CHAPTER II

ENERGY ECONOMICS AND POLICY IN INDIAN ECONOMY

This chapter is organized as follows: In section 2.1 three levels of energy economic problems are developed through theoretical descriptions. Section 2.2 justifies the focus of this study on the first level of aggregation discussed in section 2.1. Section 2.3 examines the changes in the structure of the Indian economy during the last few decades. Sections 2.4 descries the increasing emergence of energy policy issues with the development/growth of the economy. Section 2.5 contains five current energy economic issues to be examined in this study.

2. 1 Energy Economics and Policy in Perspective

With the dawn of 1982, a new era unfolded in India when the energy sector was accorded the status of priority sector in the country. Nearly thirty percent of plan outlay has been earmarked in the eighth plan for the development of this sector. New policy initiatives, imaginative and off the past trodden paths give direction to the economy in general and energy sectors in particular as the nation ventures into the process of liberalization and a cautious step toward a market managed economy.

As country as a whole geared towards a change for better, the energy sector is changing fast and needs a relook. An integrated multi-disciplinary approach, using all modern tools provided by

resource geology, geophysics, geochemistry, economics, politics, law and environment risk assessment, is an imperative for maximizing the benefits from the depletable resources. Such a multidimensional perspective also includes analytical methods that are familiar to operations research: Optimization algorithm simulation, decision analysis and econometric estimation. The ultimate objective of such an integrated approach is the development of plans and policy measures which given the absence of a simple panacea, will likely contain varied economic variables such as energy pricing, the substitution of technologies, the development of indigenous resources, direct government investment in certain priority areas, incentives and taxes etc.[1] The Eighth Five Year Plan document aptly summarizes the board objectives of energy planning and policy in India. "The strategy for energy development forms an integral part of the over all economic development strategy. The efficient uses of economic resources and long term sustainability of these resources are the two important objectives of economic planning. The concept of sustainability takes account not only the use of resource and ecological balance, but also economic equity and self reliance. Any strategy for energy planning has, therefore, to be consistent with these broad objectives."[2]

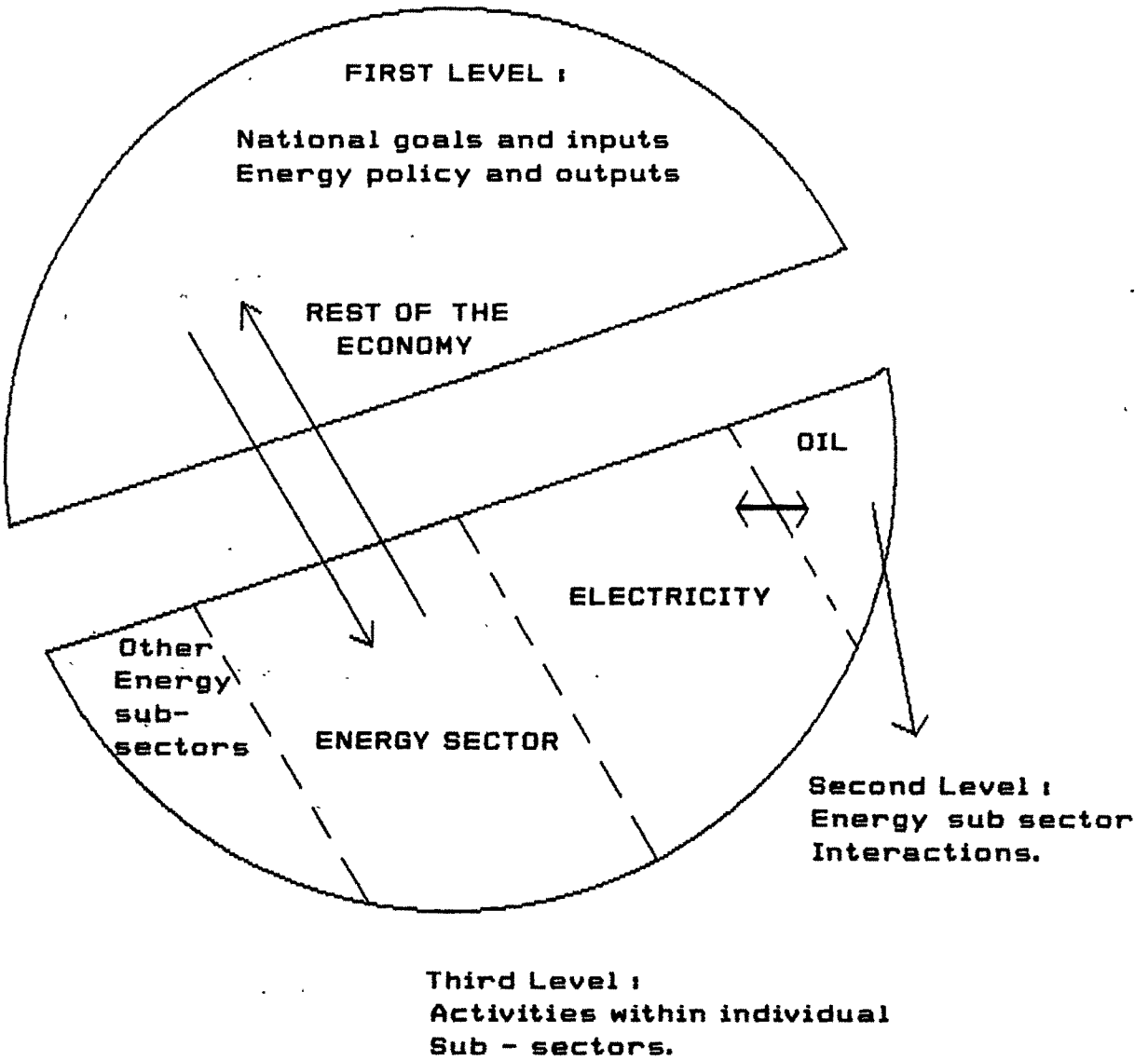
Theoretically the scope of national energy economics and policy issues can be classified into three different levels.[3] (See figure 2.1) At the highest and most aggregate level, it should be recognized that energy is but one sector of the whole economy. Therefore, energy planning requires analysis of the links between energy sectors and the rest of the economy. The range of macro economic policy options, from a long term structural adjustment to short term stabilization programs, will have significant impacts on energy portfolio management decisions. The type of link that is envisaged above involves energy sector inputs such as capital, labor, raw material and environmental

resource; the energy outputs such as electricity, petroleum products, or wood fuel and other forms of energy. The impact on economy of policies concerning availability of supply, energy prices, taxes subsidies, and so on in relation to national objectives are also included. For example, energy requirements must be considered in order to attain a desirable economic growth with distributional aspect of product and income.

"At the center of the desegregate analytical process stands macro analysis . . . the assembly and analysis of national level energy supply/demand balances and the identification of their relationship to the overall economic development plan. This segment of analytical frame work is focused on macroeconomic impacts of energy and must, therefore, provide the means to link general energy strategies to important macro indicators. Such macro analysis is possible at various levels of sophistication, from simple supply/demand balances to the more flexible Reference Energy System (RES) and to the more powerful but also more data intensive energy econometric models."[4]

The second level treats the energy sector as a separate entity composed of sub sectors such as coal, petroleum products, electricity, etc. This permits the detailed analysis, with special emphasis on interaction among the different energy sub sectors, substitution possibilities and the resolution of any resulting policy conflicts such as competition between natural gas, oil and coal for electricity generation, fuel wood and kerosene for cooking or diesel and gasoline for transportation.

Fig. 2.1 Hierarchy of Interaction in Integrated National Energy Planning (INEP)



Source: Munasinghe, 1980 P. 861

The third and most desegregate level pertain to planning within each of the energy sub sectors. The oil sub sector for example, must determine its own demand forecast for various distillates, the rate of recovery to the proven reserve available, the refining capacity and the volume that must be imported to bridge the gap between the supply and demand. It also must take into account the long term investment program for the exploration and extraction, transportation and refining process facility and so on. It is at this lowest hierarchical level that most of the detailed formulations, planning and implementation of energy schemes are carried out.

In practice, the three levels merge and overlap considerably. Furthermore, regional aggregation is required in country like India, which is large and diverse. Given the vastness of the country and the wide diversity in its stages of development and resource base, a national energy model for India should necessarily be supplemented by regional models. As well for being part of a decentralized planning exercise, the regional study of energy planning is envisaged as a necessary part of assessing regional data and potentials and is expected to aid considerably both policy makers and planners at the national and regional levels. In conjunction with the national planning, regional analysis enables the capture of regional specificities in energy supply - demand structure. Such an approach is necessary to coordinate between the decision making process from the center to the states.[5] Application of the integrated energy policy and planning process should, therefore, results in the development of a flexible and constantly updated energy strategy which can meet the national goals discussed above.

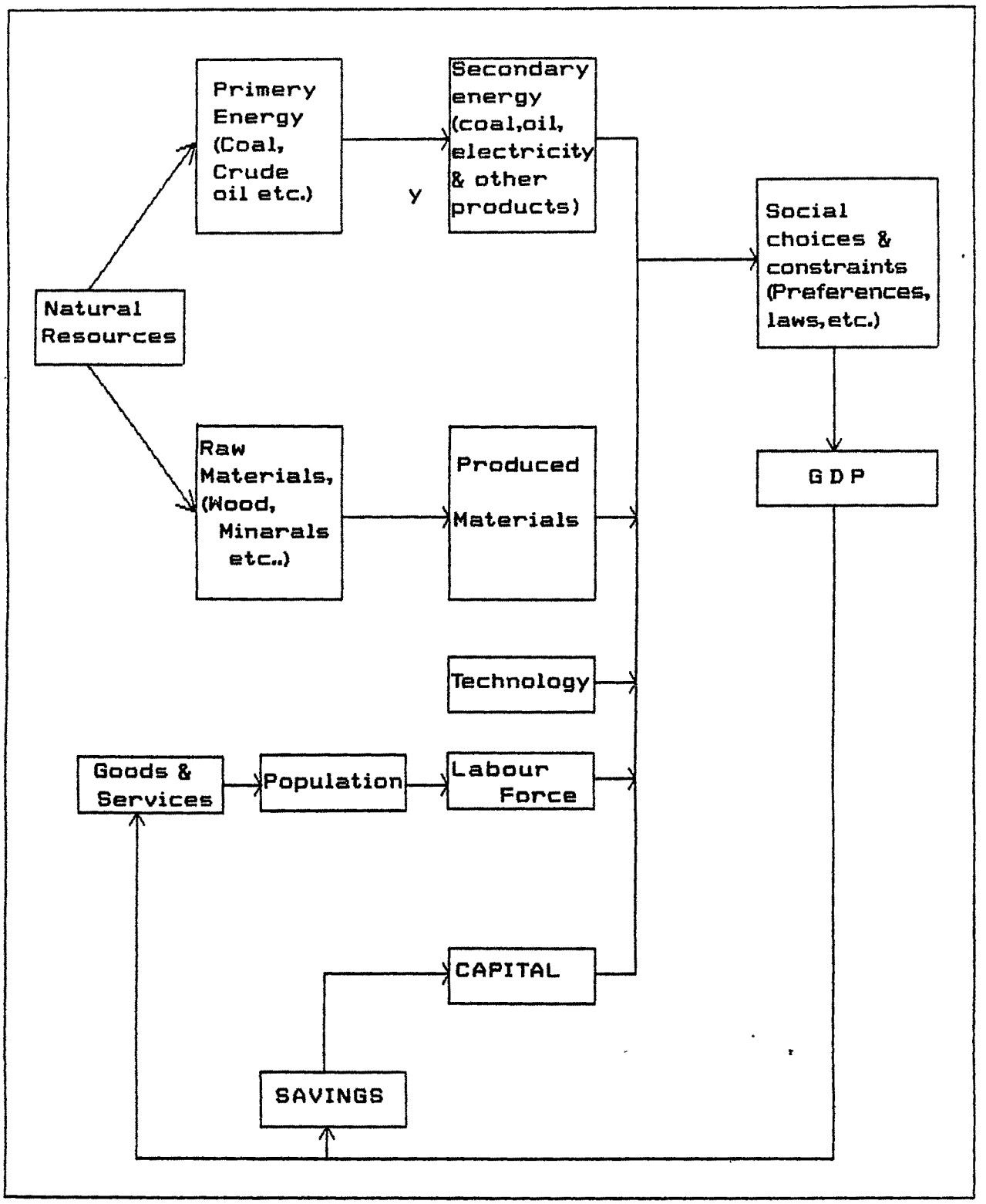
2. 2 Justification and Focus of this Study

The analysis of energy sectors, at all the three levels mentioned above, would be of immensely rewarding. However, to be realistic, this study will be centered on the first level which deals with energy economic policy planning of the links between the energy sector and the rest of the economy. Such an understanding of the aggregate framework has higher priority than micro level studies. As Samouilidis and Mitropoulos point out: "It has become obvious that the energy system cannot be treated in isolation, but within the content of a broader system which is the economy."[6] However, some of the lower level issues relevant to the findings of this study will also be discussed whenever deemed necessary.

2.3. Energy Constraints and Economic Development: A Resume

Energy use is and has always been a basic attribute of economic activity. Indeed, energy use is a characteristic of life itself, and hence all human activity. It plays a vital role in the economic development of a nation and in the progress of the society (see figure 2.2). Dunkerley et.al[7] point to three characteristics of energy that makes it unique and of great importance in economic activity. (a) energy use is pervasive virtually in all type of economic activity (b) It is difficult to substitute other inputs for energy in the short run. © Energy used in economic activity cannot be recycled or reused. These attributes have led many economists in the recent post to analyze energy as a third basic factor of production along side labor and capital.

Fig. 2.2 ECONOMIC ROLES OF ENERGY



As recently as late 1970s most energy analysts believed that energy consumption and economic output are so closely intertwined that it would be virtually impossible to have significant economic growth without growth in energy consumption. Commercial energy, as we realize today, is one of the fundamental infra structural input, its availability sets the effective constraint on the achievable rate of growth of the economy. The capabilities of other producing sectors would remain under utilized and would have adverse effect on the overall productivity of the scarce resources in the economy if power and renewable and non-renewable energies are not adequate in supply.

A two - way linkage exists between energy and economic development. The process of economic development strongly influences the amount and the type needed. At the same time, development in the energy sector affects economic growth.[8] The nexus between energy use and the economic development poses a serious dilemma. On the one hand, progressive raise in the per capita income and the raising standard of living for the growing population requires sharp increase in energy services. The high cost of providing these services through the conventional route of supply expansion could, however, divert an excessive amount of available investment funds to energy, to the extent the extent of limiting economic growth itself. On the other hand, the inability to supply needed energy services can frustrate economic and social development.[9] The unreliability and frequent power cut, outages and slippages, due to poor quality of energy supplies lead to large cost to the economy through wasted materials, slowdown or stoppages of operation and investment in standby equipments. Form the observations of the relationship between per capita income and per capita energy consumption a kind of `iron link' has been observed between energy consumption and GDP growth, though not universally at least after the first oil embargo, however holds true in most

of the Less Developed countries (LDCS). It is important to note that the great surge of post World War II economic growth in the south coincided with the "golden age of petroleum" as the energy source from 1945 to 1973 was plentiful and cheap in real terms. Never before in human history had an energy source of such flexible capability and convenience been available at such a low real cost. Therefore, it is not surprising that the transport, industrial and an urban infrastructure that was built up in the developing world during this period was heavily dependent on petroleum and petroleum products. Because a proportionately greater portion of the developing countries historical economic development occurred in the petroleum era, these countries found themselves, from the first oil embargo, in the web of their own creation.

Today most nations have to take explicit account of the role of energy while choosing a growth rate for the economy and initiating economic development polices and plan. This has become an imperative not only due to the volatility in the world oil prices which had profound repercussions on the world economy, while the future course of their prices may prove difficult to predict, but also because energy demand is derived from structure and growth of the whole economy and population. The result is that the price and the availability of energy could significantly constrain economic production, consumption and trade. All these circumstances are particularly relevant to Indian, one of the countries severely affected by the energy crises.

2. 4 ENERGY ECONOMIC ISSUED AND ECONOMIC DEVELOPMENT/GROWTH

At the very outset, before dwelling into India's energy - economic issues, it is an imperative to have a glimpse of its place in the world and developmental path it trod during last few decades. Table below shows India's place in the world.

Table 2.1

INDIA'S RANKING IN THE WORLD

	UNIT	INDIA	WORLD	RANK
ECONOMIC INDICATORS				
Population	Million	884.0	5502.0	2
Total GDP	Bn. US$	225.0	23113.0	18
Exports	Bn. US$	21.6	3686.0	33
Electricity generated	Bn.kwh.	301.0	12028.0	8
PRODUCTION INDICATORS				
Tea production	Mn. Tons	0.7	2.6	1
Groundnuts(shell)	Mn. Tons	7.4	25.0	1
Raw sugar	Mn. Tons	14.4	115.7	1
Millet	Mn. Tons	10.6	29.0	1
Rice (Paddy)	Mn. Tons	111.0	527.0	2
Rapeseed	Mn. Tons	3.7	2.0	2
Sugarcane	Mn. Tons	249.0	1103.0	2
Coal (hard)	Mn. Tons	250.0	3138.0	3
Cement	Mn. Tons	50.0	1148.0	4
Wheat	Mn. Tons	57.0	565.0	4
Cotton (lint)	Mn. Tons	2.2	17.7	4
AGRICULTURE AND ALLIED				
Arable land	Mn.Hect.	170.0	1444.0	2
Irrigated Area	Mn.Hect.	45.8	249.6	2
Cattle population	Mn.	193.0	128.0	1
Milk(cows and buffalo)	Mn.Tons	60.9	501.6	2
Eggs(hen)	Mn.Tons	1.5	37.9	5

Note : Data generally relates to 1991-93
source: World Bank

Table 2.2

Major Economic Profile of India 1950-51 to 1994-95

(Rs. Billion)

	50-51	60-61	70-71	80-81	90-91	94-95
Economic Indicators						
GDP at factor cost						
(I)at current prices	89.8	152.5	397.1	1224.3	4726.6	8583.0
(ii)at 1980-81 Prices	428.7	629.1	904.3	1224.3	2122.5	2561.0
Per capita NNP (1980-81 prices)	1126.9	1350.0	1519.6	1630.1	2222.2	2449.2
Index of agricultural production (Base: triennium ending 1981-82)	46.2	68.8	85.9	102.1	143.0	165.0
Index of Industrial Production (base: 1980-81)	18.3	36.2	65.3	100.0	212.6	253.7
Gross domestic capital Formation (as percent of GDP)	10.2	15.7	16.6	22.7	27.7	26.0
Gross domestic savings (percent of GDP)	10.4	12.7	15.7	21.2	24.3	24.9
Output						
Food grain (Mt)	50.8	82.0	108.4	129.6	176.4	191.5
Coal (Mt)	32.3	55.2	76.3	119.0	225.5	273.1
Crude Oil (Mt)	0.3	0.5	6.8	10.5	33.0	32.2
Electricity generated (Utilities: BKWH)	5.1	16.9	55.8	110.8	264.3	351.0
Foreign trade						
(I) Exports (Rs. Crore)	606.0	642.0	1535.0	6711.0	32553.0	82674.0
(ii) Imports (Rs. Crore)	608.0	1122.0	1634.0	12549.0	43198.0	89971.0
Social Indicators						
Population (mil)	361.1	439.2	548.2	683.3	846.3	915.9

Source: Economic Survey, Various issues

2. 5 Indian Economy: A structural View

From the table above it is clear that India is a developing economy with a large agricultural base and growing industrial infrastructure. It is inhabited with 915.9[10] million people, the second largest populous country in the world, spread over 3286.6 square kilometers having the density of population as high as 1625 people per square kilometers. Out of the total population, 65% live in rural areas in an estimated 600,000 villages. They constitute the backbone of what is still, largely, an agricultural economy. Agriculture is the mainstay of the majority of the population in India. Extremes in climate and variety of soil conditions made possible to cultivate almost every item from cash crops to food grains. India's growth in per capita food grain production during 1972-92 was about 1.6% per annum, which is the highest growth rate in the world during this period.

Agriculture provides a livelihood to about 65% percent of the labor force, contributes nearly 29% to the Gross domestic Products (GDP) and accounts for 8.65% of India's export. In terms of gross fertilizer consumption, India ranks 4th in the world, after USA, the erstwhile USSR and China Due to the introduction of high yield varieties of seeds, with wide spread irrigation facilities and farm mechanization, the vulnerability of the Indian agriculture sector to the vagaries of the monsoon has declined, compared to the earlier decades. This modernization and mechanization of Indian's agricultural sector greatly improved the productivity during the eighties when the weighted index of agriculture production increased at a rate of 3.6% per annum compared to 2.2% per annum in the seventies and 3% per annum in the fifties and early sixties. In all counts, 1995 was a good year for agriculture, facilitated by favorable monsoon. India's granaries are full and the initial estimates indicate that the output of food grains in 1995-96 may have touched 190 million tons, which is a little lower than the record output of 191 million tons in 1994-95.[11]

Table 2.3
GDP and its sectoral Composition

(Rs. Billion)

	GDP	Agricul.	Manufact.	Trans.	Others
1950	428.70	242.00	64.50	47.18	75.00
		(56.45)	(15.04)	(11.00)	(17.50)
1960	629.10	328.	118.00	79.45	103.80
		(52.13)	(18.8)	(12.63)	(16.50)
1970	904.10	413.90	202.10	128.80	159.50
		(45.78)	(22.35)	(14.25)	(17.64)
1980	1224.30	485.40	298.30	204.40	139.10
		(39.65)	(24.36)	(16.69)	(11.36)
1990	2122.50	698.60	594.90	377.40	451.60
		(32.91)	(28.03)	(17.78)	(21.28)
1995	2742.10	788.40	801.80	547.70	602.20
		(28.75)	(29.59)	(19.97)	(21.69)

Notes : figures in brackets represent percentage shares
Source: CSO, National Accounts Statics, various issues

Over the past decades India has recorded remarkable expansion and diversification in practically all areas of industrial development. India's vast resources (human, agricultural, the mineral industrial and infra structural endowments) have been fully exploited for this purpose. Planned development has been the basis for India's industrial policy. Core sectors were developed by the public sector enterprises to ensure equitable distribution of goods and services. In the corporate

sector, there are more than 300,000 registered companies in the country, of which 7500[12] are listed on stock markets

During 1995, the reform packages initiated in 1991 continued to have positive impact on India's economic growth. The GDP growth rate which averaged 4-5 percent between 1992 and 1994 is estimated at 6.3 percent in 1995. In 1995, India's strong industrial sector boosted annual GDP growth rates by an estimated 6.3 percent. In 1992, India ranked 22nd in the world with respect to value addition in manufacturing. High income countries experienced a decline in the share of industry in GDP over the last thirty years. In the case of India, the share of GDP increased from 20% to 27% during the same period.

The focus of the industrial policy continued to be on deregulation in 1994-95. During the year, the major policy changes include delicensing of the bulk drugs, except five essential drugs, allowing for automatic approvals of foreign approval up to 51% in most drugs and formulations and opening up of basic telecommunication services to private sectors. The new industrial policy abolishes industrial licensing in all areas except for sixteen specific industries, six industries reserved for public sectors and items reserves for small scale sectors.

The list of areas reserved for investment by the public sector has been pruned from seventeen to six. Even among these, private and foreign investment is now being permitted in the mining and hydrocarbon sectors and sections of the railway transport sector. Manufacturing industries, except those related to defense and allied industries, have been removed from the reserved list. The response

to the policy initiatives taken by the government since July 1991 has been phenomenal There has been a constant improvement in industrial production which stood at 8 2% in 1994-95 compared with 0.6% in 1991-92. The capital goods sector, which registered a negative growth in 1991, recovered significantly and clocked a growth of 23.9% in 1994-95 The new industrial policy has helped in catalyzing foreign investment into India. The total amounts of foreign direct investment approval which was Rs. 5,341 million in 1991, swelled to Rs. 141,871.9 million in 1994. Of the total FDI approvals, 80% are in the priority sectors such as power, oil refineries, electronics and electrical equipments, chemicals, telecommunication, food processing etc.

The service sectors in the Indian Economy consist of affluent salaried class in government service and in the private sector and their earning on the whole have been increasing. As the income increases, the goods demanding sector is certain to insert heavy pressure on commodity producing sectors, especially the household appliances most of which are energy users. There will be a burgeoning demand for all form of energy. The impetus to industrialization, provided by the liberalized economic polices, combined with raising income levels, is expected to further this trend. Hence a detailed discussion of the energy sector is warranted at this juncture.

2. 6 THE ENERGY SCENE IN INDIA

"The Energy resources of the country are not mutably or precisely given they can be assessed only at a particular time, and then in relation to the existing state of knowledge and techniques and to possible future changes in each of these."[13] These resources can be conveniently classified into three different broad categories: the commercial energy, constituting coal, oil, Natural gas, hydro and nuclear power. Non commercial energy resources (NCES) so termed since much of these resources are being bought and sold in any recorded fashion, includes animal waste, agriculture residue and forest resources. The third category is New and Renewable Resources (NRES) include solar, biomass, geothermal, wind energy etc.

As stated earlier, energy resources of a country are not mutably or precisely given, the assessment of the proven resources of the country is undergoing change for the better. It has been estimated in 1991 that India has a Coal reserve of 196 Billion Tones (BT) which was put at 83.7 (BT) in 1975, for crude oil, the assessment is 806.15 Million Tones (MT) and the tentative conclusion is that at the present rate of extraction, the reserve will last for another twenty eight years form now, unless new reserves are explored.

India is endowed with huge reserve of Natural Gas (NG). The assessment for which stood at 729.79 Billion cubic meters (BCM) compared to the 1975 figure of 87.67 (BCM). The New and Renewable energy resources of energy/Technology do not need any prognostic assessment as the potential is too vast to avail energy resources for the foreseeable distant future and depends on the technology and the cost-benefits to transform them into convenient form to use.

The primary power resources in India are hydro power, fossil fuels (coal and lignite, natural gas) and nuclear power. The resource position is as.

Table 2.4

Estimated Energy Primary Reserve In India

Source/Technology	Approximate Potential available
1. Hydro	:84, 000 MW @ 60% Load Factor Untapped Potential - 80%
2. Pumped Storage	:93, 920 MW
3. Coal Reserve	:186 Billion metric tons
4. Lignite Reserves	:5.06 Billion metric tons
5. Crude Oil	:728 Million metric tons
6. Natural Gas	:686 Billion Cu.Ms
7. Uranium	:6, 700 metric tons
8. Thorium	:363, 000 metric tons (India has the world's largest deposit)
Non - Conventional	
9. Biogas Plant	: 40 Million
10. Biomass	: 17,000 MW
11. Solar Energy	: 5 x 10^{15} KW hr/yr
12. Wind Energy	: 20,000 MW

Source. International trade Administration, U.S. Department of Commerce, Washington, D.C., for conventional energy resources

: Annual Report 1991-92, Department of Non-Conventional energy Government of India for Non-Conventional energy Resources

A synoptic view of the energy scene in India can be visualized from the Energy Balance Table (EBT)[14]. The Energy Balance Table (see table 2.5) is an accounting system, presenting a coherent picture of flow of all types of energy from their origin, through transformation processes and final use. It can be presented in a consistent fashion using available energy units (MTOE, KTOE, Joule or Calorie) Such an accounting framework is a way of organizing quantitative data relating to the various stages in the process of energy supply and use, thus systematically ensuring the internal consistency of the data in question and is a basic tool in sectoral energy analysis.[15] For a given year, it presents data on energy supplies and their sectoral consumption proving information on the markets for each source of energy and the fuels used in each sector.

An example of an increasingly important application is the EBT's use in drawing up policies for a rational energy use. The energy balance table makes it possible to study the trends and levels of consumption of imported energy as compared with domestic supply. By documenting the losses of energy in the transformation process, comparative efficiencies can be evaluated in the transformation stage and in the final use. If the information included in the balance table is sufficiently detailed, one can establish the consumption pattern in the various economic sector, the efficiency of various consumption processes, and the possibility of substituting energy sources to achieve consumption targets more economically.

Basically, the EBT is divided into three distinct parts. The first part contains data on the primary energy availability, including imports, exports and marine bunkers, all adjusted for changes in stock. The second part describes the energy lost in the process of transformation and distribution

Table 2.5 Commercial energy balance (in million tonnes of oil equivalent) for 1994-95

Supply-demand and sources	Supply						Availability (Inflow Outflow)	Conversion							Net availability (availability - conversion)	Consumption							Total
	Inflow			Outflow				Soft coke	Petroleum refining	Liquefied Petroleum gas extraction	Power generation	Conversion losses	Auxiliary Consumption	Total				Agriculture	Industry	Transport	Residential	Other energy uses	Non-energy uses	
	Production	Imports	Total	Export	Stock changes	Total									Transmission and distribution	Flaring of natural gas etc.	Total (Conversion)								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
I)Primary energy																									
1) Coal	126 4	4 1	130 4	0 1	-1 6	-1 5	132 0	0 2	-	-	77 6	51 8	2 8	54 3	-	-	77 8	54 2		53 9	0 3	-	-	-	54 2
2) Oil	32 2	27 4	59 6	-	3 1	3 1	56 5	-	56 5	-	-	-	-	-	-	-	56 5	-	-	-	-	-	-	-	-
3) Natural	16 6	-	16 6	-	-	-	16 6	-	-	1 8	5 4	3.9	0 0	3 9	-	1 7	8 8	7 8	0 1	1 5	-	0 2	-	-	7 8
4) Hydro	7 0	-	7 0	-	-	-	-	-	-	-	7 0	4.6	0 0	4.7	-	-	-	-	-	-	-	-	-	-	-
5) Nuclear	0 5	-	0 5	-	-	-	-	-	-	-	0 5	0 3	0 0	0 3	-	-	-	-	-	-	-	-	-	-	-
6) Soft coke	-	-	-	-	-	-	-	0 2	-	-	-	-	-	-	-	-	-	0 2	-	-	-	0 1	0 1	-	0 2
7) Liquefied petroleum gas	-	0 7	0 7	0 0	-	-	0 7	-	1 6	1 6	-	-	-	-	-	-	3 2	3 9	-	-	-	3 3	0 6	-	3 9
8) Naphta	-	-	-	2 4	-	2 4	-2 4	-	6 1	-	-	-	-	-	-	-	6 1	3 7	-	-	-	-	-	3 7	3 7
II)Secondary energy																									
1) Motor gasoline	-	-	-	-	0 0	0 0	-	-	4 4	-	-	-	-	-	-	-	4.4	4 4	-	-	4 4	-	-	-	4 4
2) Aviation turbine fuel	-	0 1	0 1	-	0 2	0 2	-0 1	-	2 1	-	-	-	-	-	-	-	2 1	2 0	-	-	2 0	-	-	-	2 0
3) Kerosene	-	4 4	4 4	-	0 6	0 6	3 9	-	5 5	-	-	-	-	-	-	-	5 5	9 4	-	-	-	7 9	1 5	-	9 4
4) High speed diesel	-	8 9	8 9	0 2	-0 2	-	9 0	-	20 3	-	0 2	0 2	0 0	0 2	-	-	20 0	29 0	0 6	2 8	25 6	-	-	-	29 0
5) Light diesel oil	-	-	-	-	-	-	-	-	1 4	-	0 2	0 1	0 0	0 1	-	-	1 2	1.2	0 0	1 1	0 1	-	-	-	1 2
6) Fuel oil	-	-	-	-	0 7	0 7	-0 7	-	9 7	-	2 2	1 4	0 1	1 5	-	-	7 5	6 8	0 2	6 1	0 4	-	-	-	6 8
7) Other Petroleum products	-	0 1	0 1	0 8	-1 0	-0 3	0 4	-	3 5	-	-	-	-	-	-	-	3 5	4 0	-	-	-	-	-	4 0	4 0
8) Total Petroleum products	-	14 3	14 3	3 4	0 2	3 6	10 7	-	54 6	1 6	2 6	1 7	0.1	1 8	-	-	53 7	64.3	0 9	10 0	32 6	11 1	2 1	7 6	64 3
9) Thermal Power	-	-	-	-	-	-	-	-	-	-	85 6	57 3	2.7	60 0	-	-	60 0	25 6	-	-	-	-	-	-	-
10)Total Power	7 4	-	7 4	-	-	-	-	-	-	-	93 1	62 3	2 7	65 0	5 9		70 9	22 2	8 7	8 5	0 5	4 0	2 5	-	22 2
11)Total energy	182 6	45 7	228 3	3 5	1 7	-	223 2	-	1 9		93 1	62 3	2 7	64 0	5 9	1 7	74 5	148 6	7 7	73 9	33 4	15 4	4 6	13 6	148 6

and what is available for distribution to various sectors. The second stage is also known as secondary energy. The third part, final energy, is what consumers utilize in their appliances. It contains information regarding consumption in various sectors.

Among other institutions in India, Tata Energy Research Institute (TERI) compiles EBT tables on a regular interval for all the years from 1970. The statistical Division of the United Nations (U N) now compiles such energy balances for many countries in the world, facilitating inter-country comparison. Now most of the energy policy planners and modelers make efficient use the EBT tables for policy planning and to peep into the future energy requirement

2. 7 CHANGES IN THE PATTERN OF ENERGY SUPPLIES

The total energy supplies, including both commercial and non commercial forms, increased from 82.7 (MOTE) in 1950-51 to about 291 (MOTE) in 1994 - 95. In this, the share of non commercial fuel has declined from 74 percent in 1950-51 to 41 percent in 1990-91. Fuel wood alone accounts for 65 percent of the total non commercial energy consumed in the country.

2. 7. 1 Coal

Among the indigenously produced primary commercial energy, the share of oil and natural gas has increased from 1.2 percent in 1950-51 to nearly 36 percent in 1994 - 95 whereas the share of coal declined from about 98 percent in 1950-51 to about 57.0 percent in 1994-95. The cooking coal production rose at a snail's pace, from 35.65 (MT) in 1985-86 to 42 (MT) in 1994 - 95. On the other hand, the non cooking coal sector registered an impressive compound annual average growth rate of 5.3 percent with production rising sharply 72.9 Million Tone in 1970-71 it rose to 211.7 Million Tone in 1990-91 and to 270 Million tone in 1995-96. Actual production of coal has eluded targets, continuously for the past few years resulting in an alarming mismatch between supply and demand.

The actual coal consumption in 1994-95 was 269 Million tone compared to the consumption of 71 Million tone in 1970-71.Power utilities are the major consumers of the non cooking coal in India. They account for nearly 79 percent of the total coal consumption. The power industries consumed 167 Mt of coal in 1994-95 compared with 162.5 Mt in 1993-94. Steel plants which

account for nearly 12% of coal consumption, increased their consumption to 34 5 Mt in 1994-95. The indigenous coal production is by and large meets the coal demand, except for the steel industries, where the quality of coal required to contain less than 17.5% ash content.

Table 2.6

Trends in energy Production in India 50-51 to 94-95

Fuel Type	50-51	60-61	70-71	80-81	90-91	94-95
Coal& lignite (Mt)	32.2	55.2	76.3	119	225.5	253.8
Crude Oil (Mt)	0.3	0.5	6.8	10.5	33.0	32.2
Electricity (Twh)	5.1	16.9	55.8	110.8	264.6	351.0

Source: Economic Survey, Various issues.

2. 7. 2 Oil

Some cheerless prospect looms large when we consider the oil industry. Production and discovery of oil reserves have not kept pace with the increase of domestic oil production in the last few years. The production performance of oil sectors was rather disappointing during and after 1991-92. The main reason for this was the increased unrest in Assam, where a majority of onshore oil reserves are located and slackening of output in a number of offshore wells at Bombay high, which has reached a production plateau and its output is likely to decline - a major source of crude oil output. But even the long term trend in crude oil production is not encouraging. The production of crude oil which started picking up in the early eighties after the discovery of Bombay high has been

more or less stagnant during the past years at around 30 (MT) and reaching a peak of 34 9 Mt in 1989-90 (MT) Even more revealing is the fact that targeted crude oil production for the year 1994 - 95 is less than the production achieved in the earlier years, implying the resistance of problems that retarded crude output in recent years.

In an effort to increase domestic oil production and limit oil imports, India embarked upon an Accelerated Exploration Program (AEP) in 1993. The AEP originally proposed investing $23 billion in the oil sector between 1994 and 1996, and called for exploration of oil shales, deep water drilling in fields up to 3,900 feet, development of coal bed methane, horizonal drilling, and implementation of Enhanced Oil Recovery (EOR) projects.

At the desegregate level, there was a steep decline in the production of the middle distillates compared to the production of the light and heavy ends. In 1991-92, production of middle ends fell by 2 percent. The share of middle ends, comprising mainly Kerosene (SKO), Aviation Turbine Fuel (ATF), and High Speed Diesel (HSD) and other products in the total output have been around 50 percent over the past twenty years. In general the growing mismatch between demand and supply of Petroleum and Oil Products (PLO) augurs ill pointing to the need for imports of final products instead crude of oil.[16]

This is also indicative of the pattern of refining capacity which has not changed for the past several years. The increased oil demand necessitated an increase in the country's refining capacity

through higher utilization rates, existing plant expansion and new gross root projects. In mid - 1995, the state owned Indian Oil Corporation (IOC) reported that capacity utilization in its six refineries was 103 percent in 1994.[17] Further, the Indian Government has undertaken a massive expansion program underway with more than 12 new programs.

To improve the supply condition and to reduce the fiscal burden due to sale of subsidized petro products, the government has decentralized the imports of kerosine, liquefied petroleum gas, Low Sulphur Heavy stocks and Superior Kerosine Oil. A parallel Marketing system (PMS) for these has been set up since February 1993. Under this system, private parties are allowed to import and market LPG/SKO/LSHS through their own distribution network at a market determined prices.

2. 7. 3 Natural Gas

Natural Gas accounts for 10% of the primary energy demand in India with the production of 19.4 billion cubic meters in 1994-95. The total production of NG by the 1996-97 estimated to reach 80 Million Cubic Meters a day, which would still leave a huge gap in the demand and supply of NG in the country. During the 1980's about 28% to 48% of the gas was flared but reached a level of 10% in 1992-93. But in the late 1980's government permitted the use of NG in the in power generation and since than the demand soared beyond the expectation.

2. 7. 4 Electricity

Good performance in the power sector is crucial to India's development. It supplies the key

input to agriculture and industry and absorbs 20 to 25 percent of the total plan outlay. The gross electricity generated in 1950-51 was 6.6 Kilowatt Hour (KWH) compared to the total power generated in 1994-95 was 351 (BKWH). In the beginning of the Eighth Five Year Plan there was a shortage of 8 percent in electrical energy and 20 percent in a peak time requirement. Even with the addition of the planned 30, 538 MW of new generation capacity during the Eighth Five Year Plan, the overall shortage position was not expected to improve any significantly in the near future as the power projects have long gestation period of four to seven-year. The reality is that the power sector is caught amid myriad problems such as a resource crunch, a high rate of slippage, Transmission and distribution losses (T&D), persisting disproportion in hydrothermal mix, burgeoning demand-supply gaps, etc. The immediate effect of a resource crunch is the heavy amount of slippage. The targets fixed for additional capacity installation has been an unfulfilled dream in all the five year plans. The slippage percentage which was 15.4 percent in the first plan rose to 35.7 percent in the second plan and continued more or less during the third plan, fell to 24.1 percent at the end of annual plans. In the fourth plan it reached an ever high of 50. 5 and came down drastically to 18.4 percent in the fifth plan, rose to 27.7 percent in the sixth plan and reached an ever lowest ebb of 3.8 percent in the seventh five year plan. But, during 1990-91, the slippage was as high as 34.1 percent. The Power Ministry's request for an outlay of Rs. 100,000 crore during the Eighth plan was materialized to the tune of Rs. 78,000 crore. The result is that there will be a yawning gap of 7000 Megha Watt (MW) in terms of demand for and supply of power at the end of Eighth Five Year Plan.[18] Apart from the problems faced from the slippage, the power sector suffers from a technical side.

(a) The Transmission and Distribution Losses (T & D) continues hover around 20 percent of the power generated and in 1994-95 it was 22.8%, which is still higher than the international average of less than 10% for the advanced countries.

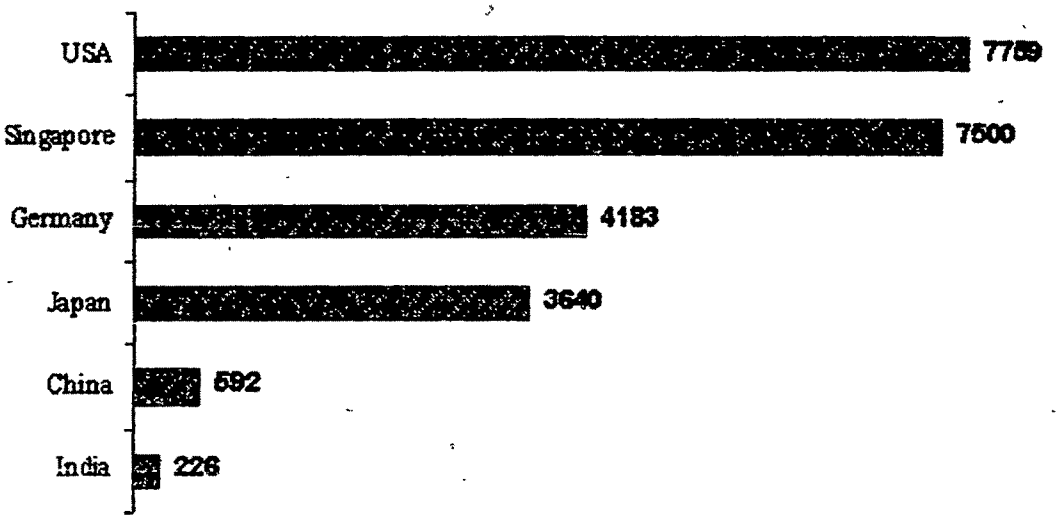
(b) Low Plant Load Factor (PLF.) of the thermal plants is another problem. The fact that the average PLF. has improved from 45 percent in 1980-81 to 53.8 percent in 1990-91, against the target of 56.1 percent, does not evoke euphoria as the present level of PLF. is still below the norm of 60 percent recommended by the World Bank. However, it has been aimed at to achieve a PLF. of 70% by the year 2010. There are likely chances that some of these problems can be contain if the interference of the State Governments in the working of the State Electricity Board's day today operations and in their investment, tariff, and personal polices kept under check.

2. 8 Energy Consumption and Macro Economic Trends in India.

The level of energy consumption in India is extremely low as is indicated by the per capita energy consumption which currently stands at 226 Kg of Oil Equivalent as compared to 7759 Kg of Oil Equivalent in the USA. Although, the per capita consumption is projected to increase by nearly 145 percent by the year 2010, the average Indian consumption would still be only a fifth of what an average American consumes today.Even though the per capita energy consumption is expected to remain low, the hift that is expected to take place due urbanization and the accompanying raise in the standard of living is bound to incert a heavy demand for commercial energy sources,a shift from non-commercial to commercial sources of energy

Fig 2.3

Per Capita Energy Consumption - Some Comparison
Figures in Kg of Oil Equivalent



2. 8. 1 Primary Energy Consumption

When we considered the primary commercial energy consumption for the overall period from 1953-54 to 1994 - 95, the final energy consumption increased from 17.6 MTOE to 146.6 MTOE

at an implicit average annual growth rate of 4.52 percent. (See table 2 6).

During the last four decades, there have been changes both in energy-mix and the sectoral pattern of energy consumption The relative shares of oil and electricity in the total final commercial energy consumption have increased steadily over the years though the consumption coal show a decline trend when we consider the final energy consumption, its share in the primary energy consumption is still very high, as coal consumed in the generation of power is not included in the final energy consumption.

Table 2.7

Percentage Share of Different Commercial Fuels in Final Energy Consumption

Fuel type	1953-54	1960-61	1970-71	1980-81	1994-95
Coal	79.60	74.10	59.10	52.85	36.47
Oil & Gas	17.10	20.90	31.30	35.45	43.27
Electricity	3.30	5.00	9.60	11.70	20.26

Compiled From

Source: Tata energy and Economy Year Book, (TEDDY), Various issues

From the table it is obvious that the relative share of coal decreased steadily from 79.6 per cent in 1953 to 39 percent 1990-91 that of oil and gas rose from 17.1 percent to 43.4 percent and that of electricity from 3.3 percent to 17.6 per cent. The adverse fallout has been the dependence on imported crude oil and petroleum products, causing heavy drain on foreign exchange reserves.

Table 2. 8

Sales/consumption (in thousand tones) of Petroleum Products: 1970-71 to 1994-95

Products	1970/71	1980/81	1990/91	1994/95*
Light distillates				
Liquidified Petroleum Gas	176	405	2415	3434
Motor Gasoline	1453	1522	3545	4141
Naphtha	904	2325	3446	3400
Others	164	136	395	662
Total (light distillates)	**2697**	**4388**	**9801**	**11637**
Middle Distillates				
Kerosine	3283	4228	8423	8964
Aviation turbine fuel	689	1125	1677	1903
High speed diesel oil	3837	10345	21139	28261
Light Speed diesel oil	1092	1122	1506	1369
others	139	236	361	479
Total (middle distillates)	**9040**	**17 056**	**33106**	**40976**
Heavy ends				
Furnace oil	3513	5406	4462	5837
LSHS	1151	2067	4524	405
Lube oil	545	593	892	668
Bitumen	777	1064	1581	1939
Petroleum coke	107	137	290	197
Others	82	85	379	180
Total (Heavy ends)	**6175**	**9452**	**12128**	**12873**
Grand Total	**17912**	**30896**	**55035**	**65487**

Compiled From

Source. Center for Monitoring Indian Economy, Current Energy Scene in India, May 1994
TEDDY, 1996-97

The share of petroleum products increased rapidly from 17.6 million tones in 1970 - 71 tyo 38.6 million tones in 1984 - 85 and the middle distillates is growing rapidly compared to the total

POL products. Its share in total consumption which was 50 percent in 1970-71 went up to 55 percent in 1980-81 and further to 60 percent in 1990-91.This was due to partly to a rise in economic activity. However, persistant shortages in coal and electricity supplies - particularly during the 1980s have also resulted in an increased demand for refined products. Furthermore, certasin pricing policies, such as subsidizing kerosine, have contributed to a rise in cooking, by making soft coal production unprofitable. In addition, as the government did not allow the deferential between consumer prices of kerosine and diesel to become too high, certain private car and auto users have also preferred to retofit their petrol driven cars and autos by even inefficient diesel engines.[20] Such conversions have been privately profitable largely because petrol prices include a large tax component to cross subsidize kerosine and diesel. Such trends in the consumption pattern have far reaching implication on the broad context of our country's economic self sufficiency and the balance of payments position, which will be discussed in section 2.7.

Table 2.9

Percentage shares in Final Energy Consumption by different Sectors

	1953-54	1960-61	1970-71	1980-81	1990-91	1994-95
Industry	39.8	40.7	51.6	57.0	50.4	49.75
Transport	46.2	44.9	29.4	23.5	24.5	22.47
Household	9.9	10.6	14.3	12.3	13.8	10.36
Agricult	1.7	1.8	3.8	6.1	9.0	5.18
Others	2.4	2.0	0..9	1.1	2 .3	12.24

Compiled From

Source: Eight Five Year Plan (1992) from 1953-54

TEDDY (1996-97) for 1994-95 (energy use and non-energy use include others)

The sectoral consumption of final energy consumption has also undergone significant changes over the years. The share of household sectors in the final use of energy declined while the industry sectors registered an increase over the years. The share of transport sectors in the final use declined till 1980 and then registered an increase. One of the reasons for this is the shift that has taken place in railways from inefficient steam traction to more efficient diesel and electric traction. However, the rapid growth in the private mode of transport in the eighties reversed the trend. The increase in the share of agriculture has been on account of increasing use of electricity and diesel pump sets and tractors run on diesel.

2. 9 Debt Energy Nexus

For India, crude oil production is a belied hope. Discoveries of oil reserves have not kept pace with the increase of domestic oil production in the last few years. The Bombay High Oil fields, which accounts for 70 percent of India's domestic oil production reached a plateau and in the years ahead, its output is likely to decline due to trouble in the Northern Easter States, especially Assam, crude oil production virtually stagnated since 1985, except in 1989-90, where production reached a peak of 34.09 MT such a doubt, will impose a severe strain on the balance of payments due to heavy import of crude and oil products. Increased reliance on the imported crude also raises concern about security. Any turmoil in the OPEC countries bound to send ripples to Indian Economy. Figure below displays the Index of self reliance.

Consumption of POL products has been growing more rapidly than the indigenous production. This is due to the accelerated growth in the automobile industries in the eighties and in the growth of transport infrastructures. It has increased at a compound annual growth rate of 6 percent in the eighties against around 5 percent during the seventies. One adverse consequence of our pattern of energy consumption is the dependence on import for crude oil and petroleum products, causing a heavy drain on the foreign exchange reserve of the country. Among all the imported items, crude oil and its refined products constitute the largest single commodity group in India's import bill.

The figure below gives the share of oil imports in total imports between 1970-71 and 1992-93. The foreign exchange outgo on import of petroleum of products in proportion to total export earnings of the country increased from 8.6 percent in 1970 to 78.4 in 1980 and then declined to 20.8 percent in 1989, but again started increasing from 1990-91, though no perceptible secular trend can be observed from the above table, there is a clear pattern in which oil imports were linked to the growth pattern of petroleum products and the trends in a domestic crude oil throughput.

Index of Self Reliance

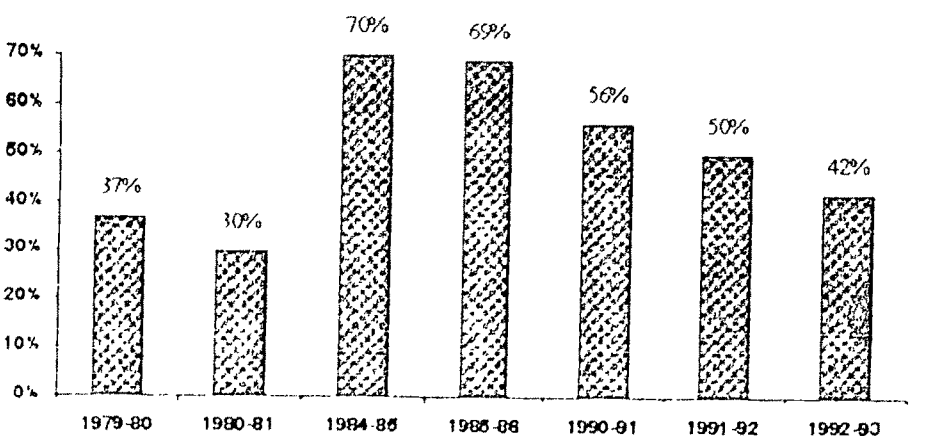
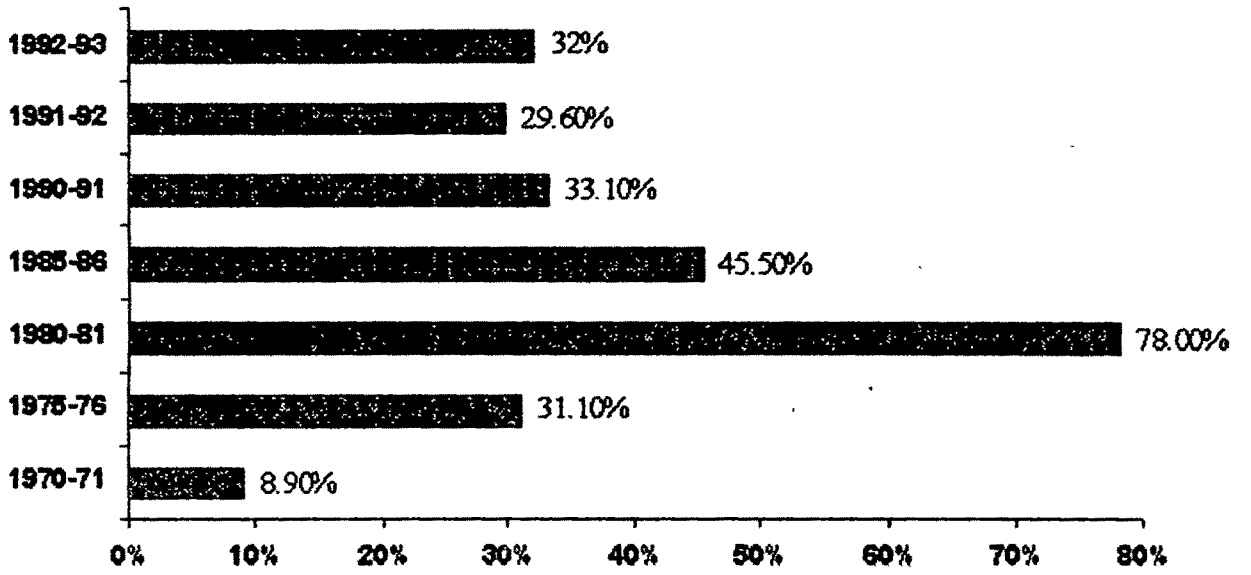


Fig.2.4
Percentage of POL Imports to India's Export



India's import of crude oil refined products consists mainly the middle distillates, but of 6.6 million tones of refined products in 1989-90, imports of diesel and kerosene were at the order of 5.64 Million tones this is due to the fact that the growth of HSD was 7 percent during the sixth plan compared with 5 5 percent growths in consumption of all petroleum products the figure for the seventh plan is 8.6 percent and 6.8 percent respectively. There is no doubt the share of HSD is bound to grow in future without respite.

To overcome the energy crisis, the Government of India has taken concerted effort during the plans. The share of commercial energy sectors in the total plan outlay has increased from 19 percent during the first plan to 30 percent during the current plan. Apart from increasing the plan outlays, the government of India opened up the energy sector for private sector participation but the response to the Government's invitation foreign oil companies to invert in India's oil exploration program has not been very good. Unless the ONGC and oil India improve upon their performance, the eighth plane target of 165.45 million tones could not be achieved and the targeted production of 41 million tones per year toward the end of eighth plan, ever remains an unfulfilled dream.

2. 10 Determining a Certain Economic Growth Rate with Minimum Consumption of energy

"An important concept in energy policy is to achieve a certain economic growth rate with a minimum consumption of energy. Energy policies therefore, should not be designed only for energy conversation but also for economic growth."[19] Thus a policy of saving energy by arresting economic growth is contrary to the economic objectives and policies of India. Growth with stability and equitable distribution of Income. Given this perspective, the problem is to minimize energy consumption while permitting economic growth to recover and continue as it has been in the recent years. This issue forms the main theme of this study.

2. 10. 1 Relationship Between Energy Consumption and Economic Growth

The usual measures of economic growth is gross domestic products (GDP). The intuitive relationship between energy and GDP suggest energy as an input with GDP as a result or output It is important to identify this functional relationship in order to assess the development alternatives. Because the energy elasticity provides a measure of correlation between energy growth and the growth in the Gross domestic Product (GDP). It is defined as how much energy would be required for effecting one percent change in GDP. Lower the coefficients, more efficient is the energy use in the economy or a given sector in the economy. A deeper insight into this functional relation is imperative, only than can effective energy - economic policies are formulated.

This functional relationship can be expressed statistically in three different ways:

$$\ln E = A + B \ln GDP$$

$$\text{Elasticity } X = dE/d\,GDP$$

Where:

E = Energy Consumption

GDP = Gross Domestic Product

B = The Elasticity of Energy with GDP

Table 2.10
Elasticities of Consumption of Commercial Energy with Reference to GDP

Period	coal	oil	Electricity	Total
54 -55 to 60- 61	1.1	2.14	3.02	1.37
60 -61 to 70 - 71	0.53	2.31	3.04	1.16
70-71 to 80 - 81	0.98	1.83	2.06	1.37
80-81 to 90 - 91	0.31	1.12	1.57	0.82

Source Eighth Five Year Plan Documents 1992

From table 2.7 it appears that the long run energy: GDP coefficients have relatively remained stable, even though considered being very high compared to developed countries where the elasticity coefficients are less than one. The Working Group on Energy Policy (WGEP) pointed out that "the long term objective of energy planning in India should be aimed at an elasticity coefficient of one or less than this, as in the case in many developing countries."[20] It can be observed from the table that the coal - GDP elasticity fell from 1.10 during 1951 - 61 to .53 during 1961 - 71, whereas, the oil - GDP elasticity rose from 2.14 to 2.31 during the same period. This may be attributed to low oil prices in real terms during this period encouraging more use of oil in the manufacturing sector. At the same time, the growth of total final energy consumption was much higher then the growth in GDP. The total final commercial energy consumption grew at an annual compound growth of 4.53 from 1954-92, where as the GDP grew 3.80 at an annual compound growth rate.

When we consider the energy - GDP elasticities for different industries, there is a profound shift in the industrial sector during 1970 -71 to 1980 - 81, after the oil embargo, the coal - GDP elasticity rose to 1.25, whereas the oil - GDP elasticity fell to 1.60. There is thus a clear shift toward more use of coal during this period. Even though the over all energy -GDP shows steep decline, this needs to be interpreted with due care. As the GDP growth tends to fluctuate unduly under the influence of monsoons, such elasticity estimates are affected by the fluctuations and the choice of the terminal year. However, significant lowering of in the elasticity of energy with respect to GDP between 1953-54 and 1990-91 could still be viewed as an evidence of changing technology of the economy and the changing pattern of demand for different forms of energy.[24]

2. 10. 2 Energy Intensity

Two considerations merit special analysis because they are central to the above discussion. "It is important to see how far the high ratio of the growth of energy use to the growth of the domestic product was the result of increased energy intensity in individual industries, how far it was the result of a shift in the relative proportions of industries with high energy intensity and those with low energy intensity."[22] The intensity of energy use defined as the ratio of the quantity of total commercial energy used per unit of value-added in the industry sector, has been increasing over time, as will be evidenced in the discussion below.

An examination of fuel-wise energy intensities indicates that the increase in electricity consumption is the main reason for the rise in the intensity of energy consumption although the rate of growth electricity consumption has been steadily decreasing. On the other hand the combined intensity of coal and oil has shown greater stability. The Working Group on Energy Policy (WGEP) analyzed the reason for the stability of oil and coal intensities.

"Except in the case of sugar, the other industries seem to be gradually switching to the use of commercial fuels. Such a shift would increase the intensity of coal and oil use. On the other hand, there is a gradual replacement of the old boilers with low efficiency by more energy efficient equipment and this would decrease the intensity of energy use. These two factors seem to have led to the apparent stability."[24]

2 . 10. 3 Lower Intensity of Energy and Oil:

Indian industries have higher energy intensity compared to their counterparts in developed countries. In India, the average energy consumption for steel production is 9.5 M Kcal/Tones where as in the developed countries the figure is 4 M Kcal/Tones. Likewise in India, the specific energy consumption for cement production is 0.2 M Kcal/Tones against 0.82 M kcal/Tones in the developed countries. Table below shows the over all energy intensities and individual fuels from 1953-54 to 1994-95

Two consideration merits real analysis because they are central to the above discussion. "It is important to see how for the high ratio of the growth of energy use to the growth of gross domestic products was the result of increased energy intensity in individual industries, how far it is the result of a shift in the relative proportions of industries with high energy intensity and those with low energy intensity."[24] Secondly, the relative proportion of industries with high energy intensity and those with low energy intensity, one should first identify energy intensities and oil intensities of the principal manufacturing industries in India.

It is important, in the interest of controlling commercial energy consumption, to examine carefully the rate at which new energy intensive industries develop. In a later chapter this study evaluates "optimal' development rates for all sectors including energy intensive industries. "Optimal" here refers to the minimization energy consumption on the one hand with simultaneous maximization of GDP on the other, this will of course, lower elasticity of energy, while achieving maximum economic growth.

2. 11 Industrial Restructuring

An alternative way of examining the optimization is "industrial restructuring." Industrial restructuring here refers to shifting of industrial structure from energy intensive to less-energy intensive or more energy efficient and more technology intensive operation. This is essentially what Japan has done in response to the energy crisis of 1970s.

> "The Japanese, by all rights, since they have no domestic energy resources, should have been devastated by it instead, because they have to the nimble, they had seen it lowing and had ahead begun to shift their economy, as a matter of national policy, from a predominantly smokestack one to a high technology one, weeding out the energy consuming industries. They went through one brief period of great hardships and now, some ten years after the Arab-Israeli war of 1973, they have cut with on the percentage of energy used while raising quite dramatically their production."[25]

2. 12. Summary

The issues outlined all along belong to the first aggregate level of energy economics and policy and are of major concern in this study. In summary, they are.

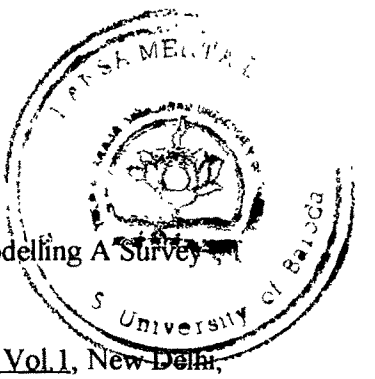
(1) What is the minimum energy supply that should the maintained as to sustain a desirable or maximum level of economic activity?

(2) What is the relationship between energy demand /supply and economic development/growth?

(3) How can the aggregate elasticity of energy and oil can the lowered?

(4) What "industrial restructuring" is required to overcome successfully disruptions in energy supply?

(5) What will be the economic impact on the Indian Economy resulting from a disruption of energy supply? And should the government manage an emergent case of this type?



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