00	-	20.00	37.50	56.30	170.00	4
3000	40.00	90.00	-	30.00	-	143.00	8
3000	30.00	2.50	-	87.50	-	120.00	5
3000	50.00	5.00	160.00	37.00	-	252.50	5
3000	70.00	2.50	-	25.00	57.00	154.50	4
3000	50.00	15.00	40.00	36.00	82.00	223.00	7
3000	60.00	6.00	160.00	18.00	-	244.00	5

Contd...

Contd...

3000	40.00	9.00	160.00	-	-	209.00	6
3200	55.00	9.00	240.00	-	-	324.00	8
3200	50.00	6.00	40.00	15.00	82.00	193.00	6
3200	80.00	15.00	80.00	15.00	82.00	272.00	9
3200	50.00	12.00	160.00	-	-	222.00	7
3200	60.00	6.00	80.00	15.00	82.00	243.00	7
3400	55.00	12.00	200.00	30.00	-	297.00	8
3500	55.00	6.00	40.00	-	82.00	183.00	7
3500	46.00	6.00	160.00	36.00	-	248.00	7
3500	52.00	12.00	80.00	30.00	82.00	256.00	10
3500	100.00	30.00	240.00	60.00	82.00	512.00	12
3500	75.00	15.00	80.00	15.00	82.00	267.00	7
3500	50.00	9.00	40.00	15.00	82.00	196.00	6
3500	35.00	12.50	20.00	-	140.00	207.50	6
3500	85.00	-	-	-	114.00	199.00	6
3500	55.00	6.00	-	36.00	83.00	180.00	5
3500	-	30.00	240.00	45.00	-	315.00	13
3500	72.00	12.00	240.00	-	-	240.00	10
3600	52.00	12.00	160.00	36.00	-	260.00	9
3600	52.00	12.00	80.00	24.00	82.00	250.00	8
3800	60.00	6.00	40.00	30.00	82.00	218.00	5
3800	65.00	6.00	120.00	15.00	-	206.00	7
4000	48.00	9.00	80.00	36.00	82.00	235.00	6
4000	45.00	6.00	160.00	15.00	-	226.00	5
4000	65.00	12.00	80.00	12.00	82.00	251.00	7

Contd...

Contd...

4000	62.00	9.00	280.00	-	-	351.00	12
4000	200.00	20.00	40.00	-	114.00	374.00	15
4000	60.00	-	-	10.00	85.00	155.00	5
4000	120.00	-	40.00	6.00	57.00	223.00	7
4000	55.00	6.00	40.00	-	82.00	183.00	3
4000	60.00	6.00	160.00	36.00	-	262.00	5
4100	62.00	12.00	80.00	30.00	82.00	266.00	7
4200	48.00	12.00	240.00	30.00	-	330.00	11
4200	55.00	12.00	-	36.00	82.00	185.00	8
4300	85.00	15.00	160.00	-	82.00	342.00	14
4400	62.00	12.00	40.00	30.00	82.00	226.00	7
4500	62.00	9.00	120.00	60.00	82.00	333.00	8
4500	48.00	9.00	80.00	-	82.00	219.00	5
4500	42.00	9.00	40.00	-	82.00	173.00	5
4500	40.00	5.00	-	-	75.00	125.00	5
4500	70.00	12.00	120.00	15.00	82.00	299.00	9
4500	80.00	15.00	40.00	45.00	82.00	262.00	7
4500	60.00	15.00	320.00	30.00	-	425.00	15
4600	62.00	12.00	280.00	30.00	-	384.00	11
4800	50.00	12.00	160.00	21.00	-	243.00	6
4800	65.00	12.00	200.00	30.00	-	307.00	10
4800	55.00	9.00	80.00	36.00	82.00	262.00	9
5000	80.00	6.00	-	15.00	82.00	183.00	6
5000	55.00	12.00	160.00	30.00	-	257.00	8
5000	55.00	2.50	-	12.50	124.00	194.00	5

Contd...

Contd...

5000	150.00	5.00	30.00	-	114.00	299.00	5
5200	80.00	15.00	400.00	36.00	-	531.00	25
5200	200.00	-	-	-	57.00	257.00	7
5200	34.00	12.00	-	-	70.00	116.50	4
5500	62.00	6.00	-	18.00	83.00	173.00	6
5500	60.00	18.00	-	30.00	83.00	191.00	6
5500	88.00	6.00	-	75.00	82.00	251.00	7
5800	55.00	6.00	80.00	60.00	-	201.00	8
5800	55.00	9.00	-	24.00	82.00	170.00	8
6000	85.00	12.00	40.00	24.00	82.00	243.00	8
6000	84.00	15.00	120.00	36.00	82.00	337.00	25
6000	70.00	6.00	200.00	-	-	276.00	8
6000	62.00	9.00	120.00	36.00	82.00	309.00	7
6000	125.00	-	-	25.00	114.00	264.00	20
6000	66.00	12.00	-	45.00	83.00	206.00	7
6200	68.00	6.00	-	15.00	82.00	171.00	5
6200	70.00	15.00	160.00	24.00	82.00	351.00	10
6200	78.00	12.00	80.00	30.00	82.00	282.00	6
6300	70.00	6.00	40.00	15.00	82.00	213.00	7
6300	60.00	9.00	40.00	36.00	82.00	227.00	9
6400	68.00	9.00	120.00	30.00	82.00	309.00	5
6500	102.00	12.00	160.00	30.00	82.00	386.00	15
6500	80.00	15.00	80.00	36.00	82.00	293.00	12
6800	90.00	15.00	80.00	45.00	82.00	312.00	8
6800	80.00	15.00	80.00	36.00	82.00	293.00	8

Contd...

Contd...

6800	92.00	9.00	80.00	30.00	164.00	375.00	13
7000	52.00	12.00	200.00	15.00	82.00	361.00	10
7500	92.00	6.00	-	30.00	82.00	210.00	6
7500	80.00	6.00	-	30.00	82.00	198.00	6
8,000	60.00	12.00	-	12.00	75.00	159.00	5
9,000	120.00	-	-	-	56.00	176.25	4

MASTER TABLE. (RURAL)

EXPENDITURE ON DIFFERENT TYPES OF FUEL AND SIZE OF FAMILIES WITH INCOME PER MONTH.

Income (Rs.)	Lighting		Cooking			Total (Rs.)	Family Size
	E. (Rs.)	K. (Rs.)	F.W. (Rs.)	K. (Rs.)	L.P.G. (Rs.)		
1	2	3	4	5	6	7	8
200	-	17.00	30.00	-	-	47.00	3
200	-	21.00	15.00	-	-	36.00	3
200	-	17.00	30.00	-	-	47.00	
250	-	12.00	48.00	-	-	60.00	
300	30.00	25.00	40.00	-	-	95.00	
300	-	18.00	40.00	-	-	58.00	
300	-	16.00	39.00	-	-	55.00	7
300	-	12.50	54.00	-	-	66.50	11
300	-	10.00	50.00	-	-	60.00	5
350	-	10.00	40.00	-	-	50.00	6
350	-	18.50	35.00	-	-	53.50	10
400	-	15.00	44.00	-	-	59.00	7
400	-	15.00	20.00	-	-	35.00	8
400	-	17.00	42.00	-	-	59.00	9
400	-	12.00	50.00	-	-	62.00	6
400	21.00	21.00	20.00	-	-	62.00	4
400	-	10.00	25.00	-	-	35.00	7
400	-	15.00	20.00	-	-	35.00	2
450	-	15.00	25.00	-	-	40.00	8

Contd...

Contd...

450	-	15.00	30.00	-	-	45.00	17
500	37.00	16.00	70.00	-	-	123.00	9
500	-	24.00	20.00	-	-	44.00	7
500	-	20.00	35.00	-	-	55.00	13
500	-	27.00	25.00	-	-	277.00	19
500	24.00	7.50	30.00	-	-	60.50	7
500	-	15.00	25.00	-	-	40.00	8
500	-	15.50	42.00	-	-	67.50	9
600	-	21.00	25.00	-	-	46.00	6
600	-	18.00	25.00	-	-	43.00	3
600	20.00	10.00	25.00	-	-	55.00	9
700	28.00	19.00	36.00	-	-		6
800	-	20.00	280.00	-	-	300.00	9
800	34.00	10.00	90.00	-	-	134.00	4
900	42.00	19.00	75.00	-	-	136.00	5
1000	42.00	26.00	75.00	-	-	143.00	9
1000	29.00	7.00	90.00	-	-	126.00	10
1000	27.00	17.00	80.00	-	-	124.00	8
1000	_	24.00	160.00	-	-	184.00	8
1000	-	18.00	120.00			138.00	4
1000	20.00	12.00	90.00	-	-	122.00	8
1000	17.00	15.00	85.00	-	-	117.00	12
1100	50.00	16.00	84.00	-	-	150.00	9
1200	55.00	17.00	40.00	-	-	112.00	8
1200	36.00	23.00	105.00	-	-	164.00	6

Contd...

Contd...

1500	35.00	25.00	40.00	-	-	100.00	6
1500	37.00	10.00	75.00	-	-	122.00	8
1500	21.00	10.00	42.00	-	-	73.00	4
1600	18.00	15.00	42.00	-	-	75.00	
1600	-	50.00	225.00	-	-	275.00	10
2200	35.00	12.00	120.00	-	-	167.00	4
2500	40.00	12.50	-	25.00	70.00	147.50	4
2500	38.00	6.00	120.00	15.00	-	179.00	5
3000	40.00	12.00	200.00	-	-	252.00	8
3000	-	80.00	260.00	-	-	340.00	14
3300	30.00	9.00	240.00	15.00	-	294.00	13
3400	30.00	-	175.00	-	-	205.00	14
3500	41.00	14.00	180.00	-	-	235.00	7
3800	24.00	25.00	280.00	-	-	329.00	11
4000	30.00	12.50	195.00	-	-	237.50	10
6000	-	47.00	260.00	-	-	359.00	9

APPENDIX II

ENERGY SURVEY IN ASSAM

(HOUSEHOLD SCHEDULE)

1.Name of village/ward-

2.Name of head of household-

3.Occupational status-

a)Cultivation-

b)Survice (specify)-

c)Business-

4.Total family members normaly eating at home-

i)Male - - - - - - - - - - - -Total No.

ii)Female - - - - - - - - - - -

5.Family monthly income-

Rs Total

i)Service - - - - - - - -

ii)Business --

iii)Others -

6)Agriculture production--

Items	Rice	Jute	Wheat	Master Seed	Potato	other
Qnty Kg/qnty						
Price (Rs.)						

7. Educational Levels of family numbers--------

(a) Primary -- Total

(b) Secondary----

(c) College----

(d) Above ----

8. Number and type of Cooking stoves in the family

Cook stoves	Number
1. Traditional Chulha 2. Kerosene stoves 3. Gas stoves 4. Bio-gas burner (Specify capacity of plant)	

9. Major live stock & dung availability -----

(i) Animal Numbers----

Animals	No.
Cattle	
Buffaloes	
Other	

(ii) Total in house dung availability (Kg/day)

10. Other Assets----

(i) Agriculture---

Assets	No	Capacity(HP)
1. Tractors 2. Pump sets Oil enginer Electric motors 3. Other (specify)		

(ii) Domestic : No. Capacity (HP)

1) Motor pump set (for drinking water purpose)

2) Scooter /motor cycle---

3) Moped--

4) Other (specify)---

11. House hold electrified : 1) Yes 2) No. If yes,

points	No.
1. Light bulbs	
2. Tube lights	
3. Fans	
4. Radio	
5. Television	
6. Refrigerator	
7. Others (specify)	

12. Energy used for Lighting (current season)

Type of fuel used	Consumption last month	Cost last month (Rs)
1. Electricity(units)		
2. Kerosene (liters)		
3. Others Specify		

Total cost.

13. Sourses of different forms of fuels used for cooking :

Type of fuel	Quantity(kg)	Price per(kg)	Total cost
1. Firewood			
2. Kerosene			
3. L.P.G.			
4. Biogas			

14. Energy used in Human Transport--

F members SL.No.	During last month Yes. No.	How many time	distance covered (km)	Modes of transport used
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Mode of Transport :

1) Train 2) Bus 3) Scooter/Motor Cycle/moped 4) Cycle 5) Walkinç

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